

Passive Vertical Integration and Strategic Delegation

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Abstract

With backward acquisitions in their efficient supplier, downstream firms profitably internalize the effects of their actions on their rivals' sales, while upstream competition is also relaxed. Downstream prices increase with passive yet decrease with controlling acquisition. Passive acquisition is profitable when controlling acquisition is not. Downstream acquirers strategically abstain from vertical control, thus delegating commitment to the supplier, and with it high input prices, allowing them to charge high downstream prices. The effects of passive backward acquisition are reinforced with the acquisition by several downstream firms in the efficient supplier. The results are sustained when suppliers charge two-part tariffs.

JEL classification: L22, L40, L8

Keywords: common agency, double marginalization, minority shareholding, strategic delegation, passive vertical integration, partial ownership

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1 Introduction

Partial acquisitions among horizontally- and vertically-related firms are very common, although their effects have rarely been analyzed.¹ We contribute by demonstrating the incentives of downstream firms to acquire financial interests in their suppliers, as well as the effects of these acquisitions on upstream and downstream prices and the profitability of the firms. The direction of acquisition – backward vs. forward – is irrelevant in the conventional models of full integration. The integrated firm is assumed to own 100 percent of the assets of both original firms and to maximize their joint profit. By contrast, the direction of acquisition matters under partial integration. Moreover, it also matters whether the acquisition is passive or controlling.

Similar to a vertical merger, both passive and controlling forward integration of an upstream supplier in its customers tends to induce *vertical* coordination, by reducing double marginalization and thus downstream prices. Obviously, this is consumer surplus increasing and pro-competitive. By contrast, we show that passive backward integration induces *horizontal* coordination, exacerbates double marginalization and increases downstream prices, which is consumer surplus reducing and anti-competitive. We also show that – in contrast to full backward integration – passive backward integration tends to be profitable for the integrating firms. This provides an answer to one of the questions addressed in this article, namely: Is passive partial backward integration really as innocent as presently believed, with respect to anti-competitive effects such as increasing prices or foreclosure?

To derive this answer, we consider a pair of vertically-related competitive markets. The downstream firms produce differentiated products and the upstream firms a homogeneous one. The upstream firms have different marginal production costs. The downstream firms may acquire financial interests in their suppliers, which may be passive or controlling, with passive interests involving pure cash flow rights; namely, claims only on the target’s profits without controlling its decisions.

Fixing first the distribution of these interests, we look at the firms’ unrestricted pricing decisions in both downstream and upstream markets. We concentrate on the case in which upstream competition is effective in the sense that the efficient supplier’s pricing decision is restricted by the next best competitor’s marginal cost. We subsequently explore the downstream firms’ incentives for backward integration.

We borrow this interesting and – we feel – empirically relevant setup from Chen (2001), with the essential difference that we consider the incentives to uni- or multilaterally acquire passive partial, as opposed to controlling full backward financial interests, as well as the effects of such acquisitions. This difference substantially changes the economics of vertical interaction between the firms. We show that in our model downstream prices *increase* with

¹The frequency of partial acquisitions in related firms is well documented by Allen and Phillips (2000). They show that in the USA, 53 percent of corporate block ownership involves firms in related industries. In the 2014 wave of the Mannheim Enterprise Panel, we found that of all German firms with more than 20 employees reported in that data base with financial interests in one or more firms in the same NACE two- and three-digit industry, 32 and 33 percent respectively held minority stakes. As only “substantive ownership” shares are recorded in that survey, these percentages are a lower bound.

the acquisition of the typical downstream firm's passive interests in the efficient supplier; by contrast, they *decrease* with the acquisition of controlling interests. Furthermore, passive partial backward integration is *profitable* when controlling full backward integration is *not*. It follows that unlike fully controlling vertical integration, passive partial backward integration gives rise to competition policy concerns.

A simple example should convey the intuition for our argument. Let a supplier U produce at zero marginal cost and sell its products to two competing retailers A and B at a unit price of 100, the cost at which each retailer could alternatively procure from a less efficient competitor – or a competitive fringe. Let retailer A acquire a non-controlling financial interest in supplier U that allows it to absorb 25 percent of U 's profit, whereas B remains non-integrated. Accordingly, A absorbs 25 percent of the profit obtained by U from selling goods to B . The margin thus obtained on sales diverted to its competitor B incentivizes A to *raise* its price, just as if it had directly acquired a financial interest in B .

However, with all else given, A is also incentivized to *reduce* its price, as for each unit of input purchased from U at a *nominal* price of 100, A obtains 25 percent back through its financial interest in U . This reduces A 's *effective* unit input price to 75, which, all else given, induces A to optimally charge a lower price to consumers. The reduction in double marginalization would thus need to be weighed against A 's incentive to divert sales to B , whereby on balance passive backward integration could well be pro-competitive.

Now, given that the shares of supplier U acquired by A are non-controlling, U continues to maximize its own profits. Thus far, A 's effective post-acquisition unit input price is only 75, whereas the alternative unit procurement cost remains at 100. Hence, the targeted efficient supplier U can profitably increase the *nominal* unit input price paid by its acquirer A to 133, whereby A 's *effective* unit input price equals $75\% \cdot 133 \approx 100$. Because retailer A then faces the same effective input price as before the acquisition, the only effect due to A 's financial interest in U is A 's incentive to divert sales to its competitor B , by increasing its own retail price. In turn, B optimally reacts to A 's higher price by increasing its price.

In equilibrium, both the owners of U and A as well as the owners of B benefit from this price increase. If supplier U can bind downstream firm B (or conversely, downstream firm B can commit) to exclusively purchase inputs from U (as in Chen (2001)), supplier U can even absorb some of the benefit generated to B from A 's acquisition of the financial interest in U , by increasing the price at which it supplies B to over and above 100.

Both downstream firms are incentivized to acquire backward financial interests in that efficient supplier. As long as they are non-controlling, these interests cumulatively contribute to higher downstream prices. However, once one of these interests becomes controlling, the integrated firm's power to commit to a high internal transfer price would break down – and with this, the power to commit to a profitably high downstream price. As a result, in a sufficiently competitive industry, the typical downstream firm prefers a non-controlling backward to a controlling financial interest in its efficient upstream supplier, which results in higher final prices.

Overall, partial backward acquisitions without the transfer of control rights are effective

in raising consumer prices when full integration is not. Thus, backward acquisition incentives are limited to below the level at which the typical downstream firm takes control over the upstream target’s pricing decisions. By contrast, if it did, the upstream firm would lose its power to commit to high transfer prices, which - as indicated - would prompt downstream prices to decrease. Hence, in the setting analyzed here, *backward acquisitions have an anti-competitive effect if they are passive – and only passive acquisitions are profitable in (sufficiently) competitive industries*. For competition policy, it follows that the effects of passive backward acquisitions tend to be much more problematic than those generated from controlling partial backward acquisitions – and even full vertical mergers.²

Academic economists argue against double marginalization effects of the type discussed here, suggesting that they vanish when the upstream supplier charges two-part tariffs. Nonetheless, we show that our effects hold, especially when supply contracts are non-exclusive. Indeed, we feel that this reinforces our claim that the pricing consequences of passive backward integration should be of concern to competition authorities.

We also generate a number of empirical predictions from the present model. One prediction is that even in competitive situations, passive backward acquisitions generically lead to increasing upstream and downstream prices, and particularly increasing prices paid and charged by the acquirer. The empirical literature relating to these results is sparse as – in particular – upstream prices are usually not visible to researchers.³

However, there is one very interesting exception, with Gans and Wolak (2012) reporting on the effects of passive backward integration of a large Australian electricity retailer into a baseload electricity generation plant. They develop an elaborate theoretical model to motivate their empirical analysis, which accounts for institutional detail in the Australian electricity pool markets and the natural hedge against uncertainty that led to a decrease in explicit contracting. Their model leads to predictions on pricing behavior that are observationally equivalent to ours, albeit derived from a very different theoretical model. Employing alternative methodologies to estimate the pricing effects of that backward acquisition, Gans and Wolak (2012) identify a significant increase in wholesale electricity prices. The outcome of their empirical analysis thus – at least – does not contradict our result, including that passive backward acquisition is profitable by revealed preference.

Another empirical prediction is that the possibility to internalize the downstream pricing externality with backward acquisition creates incentives to acquire shares in suppliers to competitors, albeit only if double marginalization on the own products is not eliminated. This could provide an explanation for the empirical puzzle demonstrated by Atalay et al. (2014) on the basis of U.S. data, namely that the majority of backward acquisitions are not accompanied by physical product flows. Accordingly, the acquisitions cannot directly reduce double marginalization of the own downstream products, but nevertheless they allow internalizing the pricing externalities of other downstream firms.

²Recently, passive partial ownership – in particular in vertically-related firms – has figured somewhat more prominently in the recent “European Commission Staff Working Document towards more effective EU merger control” of 2013, Annex 1.

³This does not preclude a much better visibility of upstream prices to the firms in the industry, however.

The remainder of this article is structured as follows. In the next section, we discuss the related literature, before we introduce the model in Section 3. In Section 4, we solve and characterize the 3rd stage downstream pricing subgame. In Section 5, we solve for and characterize the equilibrium upstream prices arising in the 2nd stage. Moreover, we also derive the essential comparative statics with respect to the typical downstream firms' backward interests. In Section 6, we analyze the profitability of passive backward acquisitions.

In the Discussion and Extension Section 7, we first characterize the subgame pricing equilibrium under controlling backward integration and compare prices and profits with those resulting under passive backward integration. Second, we allow the upstream firms to charge observable two-part – rather than linear – tariffs. The pricing results and the incentives for passive backward integration remain unchanged. Third, we touch upon the case in which upstream competition is ineffective, whereby the efficient firm can exercise complete monopoly power. Fourth, we look at the effects of bans on upstream price discrimination common to many competition policy prescriptions. We conclude with Section 8, where - inter alia - we quantify the potential price effects of passive partial backward integration and relate them to horizontal integration. All proofs are provided in the Appendix.

2 Literature

The price increasing effect of *horizontal* acquisitions is hardly controversial.⁴ However, welfare concerns have concentrated on the effects of control over the target. O'Brien and Salop (1999) and Flath (1991) are exceptions, arguing that passive acquisitions across horizontally-related firms can also be harmful to welfare. Nonetheless, the direct influence on the target's strategy is usually considered critical for policy intervention. For instance, EU merger control only applies when control is acquired, which generally excludes minority shareholdings. Although German competition law allows blocking minority acquisitions, a necessary criterion is the acquisition of "decisive influence". The US has a safe harbor for acquisitions of 10 percent or less of the company's share capital solely for the purpose of investment, whereas this harbor is as high as 20 percent in Israel.

The effect of *vertical* ownership arrangements on pricing and foreclosure is much more controversial. By the classic Chicago challenge (Bork, 1993; Posner, 1976), full vertical mergers are competitively neutral at worst. However, there are several arguments concerning how vertical mergers can yield higher consumer prices or even total foreclosure. Such arguments rely on particular assumptions such as additional commitment power of the integrated firm (Ordover et al., 1990), secret contract offers (Hart and Tirole, 1990) or costs of switching suppliers (Chen, 2001).⁵ Throughout, these authors compare complete separation between the raider and the target firm to full joint ownership and control of the two, whereas they do

⁴See Flath (1991), Brito et al. (2014) or Karle et al. (2011) for a theoretical analysis of the profitability of horizontal partial ownership, and Gilo (2000) for examples and an informal discussion of the antitrust effects.

⁵Other specifics include input choice specifications (Choi and Yi, 2000), two-part tariffs (Sandonis and Fauli-Oller, 2006), exclusive dealing contracts (Chen and Riordan, 2007), only integrated upstream firms (Bourreau et al., 2011) and information leakages (Allain et al., 2010).

not consider partial ownership.

By contrast, Flath (1989) shows that within successive Cournot oligopolies, passive forward integration of an upstream supplier in one of its customers induces vertical coordination and thus reduces double marginalization and downstream prices. With constant elasticity demand and symmetric passive ownership, pure passive backward integration has no effect. Greenlee and Raskovich (2006) confirm this invariance result under downstream competition in quantity as well as price – albeit under the assumptions that downstream demands are linear and that the upstream monopolist is restricted to charge a uniform price to all customers. These invariance results would first suggest that there is no backward integration incentive from an allocation perspective; and second that there is no need for competition policy to address passive vertical ownership. By contrast, we show that the invariance property of downstream prices does not apply within an industry structure involving both upstream and downstream price competition. In such a structure, downstream and upstream prices increase in response to an acquisition of passive backward integration and there are incentives for the involved firms to integrate in this way.

Baumol and Ordover (1994), Spiegel (2013) and Gilo et al. (2015) mainly consider the effects of controlling a bottleneck upstream monopolist via partial - as compared to full - acquisition. By contrast, our emphasis lies on the effects of non-controlling acquisitions into an efficient upstream competitor. Baumol and Ordover as well as Gilo et al. emphasize that with controlling partial acquisitions, incentives are naturally distorted when a firm only internalizes parts of another firm’s profits and losses, although it can fully distort its strategy to increase its own profit.

Spiegel also studies partial passive acquisitions, although his model differs from ours in many respects; in particular, with the demand system employed, he excludes double marginalization effects that are in the focus of our arguments. Furthermore, the downstream competitors are served by an upstream bottleneck monopolist rather than competitors, and – unlike in our model – they may vertically differentiate their supply to an undifferentiated final customer via a probabilistic investment function. Within this very different model with to some extent complementary features, he shows that passive backward integration leads to less foreclosure than controlling integration. In our model, controlling backward integration proves unprofitable; therefore, we cannot directly compare this result to ours. However, we also show that foreclosure does not arise at all with passive backward integration. The notion that the direction of acquisition matters is common to all of these models. Indeed, this feature is also shared by de Fontenay and Gans (2005), who model the bargaining process, which naturally depends on who acquires whom.

Höffler and Kranz (2011a,b) investigate how to restructure former integrated network monopolists. They find that passive ownership of the upstream bottleneck (legal unbundling) may be optimal in terms of downstream prices, upstream investment incentives and prevention of foreclosure. A key difference to our setting is that they keep upstream prices exogenous.

The competition-dampening effect identified in the present article relies on internalizing

rivals' sales through a common efficient supplier, which relates to Bernheim and Whinston (1985)'s common agency argument. Separating control from ownership to relax competition is the general theme in the literature on strategic delegation. Although this term was coined by Fershtman et al. (1991), our result is most closely related to the earlier example provided by Bonanno and Vickers (1988). In their benchmark model, two vertically integrated firms compete in prices that they charge consumers. By delegating the power over consumer prices to an exclusive retailer, each manufacturer can commit to charge the retailer wholesale prices above costs, which induce the retailer as well as its competitor to charge higher consumer prices than obtained under vertical integration.

In their model, the upstream firms use vertical separation to forward delegate the control over retail prices. By contrast, in our model the downstream firms use backward integration into the common supplier to reduce competition in the downstream market. By integrating passively, the downstream firms leave the upstream pricing decision to the upstream firm. Hence, as in our case, the Bonanno-Vickers result is that the downstream firms price less aggressively. But the reasons for doing so are different. Beyond the unusual direction that delegation takes in our case, we add to this literature by showing that the very instrument that firms customarily use to acquire control – the acquisition of financial interests – is used short of implementing control.

3 Model

Two symmetric downstream firms $i, i \in \{A, B\}$, competing in prices p_i , produce and sell imperfect substitutes demanded in quantities $q_i(p_i, p_{-i})$, that satisfy

Assumption 1. $\infty > -\frac{\partial q_i(p_i, p_{-i})}{\partial p_i} > \frac{\partial q_i(p_i, p_{-i})}{\partial p_{-i}} > 0$ (*product substitutability*).

The production of one unit of downstream output requires one unit of a homogenous input produced by two suppliers $j \in \{U, V\}$, who also compete in prices. The marginal cost of supplier U is normalized to 0, and that of V is $c > 0$, meaning that firm U is more efficient than firm V , and c is the difference in marginal costs between U and its less efficient competitor. All other production costs are also normalized to zero. Upstream suppliers are free to price discriminate between the downstream firms. We simplify the exposition by assuming that V is a competitive fringe that offers the inputs at marginal cost c .⁶

Let x_i^j denote the quantities that firm i buys from supplier j , and w_i the linear unit prices charged by supplier U . Finally, let $\delta_i \in [0, \bar{\delta}]$ denote the financial interest that downstream firm i acquires in supplier U , where $\bar{\delta} \in (0, 1)$ denotes the critical level beyond which the acquirer obtains control over the target. Information is assumed to be perfect.

The game has three stages:

1. Downstream firms A and B simultaneously acquire financial interests δ_i in supplier U .

⁶The same results are obtained when assuming that V is a strategic price setter. The restriction to two firms upstream and downstream, as well as symmetry downstream and homogeneity upstream, respectively, are assumptions made to simplify the exposition. One should be able to order the upstream firms by degree of efficiency, however.

2. Supplier U sets sales prices w_i .
3. Downstream firms simultaneously buy input quantities x_i^j from suppliers, produce quantities q_i and sell them at prices p_i .

The sequencing reflects the natural assumption that ownership is less flexible than prices are, as well as being observable by industry insiders. This is crucial as in the following we employ subgame perfection to analyze how ownership affects prices. As upstream profits concentrate on the efficient supplier in our setting, it is also natural to assume that backward acquisitions concentrate on that supplier. It emerges that the assumption that suppliers can commit to upstream prices before downstream prices are set is inessential.

We use the term *partial ownership* for an ownership share strictly between zero and one. We call *passive* an ownership share that does *not* involve control over the target firm's pricing strategy and *controlling* one that does. Controlling the target's instruments is treated as independent of the ownership share in the target. With this, we want to avoid the discussion concerning the level of shareholdings at which control arises, which depends on corporate law, the shareholder agreement and the distribution of ownership share holdings in the target firm. As financial interests could involve non-voting or multiple-voting shares, the critical level $\bar{\delta}$ can be at any point in the open unit interval. Our results thus hold for any partial ownership share, subject to the constraint that $\delta_A + \delta_B \leq 1$. Unless indicated otherwise, we assume that acquisitions are passive.

The efficient supplier U 's profit is given by

$$\pi^U = \sum_{i \in \{A, B\}} w_i x_i^U. \quad (1)$$

Downstream firm i 's profit, including the return from shares held in the upstream firm U ,

$$\Pi_i = \underbrace{p_i q_i(p_i, p_{-i}) - w_i x_i^U - c x_i^V}_{\text{operational profit}} + \underbrace{\delta_i \pi^U}_{\text{upstream profit share}}, \quad (2)$$

is to be maximized subject to the constraint $\sum_j x_i^j \geq q_i$, whereby input purchases are sufficient to satisfy the quantity demanded. For expositional clarity, denote an unintegrated downstream firm i 's profit by π_i .

We term that an allocation involves upstream *effective competition* if the efficient upstream firm U is constrained in its pricing decision by its competitor's marginal cost c , as long as it wants to serve any downstream firm's input demand. Unless indicated otherwise, we consider upstream competition to be effective.

An equilibrium in the third - the downstream pricing - stage is defined by downstream prices p_A^* and p_B^* as functions of the upstream prices w_A, w_B and ownership shares δ_A, δ_B held by the downstream firms in supplier U , subject to the condition that upstream supply satisfies downstream equilibrium quantities demanded. In order to characterize this equilibrium, it is helpful to impose the following standard conditions on the profit functions:

Assumption 2. $\frac{\partial^2 \Pi_i(p_i, p_{-i})}{\partial p_i^2} < 0$ (*concavity*)

Assumption 3. $\frac{\partial^2 \Pi_i(p_i, p_{-i})}{\partial p_i \partial p_{-i}} > 0$ (*strategic complementarity*)

Assumption 4. $\frac{\partial^2 \Pi_i(p_i, p_{-i})}{\partial p_i \partial p_{-i}} / \frac{\partial^2 \Pi_i(p_i, p_{-i})}{\partial p_i \partial p_i} > \frac{\partial^2 \Pi_{-i}(p_{-i}, p_i)}{\partial p_{-i} \partial p_{-i}} / \frac{\partial^2 \Pi_{-i}(p_{-i}, p_i)}{\partial p_{-i} \partial p_i}$ (*stability*)

An equilibrium in the second - the upstream pricing - stage is characterized by prices w_i^* conditional on ownership shares δ_i , $i \in \{A, B\}$.

Towards illustrating details, we sometimes compute closed form solutions for the complete game by using the linear demand specification

$$q_i(p_i, p_{-i}) = \frac{1}{1 + \gamma} \left(1 - \frac{1}{1 - \gamma} p_i + \frac{\gamma}{1 - \gamma} p_{-i} \right), \quad 0 < \gamma < 1, \quad (3)$$

with γ quantifying the degree of substitutability between the downstream products. The two products are independent at $\gamma = 0$ and become perfect substitutes as $\gamma \rightarrow 1$. Note that with this demand specification, the standard Assumptions 1 to 4 are satisfied.

In order to simplify notation and increase transparency, we first analyze the case whereby only downstream firm A acquires a passive financial interest in the efficient supplier U , and generalize afterward.

4 Stage 3: Supplier choice and downstream prices

Let downstream firm A hold a passive share of $\delta_A > 0$ in its efficient supplier U , while B remains without ownership in U . A 's cost of buying a unit of input from U is obtained by differentiating the downstream profit (2) with respect to the input quantity x_A , i.e.

$$\frac{\partial \Pi_A}{\partial x_A} = - \underbrace{w_A}_{\text{input price}} + \underbrace{\delta_A w_A}_{\text{upstream profit increase}}. \quad (4)$$

Thus, the unit input price w_A faced by downstream firm A is reduced by the contribution of that purchase to supplier U 's profits, whereas the unit price w_B faced by firm B remains at w_B . Call $-\frac{\partial \Pi_A}{\partial x_A}$ the *effective input price* with which downstream firm A is confronted when purchasing from firm U . *The reduction in the effective input price enjoyed by downstream firm A is the first effect due to partial backward ownership.* It follows that downstream firm A buys from supplier U as long as $(1 - \delta_A)w_A \leq c$, and firm B will do so as long as $w_B \leq c$. This implies that *the nominal price that the efficient supplier can charge its acquirer can exceed c* , namely the price at which the downstream firm can buy alternatively from the other upstream supplier.

Differentiating the two downstream firms' profits with respect to their downstream price in case both downstream firms source all inputs from the efficient supplier U yields the two first-order conditions

$$\frac{\partial \Pi_A}{\partial p_A} = [p_A - (1 - \delta_A)w_A] \frac{\partial q_A}{\partial p_A} + q_A(p_A, p_B) + \delta_A w_B \frac{\partial q_B}{\partial p_A} = 0 \quad (5)$$

and, as usual,

$$\frac{\partial \pi_B}{\partial p_B} = [p_B - w_B] \frac{\partial q_B}{\partial p_B} + q_B(p_B, p_A) = 0. \quad (6)$$

With $\delta_A > 0$, downstream firm A takes into account that changing its sales price affects the upstream profits from input sales to B through the quantities q_B . *The (partial) internalization of the downstream pricing externality is the second effect due to partial backward ownership.* If instead downstream firm B sourced from supplier V , downstream competitor A would not internalize the effect of its price setting on the demand faced by B as reflected in the last component of (5). B 's marginal profit would be the same as in (6), with w_B replaced by c .

The equilibrium of this stage is characterized by the downstream firms' choices of the supplier as discussed above, as well as the resulting downstream prices, which we denote by

$$(p_i^*(w_i, w_{-i}|\delta_A), p_{-i}^*(w_{-i}, w_i|\delta_A)). \quad (7)$$

By Assumptions 1–4, the equilibrium downstream prices are uniquely defined by the two first-order conditions characterized above.⁷

5 Stage 2: Upstream prices under passive partial ownership

As the more efficient supplier, U can always profitably undercut V 's marginal cost. U thus always ends up profitably supplying both downstream firms, and this at effective prices at most as high as c , because at higher prices the downstream firms prefer to buy from V .⁸ U 's problem is

$$\max_{w_A, w_B} \pi^U = \sum_{i=A, B} w_i q_i(p_i^*(w_i, w_{-i}|\delta_A), p_{-i}^*(w_{-i}, w_i|\delta_A)) \quad (8)$$

subject to the constraints $w_A(1 - \delta_A) \leq c$ and $w_B \leq c$, whereby both downstream firms prefer to source from U . In this article, we focus on effective upstream competition, meaning that U 's pricing decision is constrained by V 's marginal costs. Differentiating (8) with respect to w_i yields

$$\frac{d\pi^U}{dw_i} = q_i(p_i^*, p_{-i}^*) + w_i \frac{dq_i(p_i^*, p_{-i}^*)}{dw_i} + w_{-i} \frac{dq_{-i}(p_{-i}^*, p_i^*)}{dw_i}. \quad (9)$$

⁷Strategic complementarity holds under the assumption of product substitutability if margins are non-negative and $\frac{\partial^2 p_B}{\partial p_A \partial p_B}$ is not too negative (cf. Equation 5). Moreover, observe that if prices are strategic complements at $\delta_A = \delta_B = 0$, then strategic complementarity continues to hold for sufficiently small partial ownership shares.

⁸This also implies that none of the downstream firms has an interest in obtaining passive shares from the unprofitable upstream firm V .

Starting at $w_i = w_{-i} = 0$, it must be profit increasing for U to marginally increase upstream prices, as $q_i > 0$. By continuity and boundedness of the derivatives, this remains true for positive upstream prices that are not overly large. Hence, the constraints are strictly binding for any partial ownership structure for c sufficiently small. Under upstream competition effective in this way, the *nominal upstream equilibrium prices* are given by

$$(w_A^*, w_B^*) = \left(\frac{c}{1 - \delta_A}, c \right), \quad (10)$$

and the *effective upstream prices* both equal c . In this regime, U 's profits are uniquely given by

$$\pi^U = \frac{c}{1 - \delta_A} q_A(p_A^*, p_B^*) + c q_B(p_B^*, p_A^*). \quad (11)$$

It is obvious that a corresponding argument would apply if downstream firm B held a positive share $\delta_B > 0$. We summarize in

Lemma 1. *The efficient upstream firm U supplies both downstream firms at any given passive partial backward ownership shares (δ_A, δ_B) . Under effective upstream competition, U charges nominal prices $w_i^* = c/(1 - \delta_i), i \in \{A, B\}$. If $\delta_i > 0$, then the nominal input price $w_i > c$. The effective input prices always equal c , namely the less efficient supplier V 's marginal cost.*

The result that transfer prices are *higher* for vertically-related firms runs counter to the prominent view that vertically-related downstream firms are charged transfer prices below market prices. The reason is that A effectively retrieves part of its input expenses back through the profit participation in U . This rebate - implied by the ownership structure - is neutralized by the own profit maximizing entity U through a higher price for sales to A .

In our example with the linear demand function introduced in (3), competition is effective as long as $c < \frac{1}{2} \frac{2 - (\gamma + \gamma^2)}{2 - (\gamma + \gamma^2) + \frac{1}{2} \delta_A \gamma (3 - \gamma^2)}$. The higher A 's share δ_A held in U and the higher γ , i.e. the closer the substitutability between the downstream products, the lower that c must be, reflecting the difference between the two upstream firms' marginal costs. Intuitively, with an increase in δ_A , U 's incentive to sell to A rather than B increases, as the nominal price w_A increases relative to $w_B = c$. Hence, with increasing δ_A , U is incentivized to charge A a nominal price below $c/(1 - \delta_A)$, thus violating the first constraint associated with 8. Moreover, shifting demand in this way towards A is the easier the larger γ , i.e. the closer the substitutes offered by the downstream firms. Overall, a sufficiently small c preserves the case of effective competition.

With the upstream prices under effective upstream competition specified in Lemma 1, downstream profits can be condensed to

$$\Pi_i = (p_i - c) q_i + \delta_i \frac{c}{1 - \delta_{-i}} q_{-i}. \quad (12)$$

If firm i holds a financial interest $\delta_i > 0$ in firm U , its profit Π_i increases in the quantity q_{-i} demanded of its rival's product, which makes diverting demand to the rival a relatively more attractive option. Hence, i has an incentive to raise the price for its own product. Formally, firm i 's marginal profit

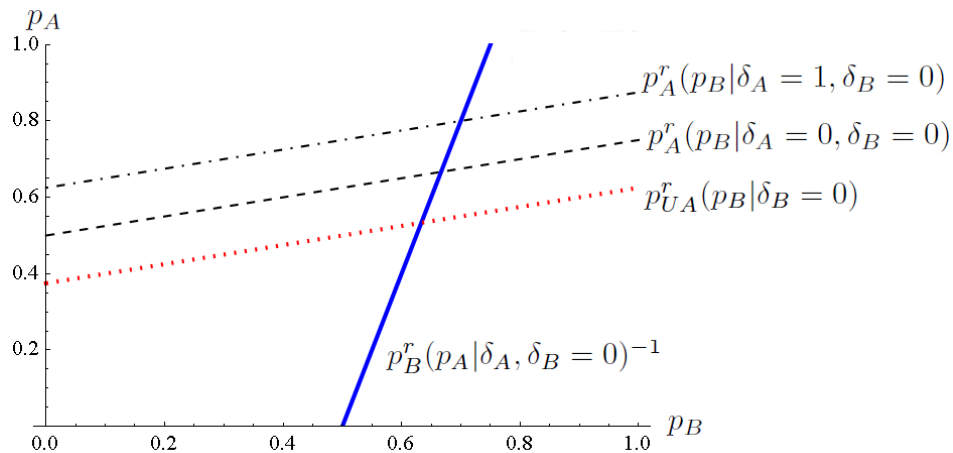


Figure 1: Best-reply functions of downstream firms A , B and the vertically integrated unit UA for linear demand as in (3), with $\gamma = 0.5$ and $c = 0.5$.

$$\frac{\partial \Pi_i}{\partial p_i} = q_i + (p_i - c) \frac{\partial q_i}{\partial p_i} + \delta_i \frac{c}{1 - \delta_{-i}} \frac{\partial q_{-i}}{\partial p_i} \quad (13)$$

increases in δ_i . This increase becomes stronger with an increase in the downstream competitor's financial interest δ_{-i} as this increases U 's margin earned on selling to $-i$, as well as with closer substitutability of the downstream products, as approximated by an increase of $\frac{\partial q_{-i}}{\partial p_i}$.

Overall, this yields the following central result:

Proposition 1. *Let Assumptions 1-4 hold and upstream competition be effective. Then*

(i) *both equilibrium downstream prices p_i^* and p_{-i}^* increase in both δ_i and δ_{-i} for any non-controlling backward ownership structure,*

(ii) *the increase is stronger when the downstream products are closer substitutes.*

The following corollary is immediate:

Corollary 1. *Any increase in passive ownership in U by one or both downstream firms is strictly anti-competitive.*

Proposition 1 is illustrated in Figure 1 for the case $\delta_A > \delta_B = 0$. The solid line is the inverted best-reply function $p_B^r(p_A)^{-1}$ of B at a given $\delta_A > 0$. The dashed line is A 's best reply $p_A^r(p_B)$ for $\delta_A = 0$, and the dashed-dotted line above this is A 's best reply for $\delta_A \rightarrow 1$. Hence, choosing δ_A amounts to choosing the best-reply function $p_A^r(p_B)$ in the subsequent pricing game. This becomes central when analyzing the profitability of acquisitions in the next section.

Thus far, we have assumed that upstream prices are set before downstream prices; nonetheless, the presented results do not depend on this assumption. To show this, suppose for a moment that all prices are set simultaneously. Subsequently, supplier U takes downstream prices as given. Consequently, for U increasing effective prices up to c does not affect quantities, as the downstream firms remain best off purchasing from U . Hence, effective equilibrium upstream prices must equal c , which yields

Lemma 2. *Under effective competition, the sequential and simultaneous setting of up- and downstream prices are outcome equivalent.*

What matters for the result is that the upstream profits from sales to the downstream competitor are affected by the downstream strategy of the integrating firm, and this remains unchanged with simultaneity. Rather than pricing, the relevant strategy could involve advertising to divert sales from the downstream competitor to the own product. By internalizing the competitor's sales, wasteful advertising would be reduced, which could well be profitable for the integrating firms.

The result that downstream price competition is softened by passive backward ownership does not directly translate to quantity competition. With simultaneous quantity competition, the marginal downstream profit is given by $\partial\pi_i/\partial p_i = (p_i - c) q_i + \partial p_i/\partial q_i$, which is independent of δ_i . This is different from the marginal profit with respect to price in (13). The reason is that if quantities are determined simultaneously, the quantity set by one of the downstream firms does not affect supplier U 's profit obtained from sales to its downstream competitor. Nonetheless, the downstream acquirer would internalize its competitor's quantity and reduce its own output if that competitor would set quantities only after the acquirer.

6 Stage 1: Passive backward acquisition

Here we assess the profitability of downstream firms' backward acquisitions of passive stakes in supplier U .⁹ Rather than specifying how bargaining for financial interests in U takes place, we show the central incentive condition for backward acquisitions to hold: starting from a situation in which all firms are owned by distinct owners, there are gains for the owners of U and each of the downstream firms from transferring claims to profits in U to the respective downstream firm.

As before, fix the stakes held by firm B at $\delta_B = 0$. Gains from trading stakes between A and U arise if the sum of A 's and U 's profits,

$$\Pi_A^U(\delta_A|\delta_B = 0) \equiv p_A^* q_A^*(p_A^*, p_B^*) + c q_B^*(p_B^*, p_A^*), \quad (14)$$

is higher at some $\delta_A \in (0, 1)$ than at $\delta_A = 0$, where p_A^* , p_B^* , q_A^* and q_B^* all are functions of δ_A . The drastic simplification of this expression results from the fact that a positive δ_A simply redistributes profits between A and U . Gains from trading U 's shares between A and U can thus only arise via indirect effects on prices and quantities induced by increases in δ_A . Why should there be such gains from trade at all?

The vertical effects of an increase in δ_A between A and U are exactly compensating, as by Lemma 1 the effective transfer price remains at c . Nonetheless, A 's marginal profit increases in δ_A , because with this A internalizes an increasing share of U 's sales to B . Again, this leads

⁹Even if supplier V could set prices strategically, there would still be no incentive to acquire passive ownership of V , as U can always profitably undercut V 's offers.

A to increase p_A , which in turn induces B to increase p_B . Whereas these moves are profitable to both downstream firms, they are not to the upstream firm U , as the quantity sold to the two downstream firms is reduced. However, it emerges that the profit increase for A due to softened downstream competition is larger than the profit decrease due to the reduction in input volumes sold by U , provided that competition in the industry is sufficiently intense. Indeed, evaluating $d\Pi_A^U/d\delta_A$ yields

Proposition 2. *An increasing partial passive ownership stake of firm i in firm U increases the combined profits of i and U , if upstream competition is sufficiently intense.*

The independent downstream firm B benefits from A 's acquisition of passive financial interest in U : the marginal profit of A increases, whereby A charges higher prices to the benefit of its competitor B .¹⁰ As B 's profit increases, industry profits also increase. Indeed, industry profits also increase if both downstream firms buy shares in the efficient supplier, under the obvious restriction that control is *not* transferred from U to any one of the downstream firms.

Corollary 2. *Increasing partial passive ownership stakes of firms i and $-i$ in firm U increase the industry profit $\Pi_{AB}^U \equiv p_A^*q_A^* + p_B^*q_B^*$ if upstream competition is sufficiently intense.*

Towards further specifying the notion of *sufficient intensity of upstream competition*, let us return to our linear demand example. Let $\delta_B = 0$. Then the sum of the profits of firms A and U , Π_A^U , is maximized at a positive passive ownership share δ_A if $c < \gamma^2/4$. For close to perfect downstream competition, i.e. γ close to 1, this implies that passive backward ownership is profitable for a range of marginal costs up to 1/2 of the industry's downstream monopoly price. Specifically, the ownership share maximizing Π_A^U is

$$\delta_A^* = \min \left(\frac{4c\gamma(1 + \gamma) + \gamma^2(2 - \gamma - \gamma^2) - 8c}{4c\gamma(2 - \gamma^2)}, \bar{\delta} \right).$$

As A 's backward interests confer a positive externality on B 's profits, the industry profits Π_{AB}^U are maximized at strictly positive passive ownership shares by *both* firms if the less restrictive condition $c < \gamma/2$ holds. The fact that $\gamma^2/4 < \gamma/2$ indicates the mutual internalization of the positive externality on the downstream competitor when both downstream firms acquire interests in the efficient upstream firm. Under this condition, the industry profit is maximized at

$$\delta_A^* = \delta_B^* = \min \left(\frac{\gamma - 2c}{\gamma - 2c + 2c\gamma}, \bar{\delta} \right). \quad (15)$$

Indeed, the ownership allocation in (15) would be the outcome of Coasian bargaining among the owners of U with the downstream firms A and B , in which all externalities among the parties are internalized.

¹⁰Our assessment of the profitability of backward ownership for the owners of U and A is conservative as we did not consider the possibility that U extracts the benefit to B from A 's backward acquisition. However, with B 's commitment to exclusive supply by U whereby the pricing externality is internalized, U could charge B a unit price higher than c . In case of a two-part tariff, it could also extract B 's additional profit by charging an upfront fee (see Section 7 for details).

7 Extensions and Discussion

Controlling backward integration and comparison

Here we characterize downstream and upstream equilibrium prices and profits when firm A is fully integrated backward into the efficient supplier U and also controls U 's pricing decisions. We compare the resulting equilibrium allocation with that under vertical separation, as well as under passive partial backward integration. We also relate to the key claims in Chen (2001). For this purpose, observe that his assumptions on costs and the downstream demand structure correspond to ours. However, in contrast to Chen, we do not model the bidding process between the two downstream firms about full ownership and control in the efficient upstream firm. In fact, competition about controlling ownership does not arise at all in our model. We will show that under controlling vertical integration, the vertically integrated firm's profits decrease. Accordingly, the downstream acquirers have no incentive to acquire a controlling majority. Instead, combined with the result just derived, the downstream firms have an incentive to acquire financial interests in the efficient upstream firm U short of obtaining control over U 's allocation decisions.

Returning to our model, consider full controlling vertical integration of A and U and let B be vertically separated, whereby $\delta_A = 1$ and $\delta_B = 0$. Under effective upstream competition, it is again optimal for U to charge firm B the input price c . Nonetheless, by virtue of being merged with U , A takes account of U 's true input cost, which is (normalized to) zero.¹¹

Consider first the effect of full integration of A and U – as compared to vertical separation – on downstream prices. Still faced with marginal input cost c , B 's best response remains unchanged. As with partial integration, full integration has two effects on A : A reacts to the new input price, which is now zero; and A is able to fully internalize the downstream pricing externality. Unlike under non-controlling partial integration where after U 's reaction the effective input price remained at c , the first effect now involves downward price pressure. As with passive partial integration, the second effect involves upward price pressure. When the own price dominates the cross price effect in absolute size, the first effect is generically stronger than the second, yielding

Proposition 3. *Under Assumption 1 and effective upstream competition, a merger between a downstream firm and U reduces both downstream prices, as compared to complete separation.*

Returning to Figure 1, note that for any $\delta_A > 0$, the best response of the merged entity, $p_{UA}^r(p_B)$ – represented by the dotted line in Figure 1 – is located below the one arising under separation.¹² We summarize our comparison of downstream equilibrium prices under the two acquisition regimes in

Corollary 3. *Consider Assumptions 1 to 4 and effective upstream competition. Compared to vertical separation:*

¹¹In line with the literature – examples include Bonanno and Vickers (1988), Hart and Tirole (1990), and Chen (2001) – the integrated firm is considered unable to commit to an internal transfer price higher than its true marginal input cost.

¹²A variant of Proposition 3 is also contained in Chen (2001). See his Lemma 7.

(i) a merger between a downstream firm and the efficient upstream supplier U reduces all downstream prices; and

(ii) any passive partial backward acquisition of one or both downstream firms in the efficient supplier U increases all downstream prices.

We now compare the combined profits of A and U under vertical separation and full integration. By Proposition 3, vertical integration reduces both downstream prices. This is associated with a decrease in the independent downstream firm B 's profit, which still has the same input costs but has to compete against a more aggressive integrated firm. Could a move from vertical separation to full integration nevertheless be profitable for the integrating firms? The answer is no for sufficiently small cost differences c between the efficient and the next efficient supplier. By continuity, there exists an interval $(0, \bar{c}]$ such that for any c in this interval, vertical integration is less profitable than vertical separation. This is summarized in

Proposition 4. *Consider Assumptions 1 to 4. Compared to vertical separation, a merger between A and U leads to:*

(i) lower profits than the combined profits of A and U ; and

(ii) lower profits to the outsider firm B ,

when upstream competition is sufficiently intense.

This result seems to contradict Chen (2001)'s central result, by which a vertical merger of A and U obtains *if and only if* $c > 0$. Unlike us, he constructs an equilibrium from the downstream firms' simultaneous bids to acquire the efficient upstream supplier.

Chen shows that $\Pi_A^U - \pi^U > \pi_B^U$, implying that the profits to A from integration exceed π_B^U , the non-integrated firm B 's profits when A is integrated. Hence, there is a rationale for the owners of U to integrate with a downstream firm as the downstream firm's owners will pay a premium for not being the only one left unintegrated. It follows that vertical integration is an equilibrium in Chen's extensive form game. By contrast, we show that $\pi^U + \pi_A > \Pi_A^U$, implying that the sum of the efficient supplier U 's and downstream firm A 's payoffs under separation are higher than the profits under integration, whereby vertical separation must be an equilibrium – provided that we neither allow for passive backward integration, nor for the possibility considered below, that allows the integrated firm to absorb portions of the benefit to B when procuring from that firm.

Chen considers situations where a downstream firm needs to make certain arrangements in order to purchase from an upstream firm and it is costly to switch suppliers, whereas for the results of the present article it is sufficient to assume that downstream firms purchase the input in a spot market. Thus, in Chen, the non-integrated downstream firm B can essentially commit to buy from a more expensive supplier – here, the integrated firm – at a marginal price above the alternative sourcing cost of c before A and B set their downstream prices. B is only willing to pay a price above c if A is vertically integrated with U , as only then does A internalize B 's sales and sets higher sales prices to the benefit of B . In this case, U charges B a higher input price under integration, which results in higher downstream prices

and thus makes full vertical integration bad for consumers. Chen interprets the higher input price for B as raising a rival's cost, or partial foreclosure. At any rate, incorporating this possibility into our model would only strengthen our results, namely increased prices from – and incentives for – passive partial backward integration. See Footnote 10 for an informal discussion. Finally observe that the absorption of B 's additional profit via an increased transfer price enhances double marginalization. Combining Propositions 2 and 4 yields

Corollary 4. *Passive partial backward integration of firm i into firm U is more profitable than vertical integration if upstream competition is sufficiently intense. It follows that downstream firms have the incentive to acquire maximal backward interests, short of controlling the upstream firm U .*

As indicated before, this result adds to the literature on strategic delegation. The particular twist here is twofold: first, delegation is oriented upwards rather than – as usual – downwards; and second, the very instrument intended to acquire control – namely the acquisition of equity in the target firm – is employed short of controlling the target. This benefits the industry but harms consumer welfare.

Two-part tariffs

The assumption of linear upstream prices is clearly restrictive if only theoretically, as argued already by Tirole (1988). Here, we show that under the conditions specified above, our results are upheld when the upstream firms are allowed to charge two-part tariffs. The reason is that even with two-part tariffs, upstream competition forces supplier U to charge marginal upstream prices below the level that induces industry maximizing downstream prices. The acquisition of passive backward financial interests in U is profitable, as it increases downstream prices for given (effective) upstream prices.

In a framework with effective upstream competition and vertical separation, Caprice (2006) as well as Sandonis and Fauli-Oller (2006) also show that observable two-part tariffs offered by the efficient supplier U implement marginal downstream prices below the industry profit maximizers. Their reasoning is as follows: U has to leave a buyer the value of its outside option, namely sourcing from V when the downstream competitor still sources at cost w from U . The profit when sourcing from V at cost c is lower when the competitor's input cost w is lower. Consequently, U has an incentive to charge a lower w to reduce the values of the outside options and thus the profits that he has to leave to the buyers. This induces U to lower the marginal prices below the industry profit maximizing level to obtain more rents through the fixed fees.

Moreover, if U cannot offer exclusive contracts, a downstream firm will source inputs alternatively once the marginal input price charged by U exceeds the alternative input price. In our setting, this implies that U cannot implement a marginal price above c to that firm without backward interests by a downstream firm. In our model, we show that U would indeed like to offer marginal prices above c . Thus, marginal input prices in equilibrium equal c and the fixed fee F equals zero, i.e. the transfer prices U charges are endogenously linear.

We now formally characterize the two-part contracting problem and show that passive backward ownership increases downstream prices under the conditions used thus far. At the outset, recall that partial ownership of A in U internalizes the downstream pricing externality as long as B also sources from U . In comparison to full separation, it is less attractive for B to deviate to sourcing from V . This generically relaxes U 's contracting problem.

We start from complete vertical separation, whereby $\delta_A = \delta_B = 0$ and maintain the assumption that all contract offers are observable to all downstream firms upon acceptance; in particular, that acceptance decisions are observed when downstream prices are set. We allow V to set prices strategically because it is not as obvious as with linear tariffs that linear prices at marginal production costs are the equilibrium result when two-part tariffs are possible.

A tariff offered by supplier j to downstream firm i is summarized by $\{F_i^j, w_i^j\}$, where F_i^j is the fixed fee downstream that firm i has to pay the upstream firm j upon acceptance of the contract, and w_i^j continues to be the marginal input price. Denote by $\pi_i^*(w_i^j, w_{-i}^k)$, $j, k \in \{U, V\}$, firm i 's reduced form downstream profits at downstream equilibrium prices as a function of the marginal input price relevant for each downstream firm, albeit gross of fixed payments. As before, U can always profitably undercut any (undominated) offer by V , whereby in equilibrium U exclusively supplies both downstream firms. As usual, we require that V 's offers – if accepted – yield it non-negative profits.

For given contract offers of V to both downstream firms, U 's problem is

$$\begin{aligned} \max_{F_A^U, F_B^U, w_A^U, w_B^U} \pi^U &= \sum_{i \in \{A, B\}} [w_i^U q_i + F_i^U] \\ \text{s.t.} \quad \pi_i^*(w_i^U, w_{-i}^U) - F_i^U &\geq \pi_i^*(w_i^V, w_{-i}^V). \end{aligned} \quad (16)$$

U has to ensure that each downstream firm's deviation to source from V is not profitable, given that the other downstream firm also sources from U . In equilibrium, the profit constraint of each downstream firm must be binding, as otherwise U could profitably raise the respective fixed fee to that downstream firm until it is indifferent between its and V 's contract offer.

Let the contracts offered by upstream firms be non-exclusive, whereby an upstream firm cannot contractually require a downstream firm to exclusively procure from it. Then, setting a marginal input price $w_i^U > c$ with $F_i^U < 0$ cannot be an equilibrium, as V could profitably offer $\{F_i^V = 0, w_i^V \in [c, w_i^U]\}$, which would provide incentives to downstream firm i to accept U 's contract offer, implying a transfer of $F_i^U > 0$ from U to i , but to source its entire input at the marginal cost w_i^V offered by V .

The equilibrium contract offers made by V must be best replies to U 's equilibrium contract offers. Hence

Lemma 3. *If U offers two-part tariffs with $w_i^U \leq c$, $i \in \{A, B\}$, then $\{0, c\}$ is V 's unique non-exclusive counteroffer that maximizes the downstream firms' profits and yields V a non-negative profit.*

Using this insight and letting $w_i \equiv w_i^U$ and $F_i \equiv F_i^U$ to simplify notation, U 's problem reduces to

$$\max_{w_A, w_B} \pi^U = \underbrace{\sum_{i \in \{A, B\}} p_i^*(w_i, w_{-i}) q_i^*}_{\text{industry profit}} - \underbrace{\sum_{i \in \{A, B\}} \pi_i^*(c, w_{-i})}_{\text{outside options}} \quad (17)$$

subject to the no-arbitrage constraints $w_i \leq c$, $i \in \{A, B\}$.

For $c = \infty$, the outside options equal 0 and U simply maximizes the industry profit by choosing appropriate marginal input prices. As c decreases, sourcing from V eventually yields positive profits for downstream firms. Moreover, firm i 's outside option – namely the profit $\pi_i^*(c, w_{-i})$ that it would obtain when sourcing from V – increases in the rival's cost w_{-i} . Hence, the marginal profit $\partial \pi^U / \partial w_i$ is below the marginal industry profit. Nevertheless, for c sufficiently small, the marginal industry profit is still positive when the arbitrage constraints are binding, i.e. at $w_A = w_B = c$. Hence, the motive of devaluing the contract partners' outside options is dominated by the incentive to increase double marginalization, yielding the result that *upstream tariffs are endogenously linear*. We summarize in

Proposition 5. *Let upstream competition be sufficiently intense. Then under vertical separation, $\{c, 0\}$ is the unique symmetric equilibrium non-exclusive two-part tariff offered by both upstream to both downstream firms.*

As before, *sufficient intensity* of upstream competition is to be seen relative to the intensity of downstream competition. In our linear demand example, it suffices to have $c < \gamma^2/4$. In passing, this is also the condition ensuring the profitability of an initial increase of passive backward ownership δ_i to i and U .

Thus far, we have discussed the case $\delta_A = \delta_B = 0$. What changes if we now allow for passive partial backward integration? As the tariff $\{0, c\}$ is a corner solution, (at least some) passive backward integration does not change the efficient upstream firm's incentive to charge maximal marginal prices.

Moreover, recall that passive backward ownership of i in U exerts a positive externality on $-i$ as i prices more softly – albeit only if both downstream firms source from U . With two-part tariffs, U can extract the upward jump in $-i$'s payoffs generated from moving procurement from V to U by charging a positive fixed fee.¹³ Maintaining the assumption that contracts are non-exclusive, we obtain

Lemma 4. *Let upstream competition be sufficiently intense and $\delta_i > \delta_{-i} = 0$. The non-exclusive two-part tariff offered by U to i is $w_i = c/(1 - \delta_i)$ and $F_i = 0$, and the tariff to $-i$ is $w_{-i} = c$ and $F_{-i} > 0$.*

Thus, when firm i has acquired a positive share, the effective input price that U charges remains at c , as under linear tariffs. With non-exclusivity, a higher marginal input price is

¹³ U could also charge B a marginal price above c , albeit only if commitment to exclusive dealing of B with U is possible. To remain consistent with our baseline model, we rule this out here.

not feasible, as firm i would buy the inputs from V , which continues to charge $\{0, c\}$. Hence, Proposition 2 still applies and we obtain

Corollary 5. *Let upstream competition be sufficiently intense. Then partial passive ownership of downstream firm i in supplier U increases bilateral profits Π_i^U as well as industry profits Π_{AB}^U compared to complete separation, if non-exclusive two-part tariffs are allowed for.*

Hence, the results derived in the main part of the article for linear tariffs are upheld with non-exclusive observable two-part tariffs if competition is sufficiently intense. When upstream competition is less intense, it is optimal for U to charge effective marginal prices below c to reduce the downstream firms' outside options. Thus, the no-arbitrage constraint $w_i \leq c/(1 - \delta_i)$ is no longer binding, which is also the case when U offers exclusive two-part tariffs. Nonetheless, passive backward integration still relaxes downstream competition for given effective input prices. Moreover, U can still extract the positive externality of backward ownership on downstream competitors by raising either the fixed fee or the marginal price. Assuming that demand is linear and V offers $\{0, c\}$, one can show that passive backward ownership is indeed both profitable and increases downstream prices for large parameter ranges of c and γ with effective marginal input prices above or below c .¹⁴

Ineffective upstream competition

Thus far, we have analyzed the effects of passive partial backward integration when there is effective upstream competition as generated by a difference c in marginal costs between the efficient firm U and the less efficient firm V sufficiently small that U was constrained in its pricing decision. We now sketch the case in which this cost difference c is so large that U behaves as an unconstrained upstream monopolist.

Consider first complete vertical separation. With linear upstream prices, double marginalization implies that in equilibrium downstream prices are above the industry profit maximizing level and only approach that level from above as downstream competition tends to become perfect. Thus, under imperfect downstream competition, the industry's profits can be increased by reducing downstream prices; for example, with maximum resale price maintenance, passive forward integration or observable two-part tariffs.

With two-part tariffs, U can maximize industry profits by setting the marginal price whereby the resulting downstream prices are at the optimal level and extracting all downstream profits through fixed fees. In this situation, the owners of U have no interest in backward ownership, because the profits that they can extract are already maximized.

With linear tariffs, the case is less straightforward. For given marginal input prices w_A and w_B set by the monopolist, an increase in the passive backward ownership share δ_A in the supplier reduces A 's effective input price as under effective upstream competition, whereby A has an incentive to lower its sales price. Nonetheless, a positive δ_A also induces A to internalize its rivals' sales, whereby A wants to increase its sales price. The first effect tends

¹⁴The analysis is more complicated if V can also offer exclusive contracts. We simplify here to increase expositional clarity.

to dominate, meaning that downstream prices tend to decrease in δ_A for given (nominal) input prices. As U is unconstrained in its price setting, it can adjust w_A and w_B in response to any ownership change until its marginal profits are zero again. Hence, both effects of an increase in δ_A on downstream prices are internalized by the unconstrained upstream monopolist. This gives rise to invariant downstream prices in case of symmetric backward ownership, at least with linear demand.¹⁵

By contrast, with effective upstream competition as in our model, only the first, marginal cost decreasing effect of an increase in δ_A is counterbalanced by the efficient upstream firm U , and that perfectly. Hence, the overall effect equals the second effect of internalizing the rivals' sales and thus both downstream prices increase in δ_A .

Non-discriminatory upstream prices

Some jurisdictions require firms to charge non-discriminatory prices. For instance, in the U.S., the Robinson-Patman Act makes non-discrimination a widely applied rule, whereas in the EU, Article 102 of the Treaty on the Functioning of the European Union restricts the application of the rule to dominant firms.

Under effective competition, symmetric passive ownership with $\delta_A = \delta_B > 0$ may arise as an equilibrium. Supplier U then has no incentive to price discriminate. Nonetheless, as we have shown in Proposition 1, symmetric passive ownership is clearly anti-competitive, meaning that a non-discrimination rule has no effect at all in this case, and in particular no pro-competitive effect.

This is different with asymmetric passive backward ownership. Consider that only downstream firm A holds a passive financial interest in supplier U . Under a non-discrimination rule, U must charge a uniform price c if it wants to serve both downstream firms. In this case, firm A obtains profit

$$\Pi_A = (p_A - c) \cdot q_A + \delta_A c \cdot (q_A + q_B).$$

Differentiating with respect to p_A and δ_A yields

$$\frac{\partial^2 \Pi_A}{\partial p_A \partial \delta_A} = c \cdot \left[\frac{\partial q_A(p_A, p_B)}{\partial p_A} + \frac{\partial q_B(p_B, p_A)}{\partial p_A} \right]. \quad (18)$$

By Assumption 1, the own price effect dominates the cross price effect and thus the cross derivative in (18) is negative – in particular at $\delta_A = 0$. Thus, marginally increasing δ_A reduces the marginal profit of A . Hence, the best reply $p_A^r(p_B|\delta_A)$ and consequently both equilibrium downstream prices decrease in δ_A at $\delta_A = 0$. By continuity, this holds for small positive δ_A . However, with the decrease in downstream prices, downstream firms have no

¹⁵For linear downstream demands and linear non-discriminatory upstream tariffs, Greenlee and Raskovich (2006) show that upstream and downstream price adjustments exactly compensate when passive backward ownership in the monopoly supplier is symmetric, whereby downstream prices remain the same independently of the magnitude of partial ownership and the intensity of downstream competition.

incentive to acquire passive financial interests in upstream firms and thus the anti-competitive effect of passive backward ownership does not arise.

This result generalizes to all feasible δ_A as long as $\frac{\partial q_B}{\partial p_A} \leq \frac{\partial q_A}{\partial p_B}$ for $p_A < p_B$, which is the case under linear demand. Hence, if a downstream firm nevertheless held a passive ownership stake in U and U served both downstream firms, then such ownership would not be anti-competitive under a non-discrimination rule.

8 Conclusion

In this article, we consider vertically-related markets with differentiated, price setting downstream firms that produce with inputs from upstream firms supplying a homogeneous product at differing marginal costs. We analyze the impact on equilibrium prices of one or more downstream firms holding passive – namely non-controlling – financial interests in the efficient and thus common supplier. In sharp contrast to earlier studies, which focused on either Cournot competition or upstream monopoly, we find that if competition is sufficiently intense, *passive backward ownership leads to increased downstream prices and thus is strictly anti-competitive*. Most importantly, *passive ownership is anti-competitive when a full vertical merger would be pro-competitive*. In passing, passive backward ownership also relaxes upstream competition.

We also show that, starting from vertical separation, incentives for passive backward acquisitions exist when full controlling integration is not profitable. Thus, the firms strictly prefer passive backward acquisition. They voluntarily abstain from controlling the upstream firm because this would remove double marginalization and thus the commitment to high prices. The additional feature brought with this to the strategic delegation literature is first, that delegation is backward, and second, that *the very instrument* – here, share acquisition – *typically employed to obtain control is used up to the point where control is not attained*.

Our result is driven by a realistic assumption on the upstream market structure, in which an efficient supplier faces less efficient competitors. The efficient supplier can soften upstream competition by serving the acquirer at a price higher than the next competitor, because that acquirer can absorb the price increase by its claim on upstream cash flows. We show that the result is robust to changes in other assumptions such as linear upstream prices or sequential price setting upstream and then downstream. Indeed, once allowing upstream firms to offer observable two-part tariffs, we find that the *equilibrium contracts are endogenously linear with passive backward ownership* if competition is sufficiently intense and the upstream offers are non-exclusive. Similar results can also be obtained with exclusive offers. Interestingly enough, under effective upstream competition, whereas being anti-competitive when price discrimination is allowed for, passive ownership in suppliers tends *not* to be anti-competitive when discrimination is not possible.

The theory generates several empirically testable hypotheses. A strong test is already provided in the contribution by Gans and Wolak (2012). For competition policy, it is important to recognize that in contrast to full vertical integration, passive ownership in suppliers shared with competitors is anti-competitive when there is both up- and downstream compe-

Passive ownership shares	Price increase of firm A	Price increase of firm B
$\delta_A = 10\%, \delta_B = 0$	5.2%	2.5%
$\delta_A = 20\%, \delta_B = 0$	10.3%	4.9%
$\delta_A = 20\%, \delta_B = 20\%$	19%	19%

Table 1: Downstream price increases compared to full separation at $c = 0.2$, $\gamma = 0.95$.

tion and thus foreclosure is potentially *not* the main concern. Most importantly, proposing passive backward ownership in a supplier as a remedy to a proposed vertical merger tends *not* to benefit but rather harm price competition in such industry structures. The reason is that full vertical integration removes double marginalization via joint control, whilst partial backward integration enhances it, as well as relaxing price competition among downstream competitors, similarly to a horizontal concentration.

The price increases due to passive backward acquisitions can be very significant for competition policy. Towards quantifying this claim, we return to our linear demand example and use a seemingly innocuous case involving a high degree of downstream competition. As can be seen in Table 1, price increases above 5 percent can arise in our linear specification if only one firm acquires a 10 percent share of the supplier, and above 10 percent when it acquires a 20 percent share. The prices increase by almost 20 percent if both downstream firms acquire a 20 percent share. Our simulation results also confirm that the downstream price effects of passive backward integration are higher when the downstream substitutability or the efficient upstream firm's margin is higher, with upstream competition still effective. Intuitively, when the downstream acquirer raises its price, more sales are diverted to its upstream rival. Accordingly the acquirer earns a higher margin on these sales, so that the price increase becomes particularly profitable.

One could also ask how downstream price increases induced by passive backward integration compare to those induced by passive horizontal integration. Towards this comparison, let us compare the profits of the downstream acquirer A under the two forms of integration with the same block share $\delta_A > 0$, and let $\delta_B = 0$. Under the same passive backward integration used thus far, the profit is

$$\Pi_A = (p_A - c) q_A + \delta_A c q_B, \quad (19)$$

whence under horizontal integration, it is

$$\Pi_A = (p_A - c) q_A + \delta_A (p_B - c) q_B. \quad (20)$$

By a first-order argument, A internalizes the sales of B more under backward integration if $c > p_B - c$, i.e. if the upstream margin of product B is larger than its downstream margin. With linear demand and effective upstream competition, passive backward integration yields a higher price level than passive horizontal integration if $c > g(\gamma)$, where g is a decreasing

function.¹⁶ Hence, for a given upstream margin c , passive backward integration is more anti-competitive if downstream products are sufficiently close substitutes ($g \rightarrow 0$ as $\gamma \rightarrow 1$).

There can be other effects of passive vertical ownership than those addressed in this article; indeed, they may well be welfare increasing. A motive for backward integration without control can be that transferring residual profit rights can mitigate agency problems; for example, when firm-specific investment or financing decisions are taken under incomplete information (Riordan, 1991; Dasgupta and Tao, 2000). Indeed, Allen and Phillips (2000) show for a sample of US companies that vertical partial ownership is positively correlated with a high R&D intensity. Güth et al. (2007) analyze a model of vertical cross share holding to reduce informational asymmetries, providing experimental evidence. Such pro-competitive effects of passive vertical ownership should be taken into account for competition policy considerations, although they need to be weighed against the anti-competitive effects of passive backward integration presented here.

¹⁶In fact, $g(\gamma) = \frac{2-\gamma-\gamma^2}{6-\gamma-\gamma^2(2+\delta_A)}$.

Appendix

Proof of Proposition 1. Suppose for the moment that only downstream firm i holds shares in U , i.e. $\delta_i > \delta_{-i} = 0$. The first order condition $\frac{\partial \pi_{-i}}{\partial p_{-i}} = 0$ implied when setting (13) equal to zero and, hence, the best-reply $p_{-i}^r(p_i)$ of $-i$ is independent of δ_i . By contrast, the marginal profit $\frac{\partial \Pi_i}{\partial p_i}$ increases in i 's ownership share δ_i for $\delta_{-i} \in [0, 1)$. This implies a higher best reply $p_i^r(p_{-i}|\delta_i)$ for any given p_{-i} . By continuity, $\frac{\partial p_i^r(p_{-i}|\delta_i)}{\partial \delta_i} > 0$. Strategic complementarity of downstream prices implies that an increase in δ_i increases both equilibrium prices. This argument straightforwardly extends to the case where both firms hold shares in U , because then $\frac{\partial^2 \Pi_i}{\partial p_i \partial \delta_{-i}} > 0$. \square

Proof of Proposition 2. Differentiating the combined profits of A , say, and U with respect to δ_A and using that $\delta_B = 0$ yields

$$\frac{d\Pi_A^U}{d\delta_A} = \left(p_A^* \frac{\partial q_A}{\partial p_A} + q_A + c \frac{\partial q_B}{\partial p_A} \right) \frac{dp_A^*}{d\delta_A} + \left(p_A^* \frac{\partial q_A}{\partial p_B} + c \frac{\partial q_B}{\partial p_B} \right) \frac{dp_B^*}{d\delta_A}. \quad (21)$$

Clearly, at $c = 0$, the derivative is equal to zero as $dp_i^*/d\delta_A = 0$ when the upstream margin is zero. To assess the derivative for small but positive c , further differentiate with respect to c to obtain

$$\begin{aligned} \frac{d^2 \Pi_A^U}{d\delta_A dc} &= \frac{d}{dc} \left(p_A^* \frac{\partial q_A}{\partial p_A} + q_A + c \frac{\partial q_B}{\partial p_A} \right) \frac{dp_A^*}{d\delta_A} + \frac{d}{dc} \left(p_A^* \frac{\partial q_A}{\partial p_B} + c \frac{\partial q_B}{\partial p_B} \right) \frac{dp_B^*}{d\delta_A} \\ &+ \left(p_A^* \frac{\partial q_A}{\partial p_A} + q_A + c \frac{\partial q_B}{\partial p_A} \right) \frac{d^2 p_A^*}{d\delta_A dc} + \left(p_A^* \frac{\partial q_A}{\partial p_B} + c \frac{\partial q_B}{\partial p_B} \right) \frac{d^2 p_B^*}{d\delta_A dc}. \end{aligned}$$

Evaluating this derivative at $c = 0$ yields

$$\left. \frac{d^2 \Pi_A^U}{d\delta_A dc} \right|_{c=0} = p_A^* \frac{\partial q_A}{\partial p_B} \left. \frac{d^2 p_B^*}{d\delta_A dc} \right|_{c=0},$$

because $\left. \frac{dp_A^*}{d\delta_A} \right|_{c=0} = \left. \frac{dp_B^*}{d\delta_A} \right|_{c=0} = 0$ and $p_A \frac{\partial q_A}{\partial p_A} + q_A = 0$ (this is the FOC of Π_A with respect to p_A at $c = 0$). Recall that $\frac{dp_B^*}{d\delta_A} > 0$ for $c > 0$ (Proposition 1) whereas $\frac{dp_B^*}{d\delta_A} = 0$ at $c = 0$. By continuity, this implies $\left. \frac{d^2 p_B^*}{d\delta_A dc} \right|_{c=0} > 0$. It follows that $\left. \frac{d^2 \Pi_A^U}{d\delta_A dc} \right|_{c=0} > 0$, which by continuity establishes the result. \square

Proof of Proposition 3. The best response function of A under complete separation is characterized by

$$\frac{\partial \pi_A}{\partial p_A} = (p_A - c) \frac{\partial q_A}{\partial p_A} + q_A = 0. \quad (22)$$

Let A merge with U , with B as an outsider. When maximizing the integrated profit $p_A q_A + w_B q_B$, it is still optimal to serve B at $w_B \leq c$ and hence A 's downstream price reaction is characterized by

$$p_A \frac{\partial q_A}{\partial p_A} + q_A + w_B \frac{\partial q_B}{\partial p_A} = 0. \quad (23)$$

Subtract the left hand side (lhs) of (22) from the lhs of (23) to obtain $\Delta \equiv c \frac{\partial q_A}{\partial p_A} + w_B \frac{\partial q_B}{\partial p_A}$. The symmetric fixed point under separation implies $p_A = p_B$, and thus $\frac{\partial q_B}{\partial p_A} = \frac{\partial q_A}{\partial p_B}$. Hence, at equal prices, Δ is negative as $-\frac{\partial q_A}{\partial p_A} > \frac{\partial q_A}{\partial p_B} > 0$ by Assumption 1 and $w_B \leq c$. A negative Δ implies that the marginal profit of A under integration is lower and thus the integrated A wants to set a lower p_A . The best-reply function of B is characterized by

$$\frac{\partial \pi_B}{\partial p_B} = (p_B - y) \frac{\partial q_B}{\partial p_B} + q_B(p_B, p_A) = 0 \quad (24)$$

with $y = c$ under separation and $y = w_B \leq c$ under integration of A and U . Hence, the best reply function $p_B^r(p_A)$ of B is (weakly) lower under integration. Taken together, strategic complementarity and stability (Assumptions 3 and 4) imply that the unique fixed point of the downstream prices under integration must lie strictly below that under separation. \square

Proof of Proposition 4. (i) We first look at the joint profit Π_A^U of A and U when we move from vertical separation to vertical integration. Recall that under effective competition, the upstream firm - integrated or otherwise - will always set the maximal input price $w_B^* = c$ when selling to firm B , and this independently of any choice of w_A . Moreover, recall that $\Pi_A^U = p_A^* q_A(p_A^*, p_B^*) + c q_B(p_B^*, p_A^*)$. Let the equilibrium downstream prices as a function of input prices be given by $p_A^*(w_A, c) \equiv \arg \max_{p_A} p_A q_A(p_A, p_B^*) + c q_B - w_A [q_A + q_B]$ and $p_B^*(c, w_A) \equiv \arg \max_{p_B} (p_B - c) q_B(p_B, p_A^*)$. Note that $w_A = 0$ yields the downstream prices under integration, and $w_A = c$ those under separation.

The effect of an increase of w_A on Π_A^U is determined by implicit differentiation. This yields

$$\frac{d\Pi_A^{U*}}{dw_A} = \frac{d\Pi_A^{U*}}{dp_A^*} \frac{dp_A^*}{dw_A} + \frac{d\Pi_A^{U*}}{dp_B^*} \frac{dp_B^*}{dw_A}.$$

First, Assumptions 1-4 imply that at $w_A = c$ and hence $p_A^* = p_B^*$, we have both $\frac{dp_A^*}{dw_A} > 0$ and $\frac{dp_B^*}{dw_A} > 0$ for $c \geq 0$. Second,

$$\frac{d\Pi_A^{U*}}{dp_A^*} = \underbrace{q_A(p_A^*, p_B^*) + (p_A^* - c) \frac{\partial q_A}{\partial p_A}}_{=0} + c \underbrace{\left[\frac{\partial q_A}{\partial p_A} + \frac{\partial q_B}{\partial p_A} \right]}_{<0 \text{ at } p_A=p_B} < 0,$$

but approaches 0 as c goes to zero. Third, $\frac{d\Pi_A^{U*}}{dp_B^*} = p_A^* \frac{\partial q_A}{\partial p_B} + c \frac{\partial q_B}{\partial p_B}$ is strictly positive for c sufficiently close to zero. In consequence, $\left[\frac{d\Pi_A^{U*}}{dp_B^*} \frac{dp_B^*}{dw_A} \right]_{w_A=c} > 0$ dominates $\left[\frac{d\Pi_A^{U*}}{dp_A^*} \frac{dp_A^*}{dw_A} \right]_{w_A=c} < 0$ as c goes to zero. Summarizing, $\frac{d\Pi_A^{U*}}{dw_A} \Big|_{w_A=c} > 0$ for c sufficiently small. By continuity, decreasing w_A from c to 0 decreases Π_A^{U*} for c sufficiently small which implies that moving from separation to integration is strictly unprofitable.

(ii) We now look at the outsider B 's profit when we move from vertical separation to vertical integration. Denote by $\pi_B(y, z)$ and $\pi_B^U(y, z)$ the outsider's profit at equilibrium prices, determined as functions of the equilibrium input costs y charged to B , and z charged

to A , before and after the integration of A into U , respectively; with a corresponding notation on equilibrium prices. Then

$$\begin{aligned}\pi_B(c, c) &= (p_B(c, c) - c) q_B(p_A(c, c), p_B(c, c)) \\ &\geq (p_B^U(c, 0) - c) q_B(p_A(c, c), p_B^U(c, 0)) \\ &> (p_B^U(c, 0) - c) q_B(p_A^U(0, c), p_B^U(c, 0)) = \pi_B^U(c, 0),\end{aligned}$$

where the first inequality follows from revealed preference and the second from Proposition 3 as well as Assumption 2. \square

Proof of Lemma 3. Suppose that firm $-i$ sources only from U . The most attractive contract that V can offer i must yield V zero profits, i.e. $F_i^V = x_i^V \cdot (c - w_i^V)$, with x_i^V denoting the quantity i sources from V . Given $w_i^U \leq c$, the arbitrage possibility due to multiple sourcing renders contracts with $w_i^V > c$ and thus $F_i^V < 0$ unprofitable as x_i^V would be 0. Recall that $p_i^*(w_i, w_{-i})$ denotes the downstream equilibrium price of i as a function of the marginal input prices. The net profit of i when buying all inputs from V is given by

$$\pi_i = (p_i^*(w_i^V, w_{-i}^U) - w_i^V) q_i(p_i^*(w_i^V, w_{-i}^U), p_{-i}^*(w_{-i}^U, w_i^V)) - F_i^V.$$

Substituting for F_i^V using the zero profit condition of V with $x_i^V = q_i$ yields

$$\pi_i = (p_i^*(w_i^V, w_{-i}^U) - c) q_i(p_i^*(w_i^V, w_{-i}^U), p_{-i}^*(w_{-i}^U, w_i^V)).$$

Increasing w_i^V at $w_i^V = c$ is profitable if $d\pi_i/dw_i^V|_{w_i^V=c} > 0$. Differentiation yields

$$d\pi_i/dw_i^V = \frac{d\pi_i}{dp_i^*} \frac{dp_i^*}{dw_i^V} + \frac{d\pi_i}{dp_{-i}^*} \frac{dp_{-i}^*}{dw_i^V}.$$

Optimality of the downstream prices implies $\frac{d\pi_i}{dp_i^*} = 0$. Moreover, $\frac{dp_{-i}^*}{dw_i^V} > 0$ follows from the strategic complementarity of downstream prices and thus the supermodularity of the downstream pricing subgame. Finally, $\frac{d\pi_i}{dp_{-i}^*} > 0$ follows directly from $\frac{\partial q_i}{\partial p_{-i}} > 0$ (substitutable products). Combining these statements yields

$$\frac{d\pi_i}{dw_i^V}|_{w_i^V=c} = \frac{d\pi_i}{dp_{-i}^*} \frac{dp_{-i}^*}{dw_i^V} > 0.$$

This implies that raising w_i^V above c would be profitable for i . However, the no arbitrage condition and $w_i^U \leq c$ renders this impossible. Analogously, reducing w_i^V below c and adjusting F_i^V to satisfy zero profits of V is not profitable for i . Consequently, the contract offer of V most attractive to any downstream firm i is given by $\{0, c\}$. \square

Proof of Proposition 5. Recall that for marginal input prices w_i and w_{-i} , i 's equilibrium downstream price is given by $p_i^*(w_i, w_{-i})$. Moreover, recall that

$$\pi_i^*(w_i, w_{-i}) \equiv [p_i^*(w_i, w_{-i}) - w_i] q_i(p_i^*(w_i, w_{-i}), p_{-i}^*(w_{-i}, w_i))$$

and substitute for $\pi_i^*(c, w_{-i})$ in (17) to obtain

$$\begin{aligned} \pi^U &= \sum_i p_i^*(w_i, w_{-i}) q_i(p_i^*(w_i, w_{-i}), p_{-i}^*(w_{-i}, w_i)) \\ &\quad - \sum_i (p_i^*(c, w_{-i}) - c) q_i(p_i^*(c, w_{-i}), p_{-i}^*(w_{-i}, c)). \end{aligned}$$

The first sum captures the industry profits and the second, as $\{0, c\}$ is V 's tariff that maximizes the downstream firms' profits (Lemma 3), the value of each of the downstream firms' outside option. An obvious candidate equilibrium tariff of U is $\{F^* = c, w^* = 0\}$ to both downstream firms. This results in $\pi^U = 2c q_i(p^*(c, c), p^*(c, c))$. Let $\{F^*, w^*\}$ denote alternative symmetric equilibrium candidates offered by U . Recall that $w^* > c$ with $F^* < 0$ is not feasible, as then the downstream firms would source all quantities from V . To assess whether U would benefit from lowering w below c (and increasing F), we differentiate π^U with respect to w at and evaluate it at $w = c$. If that sign is positive for $w_i, i \in \{A, B\}$ separately and jointly, then U has no incentive to decrease its price below c . Differentiation of π^U with respect to w_i yields

$$\begin{aligned} \frac{d\pi^U}{dw_i} &= \frac{\partial p_i^*}{\partial w_i} q_i + p_i^* \left(\frac{\partial q_i}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_i}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} \right) + \frac{\partial p_{-i}^*}{\partial w_i} q_{-i} + p_{-i}^* \left(\frac{\partial q_{-i}}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} \right) \\ &\quad - \frac{\partial p_{-i}^*}{\partial w_i} q_{-i} - (p_{-i}^* - c) \left(\frac{\partial q_{-i}}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} \right). \end{aligned} \quad (25)$$

Evaluating the derivative at $w_i = w_{-i} = c$, subtracting and adding $c \frac{\partial q_i}{\partial p_i} \left(\frac{\partial p_i^*}{\partial w_i} + \frac{\partial p_{-i}^*}{\partial w_i} \right)$, making use of downstream firm i 's FOC $\frac{\partial \pi_i}{\partial p_i} = (p_i^* - c) \frac{\partial q_i}{\partial p_i} + q_i = 0$ and simplifying, we obtain

$$\frac{d\pi^U}{dw_i} = c \left(\frac{\partial q_i}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_i}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} \right) + (p_i^* - c) \frac{\partial q_i}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i}. \quad (26)$$

Substituting for $p_i^* - c = -q_i / \frac{\partial q_i}{\partial p_i}$ from the FOC $\frac{\partial \pi_i}{\partial p_i} = 0$ yields that $\frac{d\pi^U}{dw_i} > 0$ iff

$$c < \frac{q_i}{-\left(\frac{\partial q_i}{\partial p_i} + \frac{\partial q_i}{\partial p_{-i}}\right)} \cdot \frac{\frac{\partial q_i}{\partial p_{-i}}}{-\frac{\partial q_i}{\partial p_i}} \cdot \frac{\frac{\partial p_i^*}{\partial w_{-i}}}{\frac{\partial p_i^*}{\partial w_i} + \frac{\partial p_i^*}{\partial w_{-i}}}. \quad (27)$$

The rhs of (27) remains positive as c goes to zero. Hence (27) holds for c sufficiently small. This establishes the result. \square

Proof of Lemma 4. With passive backward ownership $\delta_A > \delta_B = 0$, the important distinction is that when B buys from V , A does not internalize the sales of B . Again, given that V charges $\{0, c\}$, U sets the downstream firms indifferent with fees of

$$\begin{aligned} F_A &= \Pi_{A(U)}(w_A, w_B) - \Pi_{A(V)}(c, w_B), \\ F_B &= \Pi_{B(U)}(w_B, w_A) - \Pi_{B(V)}(c, w_A), \end{aligned}$$

where $\Pi_{i(j)}^\delta, \Pi_{i(j)}$ are the reduced form total downstream profits of i when sourcing from j as a function of nominal marginal input prices. Substituting the fees in the profit function of U yields

$$\pi^U = \sum_{i \in \{A, B\}} \left[p_i^* q_i (p_i^*, p_{-i}^*) \right] - \Pi_{A(V)}(c, w_B) - \Pi_{B(V)}(c, w_A). \quad (28)$$

As before, the profit consists of the industry profit $\pi^I \equiv \sum_i p_i^* q_i$ less the off-equilibrium outside options. The optimal marginal input prices are characterized by

$$\begin{aligned} \partial \pi^U / \partial w_A &= \partial \pi^I / \partial w_A - \partial \Pi_B(c, w_A) / \partial w_A, \\ \partial \pi^U / \partial w_B &= \partial \pi^I / \partial w_B - \partial \Pi_A(c, w_B) / \partial w_B. \end{aligned}$$

For $w_B = c$ and $w_A = c/(1 - \delta_A)$, the derivatives converge to (26) when $\delta_A \rightarrow 0$. Thus, the derivatives are still positive when δ_A increases marginally at 0. By continuity, the corner solutions are sustained for small backward integration shares and c sufficiently small. Moreover, $F_A = \Pi_{A(U)}(c/(1 - \delta_A), c) - \Pi_{A(V)}(c, c) = 0$ and $F_B = \Pi_{B(U)}(c, c/(1 - \delta_A)) - \Pi_{B(V)}(c, c/(1 - \delta_A)) > 0$ as A prices more aggressively when B sources from V , because then A does internalize sales via the profit part $\delta_A w_B q_B$. This logic extends to the case whereby δ_B also increases at 0. \square

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