Backwards Integration and Strategic Delegation

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We analyze the effects of downstream firms' acquisition of pure cash flow rights in an efficient upstream supplier when all firms compete in prices. With backwards acquisition, downstream firms internalize the effects of their actions on their rivals' sales. Double marginalization is enhanced. While full vertical integration would lead to decreasing, passive backwards ownership leads to increasing downstream prices and is more profitable, as long as competition is sufficiently intense. Downstream acquirers strategically abstain from vertical control, inducing the efficient supplier to commit to high prices. All results are sustained when upstream suppliers are allowed to charge two part tariffs.

Abstract

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1 Introduction

Passive ownership rights across firms, horizontal and even more so vertical ones, are very common, but have traditionally not been of welfare concern, and thus of concern for competition policy.[1] Whereas horizontal cross-shareholdings are a well-known strategy to anti-competitively relax competition,[2] the competitive effects of vertical ownership arrangements are more controversial. Of prominent concern is foreclosure that restricts non-integrated firms' supply, or their access to customers. The classic Chicago challenge is that vertical mergers are competitively neutral at worst (Bork, 1978; Posner, 1976). Yet several arguments are around of how vertical mergers can yield higher consumer prices, or even foreclosure. The 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).[3]

In all these models, the authors compare allocations involving completely non-integrated with those involving fully integrated firms, where integration involves a move from no control of the target firm's instruments nor participation in its returns, to full control over the instruments employed by the target firm and full ownership of its returns. Partial ownership, either non-controlling or controlling, is not considered. Yet even hindsight suggests that empirically, partial vertical ownership is the rule rather than the exception. For instance, in compustat data selected from 1988 - 2001, Fee et al., 2006 identify 37.11 per cent of all firms as customers with one or more partial equity interests in their suppliers. Fee et al., 2006 look empirically at reasons for such interests, in particular improvements on incomplete contracts and direct financing.[4] At any rate, there is very little formal analysis on the allocation effects of partial interests, and thus of the central question: Is passive partial backwards integration really as innocent as believed heretofore, with respect to anti-competitive effects such as increasing prices or foreclosure?

This is the question we address in the present article. Our focus is on passive ownership interests that price setting downstream firms may hold in their suppliers, where passive ownership involves pure cash flow rights, i.e. claims on the target's profits, without controlling its decisions. Focussing on the effects of such interests on transfer and in particular on final prices, we consider the pricing decisions of firms in a downstream market in which horizontally differentiated products are offered, and in an upstream homogeneous product market where these firms produce at different levels of marginal costs. Under effective upstream

[1] Yet in 2011, Joaquín Almunia, the EU commissioner for competition policy, voiced that there is potentially an enforcement gap as the EU Merger Regulation does not apply to minority shareholdings. See "Merger Regulation in the EU after 20 years", co-presented by the IBA Antitrust Committee and the European Commission, March 10, 2011.

[2] See Flath (1991), or more recently Brito et al. (2010) 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.

[3] Other explanations 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).

[4] Unfortunately, transfer and final prices, which are our concern, are not observed within compustat data.

competition, where the cost differences between the efficient and the other suppliers are not very large, the efficient supplier serves all downstream firms, but is restricted in its price setting by the second efficient supplier.

Whereas increasing passive downwards ownership of an upstream supplier in downstream firms tends to reduce double marginalization and thus downstream prices, passive backwards ownership of downstream in upstream firms does not reduce, but exacerbate double marginalization. The reasons are as follows: an increasing participation in the profits of its upstream supplier leads the downstream firm to soften its reaction to an upstream price increase. The upstream supplier incorporates this, and thus increases the upstream price. These two effects compensate each other. Yet the acquiring firm, via its participation in the efficient supplier's profits, incorporates indirectly the effect of its own actions on the downstream competitors' sales quantities, as long as the downstream competitors are served by the same efficient upstream firm. That downstream firm now has an incentive to raise its price. In turn, strategic complementarity induces all downstream competitors to increase theirs.[5]

We also show that the possibility to raise downstream prices incentivizes downstream firms to acquire passive interests in the efficient upstream supplier. Thus, in equilibrium, there will be backwards acquisition, as long as competition is sufficiently intense in both markets. In contrast to what one might expect, partial backwards acquisition by one active firm does *not* invite the input foreclosure of downstream competitors. Indeed, the competitors tend to *benefit*, via increasing equilibrium prices, from the acquiring firm's decision.

This acquisition, however, *takes place short of a level at which the downstream firm takes control over the upstream target's pricing decisions.* If it did, the upstream firm would lose its power to commit to high prices, and thus all downstream prices would decrease. Hence in the setting analyzed here, backwards acquisitions have an anti-competitive effect *only if they are passive.* In the extension section, we show that backwards acquisition is more profitable for the participating firms than full merger, and that all the effects hold even when the upstream suppliers are allowed to charge two-part tariffs, that in concentrated markets tend to alleviate the double marginalization problem. In all, the pricing consequences of passive backwards integration, we claim, should indeed be of concern to competition authorities.

The present analysis is related to Chen (2001) who, in a similar setting, investigates the effects of a full vertical merger. For such a merger to increase downstream prices, the unintegrated downstream rival needs to incur costs of switching between upstream suppliers. These switching costs allow the integrated firm to charge the downstream competitor an input price higher than that charged by the next efficient upstream supplier.

We show that for all downstream prices to increase, neither full vertical integration nor switching costs are necessary, nor does the input price charged to independent downstream

[5] Flath (1989) shows that with successive Cournot oligopolies, constant elasticity demand and symmetric passive ownership, the effects cancel out, so in his model, pure passive backwards integration has no effect. Greenlee and Raskovich (2006) confirm this invariance result for equilibria involving an upstream monopoly and symmetric downstream firms under competition in both, price and quantity. These invariance results would suggest 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 a more general industry structure involving upstream Bertrand competition with asymmetric costs.

firms need to increase. Indeed, partial backwards integration without the transfer of control rights is effective in raising consumer prices when full integration is not, i.e. when the Chicago argument about the efficiency increasing effect of vertical mergers does hold. The reason is that with passive ownership, only profit claims are transferred to downstream firms, but not control on upstream prices. In consequence, downstream firms can acquire profit claims of suppliers to relax downstream competition.

Separating control from ownership in order to relax competition is the general theme in the literature on strategic delegation. While that term was coined by Fershtman et al. (1991), our result is most closely related to the earlier example provided by Bonanno and Vickers (1988), where manufacturers maintain profit claims in their retailers through two-part tariffs but delegate the control over retail prices, in order to induce a softer price setting of the competitor. In the present case, strategic delegation involves backwards oriented activities. The particular twist we add to that literature is that *the very instrument firms used to acquire control is used short of implementing it*.

The competition dampening effect identified in the present paper relies on internalizing rivals' sales through a common efficient supplier. This relates to the common agency argument of Bernheim and Whinston (1985). Strategic complementarity is essential in the sense that rivals need to respond with price increases to the raider's incentive to increase price. Indeed, acquiring passive vertical ownership is a fat cat strategy, in the terms coined by Fudenberg and Tirole (1984).

A different kind of explanation for backward integration without control is 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). Güth et al. (2007) analyze a model of vertical cross share holding to reduce informational asymmetries, and provide experimental evidence.[6] While such potentially desirable effects of partial vertical ownership should be taken into account within competition policy considerations, we abstract from them for expositional clarity.

The remainder of this article is structured as follows: We introduce the model in Section 2. In Section 3, we solve and characterize the 3rd stage downstream pricing subgame. In Section 4, we solve for, and characterize the equilibrium upstream prices arising in Stage 2. In Section 5, we analyze a key element involved in the solution to the first stage of the game, namely the profitability of partial acquisitions. In the Extension Section 6, we first compare the results derived in the baseline model with those derived under full vertical integration. Second, we look at the effects of bans on upstream price discrimination common to many competition policy prescriptions. Third and fourth, we consider the effects of relaxing structural assumptions: We replace sequential by simultaneous pricing decisions, and then allow the upstream firms to charge observable two-part, rather than linear tariffs. The results remain unchanged. Fifth, we touch at the case in which upstream competition is ineffective,

[6] 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. However, a key difference to our setting is that they keep upstream prices exogenous.

so the efficient firm can exercise complete monopoly power.[7] We conclude with Section 7. All relevant proofs are removed to an appendix.

2 Model

Two symmetric downstream firms $i, i \in \{A. B\}$ competing in prices p_i produce and sell imperfect substitutes obeying demands $q_i(p_i, p_{-i})$ 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 $j \in \{U, V\}$ with marginal costs c^j, who again compete in prices. Assume that $c^U \equiv 0$ and $c^V \equiv c > 0$, so that firm U is more efficient than firm V, and c quantifies the difference in marginal costs between U and its less efficient competitor.[8][9] All other production costs are normalized to zero. Upstream suppliers are free to price discriminate between the downstream firms. Let x_i^j denote the quantities firm i buys from supplier j, and w_i^j the associated linear unit price charged by supplier j. Finally, let $\delta_i^j \in [0, \bar{\delta}]$, $0 < \bar{\delta} \leq 1$, denote the ownership share downstream firm i acquires in upstream firm j. Information is assumed to be perfect. The game has three stages:

1. Downstream firms A and B simultaneously acquire ownership shares δ_i^j of suppliers.
2. Suppliers simultaneously set sales prices w_i^j.
3. Downstream firms simultaneously buy input quantities x_i^j from suppliers, produce quantities q_i^j, and sell them at prices p_i.

Underlying the sequencing is the assumption that ownership is less flexible than prices are, and also easily observable by industry insiders. This is crucial as in the following we employ subgame perfection to analyze how (pure cash flow) ownership affects prices. The assumption that suppliers can commit to upstream prices before downstream prices are set is inessential here.

Upstream supplier j's profit is given by

$$\pi^j = \sum_{i \in \{A,B\}} \left(w_i^j - c^j \right) x_i^j. \tag{1}$$

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

$$\Pi_i = \underbrace{p_i \, q_i(p_i, p_{-i}) - \sum_{j \in \{U,V\}} w_i^j \, x_i^j}_{\text{operational profit}} + \underbrace{\sum_{j \in \{U,V\}} \delta_i^j \, \pi^j}_{\text{upstream profit shares}}, \tag{2}$$

[7]In a companion paper Hunold et al. (2012), we focus on ineffective competition and compare the effects of passive and controlling partial backward and forward integration.

[8]Alternatively, one could consider that the downstream firms could procur from the world market at marginal cost c.

[9]The symmetry assumption downstream, and the restriction to two firms downstream and upstream, are without loss of generality. Upstream firms should be ordered by degree of efficiency, however.

to be maximized with respect to its own price p_i, subject to the constraint $\sum x_i^j \geq q_i$, so that input purchases are sufficient to satisfy quantity demanded.

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 *active* one that does. The possibility to control the target's instruments is treated as independent of the ownership share in the target. With this we want to avoid the discussion of at which level of shareholdings control arises. That depends on institutional detail and the distribution of ownership share holdings in the target firm. Although a restriction of $\bar{\delta} < 1/2$ appears highly plausible for ownership to be passive, our results on passive ownership hold for any $\bar{\delta} < 1$. See O'Brien and Salop (1999), as well as Hunold et al., 2012 for a discussion of when control arises. Finally, we define an allocation to involve *effective* (upstream) *competition,* if the efficient upstream firm is constrained in its pricing decision by its upstream competitor, i.e. can charge effective unit input prices, as perceived by downstream firms, no higher than c.[10]

An equilibrium in the third, downstream pricing stage is defined by downstream prices p_A^* and p_B^* as functions of the upstream prices w_i^j and ownership shares δ_i^j, $i \in \{A, B\}; j \in \{U, V\}$ held by the downstream in the upstream firms, subject to the condition that upstream supply satisfies downstream equilibrium quantities demanded. In order to characterize that equilibrium, it is helpful to impose the following 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)*[11]

An equilibrium in the second, upstream pricing stage specifies prices w_i^{j*} conditional on ownership shares δ_i^j, $i \in \{A, B\}; j \in \{U, V\}$.

We sometimes wish to obtain closed form solutions for the complete game. Towards those we use the linear demand specification

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

with γ quantifying the degree of substitutability between the downstream products. With this demand specification, Assumptions 1 to 4 are satisfied.

[10] Intuitively, the efficient upstream firm wishes to set transfer prices so that in reaction, the downstream firms set prices close to the industry monopoly ones, but is restricted doing so by the lowest price c at which its closest competitor can sell. All else given, downstream prices are farthest away from monopoly prices if downstream markets are very competitive. Hence, in order to maintain the regime of effective competition, c can be the higher, the more competitive the downstream market.

[11] The stability assumption implies that the best-reply function of i plotted in a (p_i, p_{-i}) diagram is flatter than the best-reply function of $-i$ for any p_{-i}, implying that an intersection of the best reply functions is unique.

3 Stage 3: Supplier choice and the determination of downstream prices

Downstream firm i's cost of buying a unit of input from supplier j in which it holds δ_i^j shares is obtained by differentiating the downstream profit in (2) with respect to the input quantity x_i^j, i.e.

$$\frac{\partial \Pi_i}{\partial x_i^j} = -\underbrace{w_i^j}_{\text{input price}} + \underbrace{\delta_i^j \left(w_i^j - c^j\right)}_{\text{upstream profit increase}}.$$

Thus, the unit input price w_i^j faced by downstream firm i is reduced by the contribution of that purchase to supplier j's profits. Call $-\frac{\partial \Pi_i}{\partial x_i^j}$ the *effective input price* downstream firm i is confronted with when purchasing from firm j. The minimal effective input price for downstream firm i is given by

$$w_i^e \equiv \min\left\{w_i^U \left(1-\delta_i^U\right), \, w_i^V \left(1-\delta_i^V\right) + \delta_i^V c\right\}. \tag{4}$$

As natural in this context, firm i buys from the upstream supplier j offering the minimal effective input price. If both suppliers charge the same effective input price, we assume that i buys all inputs from the efficient supplier U as that supplier could slightly undercut to make its offer strictly preferable. Let $j(-i)$ denote the supplier j from which the other downstream firm $-i$ buys its inputs. Differentiating downstream profits with respect to the own downstream price yields the two first order conditions

$$\frac{\partial \Pi_i}{\partial p_i} = (p_i - w_i^e)\frac{\partial q_i(p_i, \, p_{-i})}{\partial p_i} + q_i\left(p_i, \, p_{-i}\right) + \delta_i^{j(-i)} \left(w_{-i}^{j(-i)} - c^{j(-i)}\right) \frac{\partial q_{-i}\left(p_{-i}, \, p_i\right)}{\partial p_i} = 0, \quad i \in \{A, \, B\}. \tag{5}$$

Observe that whenever $\delta_i^{j(-i)} > 0$, downstream firm i takes into account that changing its sales price affects the upstream profits earned not only via sales quantities q_i to itself, but also via sales quantities q_{-i} to its competitor. [12]

By Assumptions 1-4, the equilibrium of the downstream pricing game is unique, stable and fully characterized by the two first order conditions for given unit input prices and ownership shares $0 \leq \delta_i^j \leq \bar{\delta}$. Note that strategic complementarity holds under the assumption of product substitutability if margins are non-negative and $\frac{\partial^2 q_{-i}}{\partial p_i \, \partial p_{-i}}$ is not too negative (cf. Equation (5)). Also observe that if prices are strategic complements at $\delta_A = \delta_B = 0$, then strategic complementarity continues to hold for small partial ownership shares.

[12] This effect is not present with quantity competition, as then q_{-i} is not a function of the strategic variable q_i.

4 Stage 2: Determination of upstream prices under passive partial ownership

V cannot profitably sell at a (linear) price below its marginal production cost c. U as the more efficient supplier can profitably undercut V at any positive upstream price. This implies that, in equilibrium, U supplies both downstream firms, and this at effective prices at most as high as c.[13] To simplify notation, let henceforth $\delta_i \equiv \delta_i^U$ and $w_i \equiv w_i^U$. Let $p_i^*(w_i, w_{-i}|\delta_A, \delta_B)$ denote the equilibrium prices of the downstream subgame as a function of input prices. Formally, $U's$ problem is

$$\max_{w_A, w_B} \pi^U = \sum_{i=A,B} w_i \, q_i \left(p_i^*(w_i, w_{-i}|\delta_A, \delta_B), \, p_{-i}^*(w_{-i}, w_i|\delta_A, \delta_B) \right) \tag{6}$$

subject to the constraints $w_i(1-\delta_i) \leq c$, $i \in \{A, B\}$ such that downstream firms are willing to source from U. Differentiating the reduced-form profit in (6) with respect to w_i yields

$$\frac{d\pi^U}{dw_i} = q_i(p_i^*, p_{-i}^*) + w_i \frac{dq_i(p_i^*, p_{-i}^*)}{dw_i} + w_{-i} \frac{dq_{-i}(p_{-i}^*, p_i^*)}{dw_i}. \tag{7}$$

Starting at $w_i = w_{-i} = 0$, it must be profit increasing for U to marginally increase upstream prices, because both $q_i > 0$ and $q_{-i} > 0$. By continuity and boundedness of the derivatives, this remains true for small positive upstream prices. Hence the constraints are strictly binding for any partial ownership structure, so there is *effective upstream competition*, if c is sufficiently small. In this case, equilibrium upstream prices are given by

$$w_i^* = c/(1-\delta_i). \tag{8}$$

We assume this regime to hold in the core part of the paper.[14] In this regime, U's profits are uniquely given by

$$\pi^U = \frac{c}{(1-\delta_A)} \, q_A(p_A^*, p_B^*) + \frac{c}{(1-\delta_B)} \, q_B(p_B^*, p_A^*), \tag{9}$$

and V's profits are zero. We summarize in

Lemma 1. *The efficient upstream firm U supplies both downstream firms at any given passive partial backwards ownership shares (δ_A, δ_B). Under effective competition, i.e. for sufficiently small c, U charges prices $w_i^* = c/(1-\delta_i), i \in \{A, B\}$, so that the effective input prices are equal to the marginal cost c of the less efficient supplier V.*

[13] Another obvious implication is that none of the downstream firms has an interest in obtaining passive shares from the unprofitable upstream firm V.

[14] Clearly, if $\pi^U(w_A, w_B)$ is concave, one, or both of the constraints does not bind for c sufficiently large, in which case U can charge the unconstrained monopoly price below c. When both constraints do not bind, we are in the case of ineffective competition analyzed in Hunold et al., 2012.

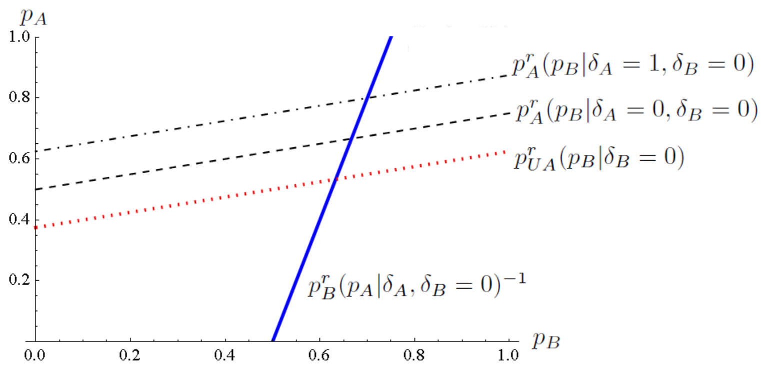

Figure 1: Best-reply functions of downstream firms A, B and the vertically integrated unit UA for linear demand as in (3), with $\gamma = 0.5$ and $c = 0.5$.

With these upstream prices, downstream profits reduce to

$$\Pi_i \quad = \quad (p_i - c)\ q_i(p_i,\, p_{-i}) + \delta_i \frac{c}{1 - \delta_{-i}} q_{-i}(p_{-i},\, p_i). \tag{10}$$

Observe that if firm i holds shares in firm U so that $\delta_i > 0$, its profit Π_i, via its upstream holding, *increases* in the quantity demanded of its rival's product q_{-i}. All else given, this provides for an incentive to raise the price for its own product. Formally, firm i's marginal profit

$$\frac{\partial \Pi_i}{\partial p_i} = q_i(p_i, p_{-i}) + (p_i - c)\frac{\partial q_i}{\partial p_i} + \delta_i \frac{c}{1 - \delta_{-i}} \frac{\partial q_{-i}}{\partial p_i} \tag{11}$$

increases in δ_i. Also, if $\delta_i > 0$, the marginal profit of i increases in δ_{-i}, as this increases the upstream margin earned on the product of $-i$. Finally, as $\frac{\partial q_{-i}}{\partial p_i}$ increases when the products $(i, -i)$ become closer substitutes, the external effect internalized via the cash flow right δ_i becomes stronger, and with it the effect on equilibrium prices. In all, 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 ownership structure

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

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 $\delta_A \to 1$. 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.

5 Stage 1: Acquisition of shares by downstream firms

In this section, we assess the profitability of backward acquisitions in form of passive stakes by downstream firms in upstream firms. We restrict our attention to the acquisition of stakes in firm U. This is easily justifiable within the context of our model: As both downstream firms decide to acquire input from the more efficient firm, the less efficient firm V does not earn positive profits in equilibrium. Hence, there is no scope for downstream firms to acquire passive interests in V.

Rather than specifying how bargaining about ownership stakes takes place and conditioning the outcome on the bargaining process, we determine the central incentive condition for backwards acquisitions to materialize, namely that there are gains from trading claims to profits in U between that upstream firm and one of the downstream firms.

In order to enhance intuition, fix for the moment stakes held by firm B at $\delta_B = 0$. Gains from trading stakes between A and U arise if the the joint profit of A and U,

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

is higher at some $\delta_A \in (0, \bar{\delta}]$ than at $\delta_A = 0$, where p_A^*, q_A^* and q_B^* all are functions of δ_A. The drastic simplification of this expression results from the obvious fact that a positive δ_A just redistributes profits between A and U. The gains from trade between A and U can thus arise only 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. All that changes are A's marginal profits. They increase, because with an increasing δ_A an increasing share of U's sales to B is internalized. This leads A to increase p_A, which in turn induces B to increase p_B. That price increase is not only profitable to B, but eventually yields a net benefit to A and U. Intuition suggests that this competition softening effect increases the profits of U and A if competition is fierce, i.e. c is sufficiently small. Indeed, evaluating $d\Pi_A^U/d\delta_A$ at small c yields

Proposition 2. *Increasing partial passive ownership stakes of firm i firm in firm U increase the combined profits of i and U, if upstream competition is sufficiently intense.*

This argument continues to hold for trades in upstream ownership shares involving both downstream firms, under the obvious restriction that control is *not* transferred from U to any one of the downstream firms.[15]

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

Using the linear demand example introduced in (3), we can make explicit how our case assumption that upstream competition is intense enough relates to the intensity of downstream competition, and in addition derive optimal shareholdings by the downstream firms.

[15]In Subsection 6.1, we consider the effect of a transfer of control, and compare the outcome with the present one.

The joint profits of firms i and U are maximized at a positive passive ownership share δ_i, given $\delta_{-i} = 0$, if $c < \gamma^2/4$. As a firm's backwards interests confer a positive externality on the second firm's profits, the industry profits $p_A^* q_A^* + p_B^* q_B^*$ are maximized at positive passive ownership shares if the less restrictive condition $c < \gamma/2$ holds.[16]

There are several ways of how one can define the ownership acquisition game. One natural benchmark is Coasian bargaining among the owners of U with the downstream firms A and B: As all externalities among the parties are internalized, the resulting allocation is characterized by (**??**).

Implementing the industry profit maximizing allocation can be difficult when the downstream firms cannot commit to hold these shares. As an increase in δ_A exerts a positive externality on B, firm A may have an incentive to reduce δ_A below the level which maximizes industry profits. Yet even if such deviations cannot be prevented, passive backwards ownership is the expected outcome once competition is sufficiently intense: Whenever there is no backwards ownership, there are bilateral gains from trade between a downstream firm and the external owners of U (Proposition 2).

6 Extensions

6.1 Effects of control

In this extension, we compare the effects of passive partial backwards integration with those generated by full vertical integration (i.e. a vertical merger) between one of the downstream firms, say A, and the efficient upstream firm U. We first consider full vertical integration.

Let the ownership structure under vertical integration be described by $\{\delta_A = 1, \delta_B = 0\}$, and let A control $U's$ pricing decisions. As U is more efficient than V, the vertically integrated firm continues to meet any positive price w_B^V charged by V. Under effective upstream competition, it is again optimal to set $w_B^U = c$. By contrast, A, within the vertically integrated firm, takes account of the true input cost normalized to zero.[17]

Consider now the effect of vertical integration on downstream prices. Still faced with marginal input costs of c, vertical integration does not change the best response function of B. However, vertical integration has two countervailing effects on the setting of p_A. Upward price pressure arises because the integrated unit fully internalizes the upstream profit from selling to firm B, that is $c\, q_B(p_B, p_A)$. Conversely, downward price pressure arises because double marginalization on product A is eliminated, as the downstream costs, $c\, q_A(p_A, p_B)$ under separation, are decreased to zero. Indeed, it can be shown that the downward pressure is stronger when the own price effect dominates the cross price effect, yielding

[16] Observe that $\gamma^2/4 < \gamma/2$. This indicates the internalization of the positive externality on the downstream competitor when interests in the efficient upstream firm are acquired to maximize industry profits .

[17] In line with the literature - examples are Bonanno and Vickers (1988) or Chen (2001) - we assume here that under vertical integration, the upstream firm is unable to commit to an internal transfer price to the vertically integrated downstream firm that is higher than its true marginal cost.

Proposition 3. *Under Assumptions 1 to 4, a vertical merger between one downstream firm and U decreases both downstream prices, as compared to complete separation.*

As another consequence, observe that input foreclosure does not arise under vertical integration.

Returning to Figure 1, note that for any $\delta_A > 0$, the best response of the merged entity, $p^r_{UA}(p_B)$, represented by the dotted line in Figure 1, is located below the one arising under separation.

Proposition 3 is also contained in Chen (2001). Yet for an anti-competitive increase in downstream prices to occur in that model, Chen needs to assume that B has to make supplier specific investments to buy from U, such that the integrated firm can set $w^U_B > c$, and still continue to be the exclusive supplier of B. By contrast, as we state in Proposition 1, downstream prices increase even without switching costs, once we allow for the separation of profit claims and control of the target. Summarizing:

Corollary 3. *Under Assumptions 1 to 4 and effective upstream competition, a vertical merger between one of the downstream firms and the efficient upstream firm leads to a decrease of all downstream prices when compared to those arising under vertical separation, whence any passive partial backwards ownership of one or both downstream firms in the efficient supplier U leads to an increase in all downstream prices.*

We now turn to a comparison of the combined profits of A and U under full vertical separation and full integration. By Proposition 3, vertical integration decreases both downstream prices. This is not necessarily desirable for A and U when the overall margins earned under vertical separation are below the industry profit maximizing level. In order to assess whether separation increases the combined profits Π^U_A, we ask the following question: Starting at vertical separation, is it profitable to move towards integration? Indeed, it can be shown that this is initially strictly unprofitable for c sufficiently small. By continuity, there exists an interval $(0, \bar{c}]$ such that for any c in this interval vertical separation is more profitable than integration. Hence

Lemma 2. *A merger between A and U is less profitable than complete vertical separation if upstream competition is sufficiently intense.*

Combining Proposition 2 and Lemma 2 yields

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

As emphasized before, this result is nicely related to the literature on strategic delegation. The particular twist here is that *the very instrument intended to acquire control, namely the acquisition of equity in the target firm, is employed short of controlling the target. While this benefits the industry, it harms consumer welfare.*

A remark on control with partial ownership. The key driver behind Corrollary 4 is that passive ownership preserves double marginalization, whereas a vertical merger eliminates it. It is common in the literature on vertical relations to assume that a merged entity cannot commit to internal transfer prices above marginal costs (cf. footnote 17). This assumption is arguably less straightforward when the acquirer obtains control with partial ownership only. With full control and no additional restrictions, it still appears plausible that commitment is not possible, as with a merger. However, additional restrictions such as transfer price regulations or duties towards minority shareholders could establish transfer prices above costs - as derived here in the case of no control.

Control is often not either full or non-existent, but rather partial. It appears plausible that a block of voting shares allows the owner to influence the target's decisions, but the same applies to other blockholders. This raises the question of how a decision is taken once there are conflicts of interest among the influential shareholders. If competition is sufficiently strong as in the cse discussed here, the shareholders of A and U, say, collectively have an incentive to commit to a higher transfer price w_A. Hence as long as commitment to a price w_A above 0 is feasible when A has partial control of U, and A can be compensated, e.g. with a fixed payment, the equilibrium still exhibits $w_A = c/(1-\delta_A)$ and $w_B = c$. By contrast, if A cannot be compensated or commitment is not feasible as re-negotiations remain possible, A will use its control to decrease w_A, its own input costs. It can be shown that the price w_A decreases more, the more control A has over U, whereas the price for B remains unchanged as there is no conflict of interest among the shareholders of U.

6.2 Non-discriminatory upstream prices

Many competition laws require a firm to charge non-discriminatory prices. While by the U.S. Robinson-Patman Act, non-discrimination is a widely applied rule, Article 102 of the Treaty on the Functioning of the European Union restricts the application of the rule to dominant firms.

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

Consider instead one of the firms', say A's, incentive to acquire a backwards interest in firm U when non-discrimination is effective and $\delta_B = 0$. Then U must charge a uniform price c if it wants to serve both downstream firms. This yields profits to A of

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

Differentiating with respect to p_A and δ_A yields

$$\frac{\partial^2 \Pi_A}{\partial p_A \partial \delta_A} \quad = \quad c \cdot \left[\frac{\partial q_A(p_A, p_B)}{\partial p_A} + \frac{\partial q_B(p_B, p_A)}{\partial p_A} \right] . \tag{12}$$

By Assumption 1, the own price effect dominates the cross price effect, and therefore the cross derivative in (12) is negative if $\frac{\partial q_B(p_B,p_A)}{\partial p_A} \leq \frac{\partial q_A(p_A,p_B)}{\partial p_B}$. At $\delta_A = 0$, the equality $p_A = p_B$ implies that $\frac{\partial q_B}{\partial p_A} = \frac{\partial q_A}{\partial p_B}$. Thus increasing δ_A decreases the marginal profit of A. Hence, the best reply $p_A^r(p_B|\delta_A)$ and, in consequence, both equilibrium downstream prices, decrease in δ_A at $\delta_A = 0$. By continuity, this holds for small positive δ_A. 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 $p_A < p_B$, e.g. in case of linear demand. Under this condition, if only one downstream firm has passive ownership in U, and U optimally serves both downstream firms, then such ownership is not anti-competitive under a non-discrimination rule.[18]

6.3 Simultaneous price setting

So far, we have assumed that upstream prices are set before downstream prices. Consider now that all prices are set simultaneously. In this situation, upstream firms take downstream prices as given. For U, increasing effective prices up to c does not affect quantity. Hence, effective equilibrium upstream prices must be equal to c. However, with simultaneous price setting, an equilibrium does only exist as long as the participation constraints of downstream firms are not violated at effective upstream prices of c.

Lemma 3. *Under effective competition, sequential and simultaneous setting of up- and downstream prices are outcome equivalent.*

Note that as long as the participation constraints of downstream firms do not bind, the simultaneous price setting is equivalent to the case in which downstream prices are set first, followed by upstream prices and, finally, downstream firms choose where to buy inputs.

6.4 Two-part tariffs

The assumption of linear upstream prices is clearly restrictive, as argued already in Tirole (1988). Caprice (2006) and Sandonis and Fauli-Oller (2006) have pointed out that with effective upstream competition, observable two part tariffs offered by the efficient supplier U implement downstream prices below the industry profit maximizers. The reason is that U cannot, or does not want to offer sufficiently high marginal input prices.

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 without backwards interests by a downstream firm, U cannot offer a marginal price above c to that firm. We show that in the case discussed heretofore, U indeed would like to offer marginal prices above c. Thus marginal input prices in equilibrium

[18] U wants to serve both downstream firms for a small δ_i, given $\delta_{-i} = 0$. Once δ_i becomes large, U may find it profitable to set a high nominal price at which only i wants to purchase. This makes $-i$ dependent on V. In turn, V can raise the price charged to $-i$ above c, yielding partial foreclosure. However, it is unclear whether partial foreclosure is an equilibrium. In a forthcoming paper, we will discuss in detail the effects of non-discrimination rules in the different case situations.

equal c and the fixed fee F equals zero, i.e. the transfer price $\underline{\underline{U}}$ charges to the firm with backwards interests in it, is endogenously linear.

If c is larger or U can offer exclusive tariffs, i.e. forbid customers to source alternatively, U generally wants to charge a fixed fee $F \neq 0$. Downstream firm $i's$ alternative to sourcing from U, given its rival $-i$ sources from U, is more valuable when U charges $-i$ a higher marginal price. This induces U to lower the marginal prices below the industry profit maximizing level in order to obtain more rents through the fixed fees.

In what follows, we formally characterize the two-part contracting problem with and without exclusivity clauses of U and show that passive backward ownership can increase downstream prices in both cases.

We start from complete vertical separation, so $\delta_A = \delta_B = 0$, and maintain the assumption that all contract offers are observable to all downstream firms upon acceptance, and that acceptance decisions are observed when downstream prices are set. A tariff offered by supplier j to downstream firm i is summarized by $\{w_i^j, F_i^j\}$, where F_i^j is the fixed fee downstream 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, but net of any fixed payment. With the model constructed as in the main part of the paper, the Bertrand logic still holds: U can still always profitably undercut any (undominated) offer by V, so in equilibrium U exclusively supplies both downstream firms. Yet if upstream competition is effective, U is restricted by V in its price setting. V's offers, if accepted, must yield it non-negative profits in order to be feasible.

More formally, for given contract offers of V to firm A and B, U's problem is

$$\begin{aligned} \max_{f_A^U, f_B^U, w_A^U, w_B^U} \pi^U &= \sum_{i \in \{A,B\}} \left[w_i^U q_i + F_i^U \right] \\ s.t. \qquad & \pi_i^*\left(w_i^U, w_{-i}^U\right) - F_i^U \geq \pi_i^*\left(w_i^V, w_{-i}^U\right) - F_i^V. \end{aligned} \tag{13}$$

U has to ensure that an individual deviation of each downstream firm to source from V is not profitable. In equilibrium, the profit constraints of both downstream firms $i \in \{A,B\}$ must be binding, for otherwise U could profitably raise the respective fixed fee F_i^U, until downstream firm i is indifferent between its and V's contract offer.

Non-exclusive contracts. When contracts are non-exclusive, i.e. when the downstream firms can procur their input from both upstream firms, setting a marginal input price $w_i^U > c$ with $F_i^U < 0$ cannot be an equilibrium, as V could profitably offer $\{w_i^V \in [c, w_i^U), F_i^V = 0\}$ and thus downstream firm i accept U's contract offer in order to cash in F_i^U, but 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 4. *If U offers two-part tariffs including $w_i^U \leq c$, $i \in \{A,B\}$, then $\{c, 0\}$ 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

$$\max_{w_A, w_B} \pi^U = \underbrace{\sum_{i \in \{A,B\}} p_i^*(w_i, w_{-i})\, q_i^*}_{\text{industry profit}} - \underbrace{\sum_{i \in \{A,B\}} \pi_i^*\,(c,\, w_{-i})}_{\text{outside options}} \tag{14}$$

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 downstream firms positive profits. Moreover, firm i's outside option, its profit $\pi_i^*\,(c,\, w_{-i})$ increases in the rival's cost w_{-i}. In turn, the marginal profit $\partial \pi^U / \partial w_i$ is below the marginal industry profit. For c sufficiently small, the marginal profit is still positive when the arbitrage constraints bind, 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.*

Proposition 4. *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 backwards ownership δ_i to i and U.

What does change if we allow for passive partial backwards integration? As $\{c, 0\}$ is a corner solution, (at least some) passive backwards integration does not change the efficient upstream firm's incentive to charge maximal marginal prices. Hence

Lemma 5. *Let upstream competition be sufficiently intense. If $\delta_i > 0$, then the non-exclusive two-part tariff offered by U is $w_i = c/(1 - \delta_i)$.*

Thus, when firm i has acquired a positive share, the effective input price remains at c as under linear tariffs. Without exclusivity, a higher marginal input price is not feasible, as then firm i would buy the inputs from V, that continues to charges $\{c, 0\}$. Suppose, however, that i does not own shares in U, but $-i$ does. Then i faces a tradeoff: would it source from V, the rival A would not internalize its sales and thus would price more aggressively. This allows U to exploit on the rent B could absorb from A's less aggressive pricing when procuring from U, by charging a marginal price $w_B > c$. 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 and industry profits Π_{AB}^U compared to complete separation even if non-exclusive two-part tariffs are allowed for.*

Hence the results derived in the main part of the paper for linear tariffs are upheld even if observable two-part tariffs are allowed for and competition is sufficiently intense. When competition is less intense, it is optimal for U to charge effective marginal prices below c. Hence the no-arbitrage constraint $w_i \leq c/(1-\delta_i)$ does no more bind, which corresponds to the case of exclusive two-part tariffs which we discuss now.

Exclusive two-part tariffs

Assume that V always offers $\{c, 0\}$ and let U be able to offer exclusive two-part tariffs forcing the downstream firm agreeing to be supplied to by all from U.[19] Without backward ownership, U simply maximizes (14). Now assume that $\delta_B = 0$ and $\delta_A > 0$. U's problem becomes

$$\max_{w_A, w_B} \pi^U = \sum_{i \in \{A,B\}} [p_i^* q_i^*] - [(p_A^*(c, w_B) - c)\ q_A^* + \delta_A\, w_B\, q_B^*] - [(p_B^*(c, w_A) - c)\ q_B^*]\,. \qquad (15)$$

The marginal profit of A includes $\delta_A w_B \partial q_B / \partial p_A$ independent of whether A sources from U, as long as B does so. For given effective input prices charged by U, this relaxes downstream competition.

The marginal profit of B does not depend on where B sources. However, once B sources alternatively, the marginal profit of A decreases by $\delta_A w_B \partial q_B / \partial p_A$, inducing A to price more aggressively. The only effect of backwards ownership of A in case of such a deviation is that the effective marginal input price of A is $w_A(1-\delta_A)$. As with non-exclusive tariffs, U can extract the positive externality generated from A's backwards ownership, either trough F_B or w_B. Through this channel, two-part tariffs again increase the bilateral profitability of backwards ownership, relative to linear tariffs.

Recall that with the linear demand specification (3) and linear tariffs, passive ownership is profitable for $c < \gamma^2/4$; thus for $c \geq 1/4$, i.e. half the downstream monopoly price or more, passive ownership is always bilaterally unprofitable as $\gamma < 1$. Instead, with two part tariffs, passive backwards ownership is profitable at $c = 1/4$ whenever $\gamma > 0.65$; at $c = 1/2$, it is still profitable for $\gamma > 0.72$. Hence with two-part tariffs, passive backwards ownership is bilaterally profitable for a larger set of parameters, in particular even if competition is less intense. Moreover, downstream prices increase in δ_i for large ranges of the parameters. Starting at $\delta_A = \delta_B = 0$, for $\gamma \in (0,1)$ and $c \in (0, 1/2)$, a marginal increase in δ_A increases p_A, and p_B if $\gamma > 0.69$ and for $\gamma \in [0.57, 0.69]$ if c is sufficiently small. Hence passive backwards ownership is both profitable and anti-competitive for large parameter ranges.

6.5 Ineffective competition

In the baseline model, we have analyzed the effects of passive partial backwards integration when there is *effective upstream competition*, as generated by a difference c in marginal costs

[19] Once V can also offer exclusive contracts, the analysis is more complicated. We simplify here to increase expositional clarity.

between the efficient firm U and the less efficient firm V, such that U was constrained in its pricing decision by the lowest price c that can be offered by V. We now sketch the case where the cost difference$c$ between the efficient and the next efficient firm is so high that U can behave as an unconstrained upstream monopolist.

Consider first complete vertical separation. With linear upstream prices, the well known double marginalization problem arises, as the equilibrium downstream prices are above the level that maximizes industry profits, and approach the industry profit maximizing prices from above only as downstream competition tends to become perfect. For the industry, it is not desirable to further relax competition. Instead, it is desirable to reduce margins with, for example, maximum resale price maintenance, passive forward integration, or observable two-part tariffs. With two-part tariffs, U can maximize the industry profits by choosing the marginal price in accordance to downstream competition and extracting all downstream profits through a fixed fee. Hence the owners of U have no interest in backward ownership because their profits are already maximized.

For linear upstream tariffs and symmetric passive backward ownership in the monopoly supplier, Greenlee and Raskovich (2006) show that upstream and downstream price adjustments exactly compensate, so downstream prices stay the same independent of the magnitude of partial ownership and the intensity of downstream competition.

As before, for given input prices w_A and w_B, an increase in the passive backwards ownership share δ_A in the supplier reduces the effective input price of A, so A has an incentive to lower its sales price. Yet a positive δ_A also induces A to internalize its rivals' sales, so that A wants to increase its sales price. The first effect tends to dominate, so that downstream prices decrease in δ_A for given (nominal) input prices. As U is unconstrained, 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.[20]

By contrast, with effective upstream competition 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.

7 Conclusion

In this article, we consider vertically related markets with differentiated, price setting downstream firms, that produce with inputs from upstream firms supplying a homogenous input at differing marginal costs. We analyze the effect of one or more downstream firms holding passive, that is non-controlling ownership shares in the efficient, and therefore common, supplier. In sharp contrast to related studies who focused either on Cournot competition or

[20] In Hunold et al. (2012), we show that for linear demand, linear prices and upstream price discrimination, there is no incentive to acquire passive backwards ownership in the monopoly supplier; moreover, consumer surplus increases with asymmetric backward ownership.

upstream monopoly, we find that if competition is sufficiently intense, *passive ownership leads to increased downstream prices and thus is strictly anti-competitive.* Also, *passive ownership is anti-competitive where a full vertical merger would be pro-competitive.* Thus, confronted with the choice between passive backwards integration and a full vertical merger, the firms prefer the former. They voluntarily abstain from controlling the upstream firm, because this would do away with its power to commit to a high industry profit increasing price. *The very instrument typically employed to obtain control is used up to the point where control is not attained.* This brings an additional feature to the strategic delegation literature.

Our result is driven primarily by a realistic assumption on the upstream market structure, in which an efficient supplier faces less efficient competitors, allowing it to increase upstream prices only when the price increasing effect is absorbed by the downstream firm(s), via their claims on upstream cash flows. We show the result to be robust to changes in other assumptions such as linear upstream prices, and 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* if competition is sufficiently intense. Interestingly enough, under effective upstream competition, passive ownership in suppliers tends *not* to be anti-competitive under a non-discrimination clause.

For competition policy, it is important to recognize that anti-competitive passive ownership in common suppliers is profitable when there is both up- and downstream competition and thus foreclosure potentially *not* the main concern. Most importantly, proposing passive backwards ownership in a supplier as a remedy to a proposed vertical merger tends *not* to benefit competition but eventually worsens the competitive outcome, as long as upstream competition is effective and the upstream supplier serves competitors of the raider. The reason is that full vertical integration tends to remove double marginalization via joint control, whilst partial backwards integration tends to enhance that.

In the present setting, we abstract from other, potentially socially desirable motives for partial backwards ownership. A particularly important effect is the mitigation of agency problems in case of firm-specific investments (Riordan, 1991; Dasgupta and Tao, 2000) such as investment in specific R&D. 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. Yet such potentially pro-competitive effects need to be weighed against the anti-competitive effects of passive backwards integration presented here.

Appendix: Proofs

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 by (11) and, hence, the best-reply $p^r_{-i}(p_i)$ of $-i$ is independent of δ_i. In contrast, the marginal profit $\frac{\partial \Pi_i}{\partial p_i}$ increases in $i's$ ownership share δ_i. This implies a higher best reply $p^r_i(p_{-i}|\delta_i)$ for any given p_{-i}. By continuity, $\frac{\partial p^r_i(p_{-i}|\delta_i)}{\partial \delta_i} > 0$. 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 $\frac{\partial^2 \Pi_i}{\partial p_i \partial \delta_{-i}} \geq 0$. □

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

$$\frac{d\Pi^U_A}{d\delta_A} = \left(p^*_A \frac{\partial q_A}{\partial p_A} + q^*_A + c \frac{\partial q_B}{\partial p_A}\right) \frac{dp^*_A}{d\delta_A} + \left(p^*_A \frac{\partial q_A}{\partial p_B} + c \frac{\partial q_B}{\partial p_B}\right) \frac{dp^*_B}{d\delta_A}. \tag{16}$$

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

$$\begin{aligned}\frac{d^2\Pi^U_A}{d\delta_A dc} &= \frac{d}{dc}\left(p^*_A \frac{\partial q_A}{\partial p_A} + q^*_A + c \frac{\partial q_B}{\partial p_A}\right) \frac{dp^*_A}{d\delta_A} + \frac{d}{dc}\left(p^*_A \frac{\partial q_A}{\partial p_B} + c \frac{\partial q_B}{\partial p_B}\right) \frac{dp^*_B}{d\delta_A} \\ &\quad + \left(p^*_A \frac{\partial q_A}{\partial p_A} + q^*_A + c \frac{\partial q_B}{\partial p_A}\right) \frac{d^2p^*_A}{d\delta_A dc} + \left(p^*_A \frac{\partial q_A}{\partial p_B} + c \frac{\partial q_B}{\partial p_B}\right) \frac{d^2p^*_B}{d\delta_A dc}.\end{aligned}$$

Evaluating this derivative at $c = 0$ yields

$$\frac{d^2\Pi^U_A}{d\delta_A dc}|_{c=0} = p^*_A \partial_{p_B} q^*_A \frac{d^2 p^*_B}{d\delta_A dc}|_{c=0},$$

because $\frac{dp^*_A}{d\delta_A}|_{c=0} = \frac{dp^*_B}{d\delta_A}|_{c=0} = 0$ 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) while $\frac{dp^*_B}{d\delta_A} = 0$ at $c = 0$. By continuity, this implies $\frac{d^2p^*_B}{d\delta_A\, dc}|_{c=0} > 0$. It follows that $\frac{d^2\Pi^U_A}{d\delta_A dc}|_{c=0} > 0$ which, by continuity, establishes the result. □

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

$$\frac{\partial \Pi_A}{\partial p_A} = (p_A - c) \frac{\partial q_A}{\partial p_A} + q_A(p_A, p_B) = 0. \tag{17}$$

When maximizing the integrated profit $p_A q_A + w_B q_B$, it is - as argued before - still optimal to serve B at $w_B \leq c$ and, hence, the corresponding downstream price reaction is characterized by

$$p_A \frac{\partial q_A}{\partial p_A} + q_A(p_A, p_B) + w_B \frac{\partial q_B}{\partial p_A} = 0. \tag{18}$$

Subtract the left hand side (lhs) of (17) from the lhs of (18) 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 ($\delta_A = \delta_B = 0$) must have $p_A = p_B$. This implies $\frac{\partial q_B}{\partial p_A} = \frac{\partial q_A}{\partial p_B}$. 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

$$\frac{\partial \Pi_B}{\partial p_B} = (p_B - y)\,\frac{\partial q_B}{\partial p_B} + q_B(p_B, p_A) = 0 \tag{19}$$

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 (Assumption 3) implies that the unique fixed point of the downstream prices under integration must lie strictly below that under separation. □

Proof of Lemma 2. We 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 not, will always set the maximal input price $w_B^* = c$ when selling to firm B, and this independently of any choice of w_A. Also 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 $p_A^*(w_A, c) \equiv \arg\max_{p_A}\; p_A\,q_A(p_A, p_B^*) + cq_B - w_A\,[q_A + q_B]$ 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,

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

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, $\frac{d\Pi_A^{U*}}{dw_A}|_{w_A = c} > 0$ 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. □

Proof of Lemma 4. 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 sourced by i 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 with it, 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, decreasing w_i^V below c and adjusting f_i^V to satisfy zero profits of V is not profitable for i. In consequence, the contract offer of V most attractive to any downstream firm i is given by $\{0, c\}$. □

Proof of Proposition 4. Recall that for marginal input prices of w_i and w_{-i}, $i's$ equilibrium downstream price is given by $p_i^*(w_i, w_{-i})$. Also recall that $\pi_i^*(w_i,\, w_{-i}) \equiv [p_i^*(w_i, w_{-i}) - w_i] \cdot q_i\left(p_i^*(w_i, w_{-i}), p_{-i}^*(w_{-i}, w_i)\right)$ and substitute for π_i^* in (14) to obtain

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

The first sum captures the industry profits and the second, as $\{0, c\}$ is V's tariff that maximizes the downstream firms' profits, the value of each of the downstream firms' outside option. An obvious candidate equilibrium tariff of U is $\{f^* = 0, w^* = c\}$ 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. Towards assessing 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

$$\frac{d\pi^U}{dw_i} = \frac{\partial p_i^*}{\partial w_i} q_i + p_i^* \cdot \left(\frac{\partial q_i}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_i}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} \right) + \frac{\partial p_{-i}^*}{\partial w_i} q_{-i} + p_{-i}^* \cdot \left(\frac{\partial q_{-i}}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} \right)$$
$$- \frac{\partial p_{-i}^*}{\partial w_i} q_{-i} - \left(p_{-i}^* - c \right) \left(\frac{\partial q_{-i}}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} \right). \quad (20)$$

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

$$\frac{d\pi^U}{dw_i} = c[\frac{\partial q_i}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i} + \frac{\partial q_{-i}}{\partial p_i} \frac{\partial p_i^*}{\partial w_i} + \frac{\partial q_i}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i}] + [p_i^* - c] \frac{\partial q_i}{\partial p_{-i}} \frac{\partial p_{-i}^*}{\partial w_i}. \quad (21)$$

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

$$c < \frac{q_i}{-\left(\frac{\partial q_i}{\partial p_i} + \frac{\partial q_i}{\partial p_{-i}} \right)} \cdot \frac{\frac{\partial q_i}{\partial p_{-i}}}{-\frac{\partial q_i}{\partial p_i}} \cdot \frac{\frac{\partial p_i^*}{\partial w_{-i}}}{\frac{\partial p_i^*}{\partial w_i} + \frac{\partial p_i^*}{\partial w_{-i}}}. \quad (22)$$

The rhs of (22) remains positive as c goes to zero. Hence (22) holds for c sufficiently small. This establishes the result. □

Proof of Lemma 4. With passive backwards 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

$$F_A = \Pi_{A(U)}(w_A, w_B) - \Pi_{A(V)}(c, w_B),$$

$$F_B = \Pi_{B(U)}(w_B, w_A) - \Pi_{B(V)}(c, w_A),$$

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 input prices. Substituting the fees in the profit function of U yields

$$\pi^U = \sum_{i \in \{A,B\}} \left[p_i^{\delta}(w_A(1 - \delta_A), w_B)\, q_i^{\delta} \right] - \Pi_{A(V)}^{\delta}(c, w_B) - \Pi_{B(V)}(c, w_A). \quad (23)$$

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

$$\partial \pi^U / \partial w_A = \partial \pi^I / \partial w_A - \partial \Pi_B(c, w_A) / \partial w_A,$$

$$\partial \pi^U / \partial w_B = \partial \pi^I / \partial w_B - \partial \Pi_A(c, w_B) / \partial w_B.$$

For $w_B = c$ and $w_A = c/(1-\delta_A)$, the derivatives converge to (21) used in the Proof of Proposition 4 when $\delta_A \to 0$. Thus the derivatives are still positive when δ_A increases marginally at 0. By continuity, the corner solutions are sustained for small backwards 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 that also δ_B increases at 0. □

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