Backward partial vertical integration with discriminatory pricing*

Ricardo Gonçalves†
Faculdade de Economia e Gestão, Universidade Católica Portuguesa (Porto)

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Abstract

We analyze the market impact of a partial vertical integration whereby a retail firm acquires a non-controlling stake in the capital of an upstream firm, which supplies an essential input. In addition, we assume that this upstream firm can price discriminate between two groups of retail firms: the retail firm which (now) owns a stake in its capital and all of its retail rivals. Although apparently counterintuitive, we find that it is profit-maximizing for the upstream firm to discriminate *against* its retail shareholder. Compared to a vertical separation scenario, this partial vertical integration induces input foreclosure, higher retail prices and lower social welfare. From a competition policy viewpoint, this suggests that such partial vertical integrations should be analyzed with particular concern.

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†Postal address: Faculdade de Economia e Gestão, Universidade Católica Portuguesa (Porto), Rua Diogo Botelho, 1327, 4169-005 Porto, Portugal. E-mail: rgoncalves@porto.ucp.pt.

1 Introduction

The acquisition by a firm in the supply chain of a share in the capital of another firm is relatively common. Whilst falling short of a full vertical integration, such partial vertical integrations may help "...align the interests of the target and acquirer, reducing transaction costs or encouraging non-contractible effort or specific investment" (Greenlee and Raskovich, 2006, p. 1018) and may also contribute to a reduction in the double marginalization problem when the firms have market power in the segments where they operate along the supply chain.

The latter explanation is particularly relevant for competition policy. Vertical mergers of firms with market power typically attract scrutiny from competition authorities. Of particular concern is the potential for input foreclosure, whereby the (now) vertically integrated firm constrains access to an input it produces to its (non-integrated) rivals in a downstream segment.[1] However, as it is well known in the literature (e.g., Motta, 2004), the efficiency features of vertical mergers, namely the potential to reduce the double marginalization problem, typically make them less worrisome than their horizontal counterparts.[2]

The (relatively scarce) literature on partial vertical integrations looks at whether the main results obtained under vertical mergers also apply when a firm acquires less than 100% of the capital of another firm along the supply chain. Baumol and Ordover (1994) provide an early warning that results may differ significantly when the vertical integration is only partial. This literature can be broadly divided into two categories: one in which the partial acquisition gives the acquiring firm a controlling stake in its target (effectively allowing it to define prices)[3] and another (to which this paper belongs) where the partial acquisition gives the acquirer a non-controlling stake in the target's capital (which, thus, does not allow it to influence the target's decisions).[4]

Greenlee and Raskovich's (2006) setup is that of a two-stage game, where N retail firms compete after purchasing an essential input from an upstream monopolist. One of the retail firms is assumed to have a non-controlling stake in the upstream firm's capital (effectively a backward partial vertical integration, as defined by Spiegel, 2011), which, in the first stage, maximizes its profits independently from that stake by choosing a linear and uniform

[1] Rey and Tirole (2007) and Riordan (2008) provide good overviews of vertical foreclosure.

[2] Motta (2004, p. 378) even suggests a two-step procedure for the analysis of vertical mergers: in the first step, competition authorities should analyze whether the merger will lead to input foreclosure (thus harming competitors); if the answer is positive, a second step would be to establish whether final consumer prices are likely to increase (harm to competition). In essence, authorities should weigh the anti-competitive (input foreclosure) and pro-competitive (elimination of double marginalization and consequent final price reductions) effects of vertical mergers.

[3] For instance, Spiegel (2011).

[4] For instance, Greenlee and Raskovich (2006) or Hunold et al. (2012).

wholesale price.[5] Under an homogenous good Cournot setting in the retail segment, as well as under a symmetric and differentiated Bertrand setting, they find that this partial vertical integration does not affect the price or quantity choices of downstream firms and, thus, does not affect social welfare.

Hunold et al. (2012) differ from Greenlee and Raskovich (2006) in three important dimensions: (i) they consider a (possibly cost-asymmetric) duopoly in the upstream segment; (ii) they allow for the upstream firms to price discriminate; and (iii) in the (cost-symmetric) downstream segment, only price (Bertrand) competition is considered.[6] They find that backward partial integration has anti-competitive effects, in the form of higher retail prices and an exacerbation of the double marginalization problem. In the particular case of a monopoly upstream firm (which Hunold et al., 2012, refer to as 'ineffective competition'), the possibility of upstream price discrimination eliminates the incentive for a downstream firm to (partially) integrate backwards, that is, the combined profits of the upstream and downstream (acquiring) firm are lower than under vertical separation.[7]

This paper shares features of Greenlee and Raskovich (2006) - a single upstream supplier and competition in the downstream segment - and of Hunold et al. (2012) - who allow for upstream price discrimination. In particular, we assume that downstream firms compete on quantity (Cournot) and the upstream monopolist chooses (possibly discriminatory) linear wholesale prices which differ across two groups of retail firms: one which contains solely the retail firm with the non-controlling stake in the upstream firm's capital and another which contains its rivals in the downstream segment. This is the key distinction from Greenlee and Raskovich's (2006) setup, who assume that the upstream firm chooses a linear and uniform wholesale price.

We find that (i) the upstream firm finds it profit-maximizing to price discriminate between retail firms, charging a *higher* wholesale price to the retail firm which owns a non-controlling stake in its capital; (ii) increased competition (higher number of firms) at the retail level reduces wholesale prices and, particularly, their asymmetry; (iii) compared to a scenario of vertical separation (where the partial integration does not occur), there is input foreclosure (insofar as the wholesale prices charged under partial vertical integration are higher than the

[5] Greenlee and Raskovich (2006) analyse such partial vertical integrations under symmetric and asymmetric homogeneous-good Cournot and differentiated-good Bertrand settings.

[6] In the upstream segment, a homogeneous good is assumed to be produced, whilst in the downstream segment products may be homogeneous or differentiated.

[7] Hunold et al. (2012) assess the desirability of backward partial integrations by looking at whether there may be gains from trading the claims on the upstream firm's profit between that firm and one of the downstream firms.

price charged under vertical separation[8]) and the final retail price is higher; (iv) backward partial integration is desirable (i.e., a downstream firm finds it optimal to acquire a strictly positive share of the upstream firm's capital and their combined profits are higher than under vertical separation) but (v) has a detrimental effect on social welfare. Results (i), (iii) and (v) are similar to those obtained by Hunold et al. (2012). However, they find that backward partial integration is only desirable (insofar as it increases the combined profits of the upstream and the downstream acquiring firm) if upstream competition is sufficiently intense.[9] Therefore, under an upstream monopoly, contrary to our result (iv), such backward partial integrations would not materialize, and this is explained by their Bertrand-competing duopoly assumption in the downstream segment (which contrasts with our N-firm Cournot competition assumption).

Result (i) appears, at first glance, counterintuitive, as one would expect the upstream firm, if allowed to price discriminate, to favour the retail firm which has acquired a share in its capital. A full vertical merger would typically yield such a result, whereby the upstream firm would effectively charge a wholesale price equal to marginal cost to its (now) downstream subsidiary (eliminating the double marginalization problem) and (possibly) choose to constrain input access to its rivals (input foreclosure) (Motta, 2004, p. 375; Inderst and Valletti, 2011). This, however, is not what happens in equilibrium: the partial stake in the upstream firm's capital held by a retail firm works as a rebate to the wholesale price it faces. This, in turn, induces that firm to expand its production and, thus, its demand for the upstream input. The upstream firm takes advantage of this increased demand and finds it profit-maximizing to charge that firm a higher wholesale price than that which it charges its rivals. Result (ii) suggests that increased competition at the retail level reduces the quantity produced by each retail firm and, thus, the upstream firm finds it profit-maximizing to decrease wholesale prices - more so for the acquiring downstream firm, which is more adversely affected (in terms of quantity reduction) by this increased competition.

Results (iii) and (v) convey interesting competition policy implications: whilst the acquiring retail firm is not favoured by the upstream firm (as it typically would if a full vertical merger were to occur), strategic substitutability implies that the two wholesale prices (that which is charged to the acquiring retail firm and the other which is charged to its rivals) are higher than the (uniform) wholesale price charged under vertical separation. This implies that whilst in equilibrium the acquiring retail firm produces more than it would under ver-

[8] Salinger (1988, pp. 352-353) suggests that an increase in the wholesale price is "...an economically meaningful definition of market foreclosure of downstream firms".

[9] Hunold et al. (2012), Proposition 2.

tical separation, the input foreclosure to its retail rivals is the dominant effect, which leads to a lower total quantity, a higher final retail price and lower social welfare. This result - similar to that obtained by Hunold et al. (2012) - is clearly different from Greenlee and Raskovich (2006): in their model, the upstream firm also faces increased input demand when retail firms acquire partial stakes in its capital and, thus, raises wholesale prices. However, constrained to set linear and uniform wholesale prices, these two effects cancel each other out, so that total output and final consumer prices remain unaffected. Therefore, a policy implication of our results is that competition authorities should analyze such partial vertical integrations with particular concern and, if possible, constrain the upstream firm's ability (post-acquisition) to price discriminate.

Interestingly, this result differs somewhat from that of Höffler and Kranz (2011) in their comparison of vertical separation with 'legal unbundling' - a situation where a downstream firm fully owns the upstream firm, but cannot (for legal or regulatory reasons) make upstream price or non-price decisions (in their setup, the upstream firm can choose non-tariff 'sabotage' strategies against other downstream firms, i.e., non-price discrimination is allowed). They find that, under legal unbundling, although the vertically integrated downstream firm has incentives to expand its output[10], its downstream rivals reduce their output (under quantity competition) and the net effect on total quantity ('downstream expansion effect') is positive (whereas in our case it is negative), that is, legal unbundling leads to higher quantities than vertical separation. The intuition underlying the difference in results is relatively straightforward: in Höffler and Kranz (2011), the optimal 'sabotage' strategy is similar in the legal unbundling and vertical separation scenarios, because it does not affect the upstream firm's profits directly (only indirectly, through its impact on total quantity sold), i.e., the upstream firm maximizes profits by maximizing total output (and, thus, by not sabotaging other downstream firms). By contrast, in our case, the upstream firm's discrimination tool is price-based and, hence, affects its profits directly. In this situation, the upstream firm finds it optimal to implement price discrimination, as it trades-off a lower overall quantity sold with a higher profit margin on each unit.

The paper is structured in the following way: section 2 describes the model; section 3 contains the main results and section 4 concludes.

[10] The rationale is similar to ours: full ownership of the upstream firm is equivalent to the maximum possible rebate a downstream firm can benefit from in the purchase of the essential input.

2 The model

We assume that the supply chain consists of two segments or levels: the upstream segment, where only one firm - firm U - is assumed to operate, producing an essential input for all firms in the downstream or retail segment, where N firms compete to produce a (homogeneous) final good for consumers. The underlying production process we assume is relatively simple and consists of a one-to-one fixed proportions technology. Firm U, which we assume not to have any production costs, produces an input which retail firms acquire and somehow 'transform' or 'convert' into a retail product (which, thus, also implies a retail production cost on top of the input purchase costs).

Two examples can be given of such simple processes. In the telecommunications sector, retail firms which do not possess a telecommunications network can typically purchase wholesale services from the incumbent which allow it to sell services directly to consumers. For instance, through local loop unbundling, retail firms can purchase from the incumbent wholesale access to local loops and thus sell directly to consumers a variety of services, such as broadband internet or voice calls.[11] In the music industry, promoters organize music concerts by essentially securing deals with musicians and booking a venue for the show.[12] For concerts which attract significant demand (e.g., well-known musicians in world tours), there is typically a relatively low number of large capacity venues (over 15,000 seats) in each country (the O2 arena in London, the Manchester Arena in Manchester, the Bercy Arena in Paris or the Lanxess Arena in Cologne), which promoters can book in order to sell tickets for a particular concert.[13]

Therefore each downstream firm $i \in \{1, ..., N\}$ is assumed to have two elements in its cost function: first, the cost associated with the purchase of the essential input from firm U; second, a constant marginal cost of c. Inverse consumer demand is assumed to be linear and given by $p = a - \sum_{i=1}^{N} q_i$, with $a > c$.

The scenario we explore in this paper is one where a retail firm (firm 1, for simplicity) acquires a non-controlling share $\alpha \in (0, 1)$ in firm U's capital. As suggested by Spiegel

[11] Naturally, on top of the wholesale access costs, retail firms then incur a variety of retail costs (e.g., billing, service maintenance, complaints, etc.).

[12] Therefore, on top of the venue's rental costs, promoters must pay musicians, as well as support a variety of marketing costs (namely advertising).

[13] In the case of music concerts, the quantity variable could be interpreted as the number of concerts. For instance, firm U, by renting out its venue for, say, a 3-day block (one day to setup the stage, the concert day, and another day to pack all the material), is effectively allowing a downstream firm to promote one concert. The inverse demand function would thus provide an overall (by all consumers) willingness to pay for a concert, which is inversely related to the number of concerts promoted by downstream firms.

(2011), this is a backward partial vertical integration, where a firm acquires less than 100% of the shares of a supplier. Of critical importance to our analysis is the assumption that this share in firm U's capital does not allow it to control firm U and, in particular, to set wholesale prices. Therefore, the acquisition by firm 1 of a share α of firm U's capital can be seen as a passive ownership which involves pure cash flow rights - firm 1 expects to receive a share of firm U's profits. This setup is similar to that of Greenlee and Raskovich (2006). We differ from it by allowing firm U to price discriminate (in linear prices) between two groups of retail firms: firm 1, its non-controlling shareholder, and its $(N-1)$ retail rivals.[14] Therefore, we assume that firm U sets a wholesale price w_1 per unit purchased by firm 1 and a (possibly different) wholesale price $\bar{w}$ to all other retail firms. Greenlee and Raskovich (2006), by contrast, assume that firm U sets a linear and uniform wholesale price.

Decisions are assumed to be sequential in a three-stage game: first, firm 1 determines α, the share of firm U's capital it intends to acquire; second, firm U sets the wholesale price for the essential input it provides; third, retail firms observe the wholesale price and choose the quantity they provide to final consumers (Cournot competition).

3 Equilibrium results

3.1 Price and quantity choices (second and third stages)

The subgame-perfect equilibrium is obtained by backward induction. In the third stage of the game, each retail firm $j \in \{2, ..., N\}$ chooses a quantity q_j which maximizes its profits $\pi_j = \left(a - q_1 - \sum_{k=2}^{N} q_k\right) q_j - \bar{w}q_j - cq_j$, where $\bar{w}$ is the price set by firm U for each unit produced by firms $j = 2, ..., N$. Symmetry ensures that $q_2 = ... = q_N$, so each firm j will have the following reaction function:

$$q_j = \frac{a - q_1 - \bar{w} - c}{N}, \ \forall j \in \{2, ..., N\} \tag{1}$$

Firm 1 (denoted '$1I$' to highlight that its profits are now those of a backward partially integrated firm) also chooses a quantity q_1 which maximizes its profits $\pi_{1I} = \pi_1 + \alpha\pi_U = \left(a - q_1 - \sum_{k=2}^{N} q_k\right) q_1 - w_1 q_1 - cq_1 + \alpha \left(w_1 q_1 + \sum_{k=2}^{N} \bar{w} q_k\right)$, where the latter term represents the share of firm U's profits received by firm 1. Firm 1's reaction function is given by:

[14] Hunold et al. (2012) also allow for price discrimination to occur at the upstream level.

$$q_1 = \frac{a - \sum_{k=2}^{N} q_k - w_1 - c + \alpha w_1}{2} \tag{2}$$

As it is standard in Cournot settings, we have strategic substitutability. In a Cournot-Nash equilibrium, we have:

$$q_1 = \frac{a - N(1-\alpha) w_1 + (N-1)\bar{w} - c}{N+1} \tag{3}$$

$$q_j = \frac{a + (1-\alpha) w_1 - 2\bar{w} - c}{N+1}, \ \forall j \in \{2, ..., N\} \tag{4}$$

In the second stage of the game, firm U in the upstream segment chooses wholesale prices w_1 and $\bar{w}$ to maximize $\pi_U = w_1 q_1 + \sum_{k=2}^{N} \bar{w} q_k$, which yields the following equilibrium prices:

$$w_1^* = \frac{(2N - \alpha N + 2 + \alpha)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2} \tag{5}$$

$$\bar{w}^* = \frac{(2N - 2\alpha N + 2 - \alpha)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2} \tag{6}$$

Faced with these equilibrium wholesale prices, downstream firms will produce:

$$q_1^* = \frac{(1-\alpha)(\alpha N - \alpha + 2)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2} \tag{7}$$

$$q_j^* = \frac{(2-3\alpha)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2}, \ \forall j \in \{2, ..., N\} \tag{8}$$

Total quantity produced is given by $Q^* = q_1^* + \sum_{k=2}^{N} q_k^* = \frac{(\alpha^2 - 2\alpha N - \alpha^2 N + 2N)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2}$ and the equilibrium retail price is $p^* = a - Q^*$.

Parameter restrictions: We focus on interior solutions in which all downstream firms are active. Two restrictions ensure that all quantities produced in the retail segment are strictly positive. First, for firm 1, in order for $q_1^* > 0$, $4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2 > 0$, which is equivalent to requiring that $\alpha < \tilde{\alpha} = \frac{-2N - 2 + 2^{3/2} N^{1/2} (N+1)^{1/2}}{N-1}$.[15] Note that $\tilde{\alpha}$ is a decreasing function of N and $\lim_{N \to \infty} \tilde{\alpha} = -2 + 2^{3/2} \approx 0.83$. Second, for firms $j \in \{2, ..., N\}$, in order for $q_j^* > 0$, in addition to the previous restriction we must have that $(2 - 3\alpha) > 0$,

[15] The numerator of q_1^* is always positive because $a > c$ by definition.

which is equivalent to requiring that $\alpha < 2/3$. This second restriction is more stringent than the first, and hence provided $\alpha < 2/3$, both q_1^* and q_j^* ($\forall j \in \{2, ..., N\}$) are always positive.[16]

With this setup, we obtain the following results:

Proposition 1 *Provided $\alpha < 2/3$, it is profit-maximizing for firm U to price discriminate between retail firms: $\bar{w}^* < w_1^*$.*

Proof. From equations (5) and (6) we obtain $w_1^* - \bar{w}^* = \frac{(a-c)(2+N)\alpha}{4N-4\alpha N+4-4\alpha-\alpha^2 N+\alpha^2}$, which is positive when $\alpha < 2/3$. ■

By acquiring a share α of firm U's capital, firm 1's profit function becomes different from that of firms $j \in \{2, ..., N\}$. In particular, firm 1 effectively receives a 'rebate' or 'discount' in the wholesale price it pays firm U for each unit it produces. This is equivalent to saying that firm 1's marginal cost becomes, in effect, lower than that of firms $j \in \{2, ..., N\}$. As is standard in a Cournot setting with asymmetric costs, this induces firm 1 to expand its production compared to its competitors. Firm U, however, when deciding which wholesale prices to set, takes this asymmetry into account and, because it defines prices independently from firm 1 (which is now its non-controlling shareholder), finds it profit-maximizing to extract rent from the retail firm with higher input demand - firm 1 - thus charging it a higher wholesale price and effectively moderating firm 1's incentive to expand production (which, in any case, occurs in equilibrium). At a first glance, it appears almost counterintuitive that firm U discriminates *against* its new shareholder - firm 1 -, but it is crucial to understand that firm U sets (wholesale) prices in an independent and profit-maximizing manner. Also, although $\bar{w}^* < w_1^*$ in equilibrium, the 'net' or 'effective' input price paid by firm 1 (because of its α-share in firm U's capital) is $(1-\alpha)\, w_1^* < \bar{w}^*$, which explains why, in equilibrium, firm 1 chooses higher production levels than its retail competitors.[17]

Corollary 1 *Provided $\alpha < 2/3$, an increase in the number of firms at the retail level reduces wholesale prices in an asymmetric manner: $\partial w_1^*/\partial N < 0$ and $\partial \bar{w}^*/\partial N < 0$, but $|\partial w_1^*/\partial N| > |\partial \bar{w}^*/\partial N|$.*

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[16] A more detailed analysis of the implications of this parameter restriction would certainly be very interesting, although we do not pursue it in full in this paper. In general across jurisdictions, a majority shareholding (51 per cent) is sufficient to ensure corporate control. Therefore, this parameter restriction suggests that the acquisition by firm 1 of such a shareholding ($\alpha \leq 0.5$) in firm U's capital is consistent with the interior solutions we are interested in. These interior solutions are also consistent with the acquisition of a larger ($\alpha < 2/3$) share of firm U's capital, as long as it does not provide firm 1 with a majority of voting rights.

[17] From equation (5), we find that $(1-\alpha)\, w_1^* = \frac{(1-\alpha)(2N-\alpha N+2+\alpha)(a-c)}{4N-4\alpha N+4-4\alpha-\alpha^2 N+\alpha^2} < \bar{w}^* = \frac{(2N-2\alpha N+2-\alpha)(a-c)}{4N-4\alpha N+4-4\alpha-\alpha^2 N+\alpha^2}$ for $\alpha < 2/3$.

Proof. From equation (5) and (6), we obtain:

$$\frac{\partial w_1^*}{\partial N} = \frac{4(3\alpha-2)(a-c)\alpha}{(4N-4\alpha N+4-4\alpha-\alpha^2N+\alpha^2)^2} \tag{9}$$

$$\frac{\partial \bar{w}^*}{\partial N} = \frac{(3\alpha-2)(2-\alpha)(a-c)\alpha}{(4N-4\alpha N+4-4\alpha-\alpha^2N+\alpha^2)^2} \tag{10}$$

Both are negative when $\alpha < 2/3$. From these expressions, we obtain:

$$\frac{\partial w_1^*}{\partial N} / \frac{\partial \bar{w}^*}{\partial N} = \frac{4}{2-\alpha} > 0 \tag{11}$$

Therefore, $|\partial w_1^*/\partial N| > |\partial \bar{w}^*/\partial N|$. ■

Again, as is standard with Cournot competition, an increase in the number of firms at the retail level reduces the individual quantity each firm produces (although it increases the overall quantity produced). In turn, this induces firm U to reduce the wholesale price it charges to all firms, although it is profit-maximizing to reduce w_1^* more than $\bar{w}^*$ (thus reducing the asymmetry between wholesale prices) because firm 1's production decreases more than that of its rivals when the number of firms increases.

Corollary 2 *An increase in the share of firm U's capital owned by firm 1 increases wholesale prices in an asymmetric manner: $\partial w_1^*/\partial\alpha > 0$ and $\partial \bar{w}^*/\partial\alpha > 0$, but $|\partial w_1^*/\partial\alpha| > |\partial \bar{w}^*/\partial\alpha|$.*

Proof. From equation (5) and (6), we obtain:

$$\frac{\partial w_1^*}{\partial \alpha} = \frac{[\alpha^2(2N-1)+N^2(4-\alpha^2)+\alpha(4N^2-4)+12+16N](a-c)}{(4N-4\alpha N+4-4\alpha-\alpha^2N+\alpha^2)^2} > 0 \tag{12}$$

$$\frac{\partial \bar{w}^*}{\partial \alpha} = \frac{[4(1-\alpha)+\alpha N^2(4-2\alpha)+N(4+\alpha^2)+\alpha^2](a-c)}{(4N-4\alpha N+4-4\alpha-\alpha^2N+\alpha^2)^2} > 0 \tag{13}$$

From these expressions, we obtain:

$$\frac{\partial w_1^*}{\partial \alpha} - \frac{\partial \bar{w}^*}{\partial \alpha} = \frac{[4(N+1)+\alpha^2(N-1)](N+2)(a-c)}{(4N-4\alpha N+4-4\alpha-\alpha^2N+\alpha^2)^2} \geq 0,\ \forall N \geq 2 \tag{14}$$

■

An increase in α, from firm 1's perspective, increases the 'rebate' it benefits from when purchasing the input from firm U. Therefore, as outlined above, this further induces it to expand its production. In this context, firm U finds it profit-maximizing to further increase the wholesale price it charges firm 1. Strategic substitutability explains why the wholesale price charged to other firms increases as well: the higher wholesale price charged to firm 1 effectively reduces its input demand and, thus, increases that of its rivals. Firm U, therefore, is able to also charge a higher wholesale price to other firms, although this increase is lower than that in firm 1's wholesale price.

Of particular interest from a competition policy perspective is a comparison between a scenario where a partial vertical integration occurs and an alternative scenario where it does not (vertical separation). In the latter, firm 1 does not acquire a share of firm U's capital; instead, firm U (in the upstream segment) sets a uniform wholesale price w^{VS} ('VS' stands for vertical separation) and N firms compete on quantities in the downstream segment.[18] Hence, this scenario is equivalent to setting $\alpha = 0$ in the model of section 2. We obtain the following main result:

Proposition 2 *Provided $\alpha < 2/3$, and in comparison to a vertical separation scenario, backward partial vertical integration with price discrimination leads to input foreclosure and higher retail prices: $w^{VS} < \bar{w}^* < w_1^*$, $q_j^* < q_i^{VS} < q_1^*$, $\forall j \in \{2, ..., N\}$, $\forall i \in \{1, ..., N\}$, $Q^{VS} > Q^*$ and, consequently, $p^{VS} < p^*$.*

Proof. In a vertical separation scenario, $w^{VS} = (a - c)/2$ (readily obtained by substituting $\alpha = 0$ in equations (5) or (6)). We thus obtain $w^{VS} - \bar{w}^* = -\frac{\alpha(2+\alpha(N-1))(a-c)}{2(4N-4\alpha N+4-4\alpha-\alpha^2 N+\alpha^2)} < 0$ if $\alpha < 2/3$. Similarly, under vertical separation, $q_1^{VS} = q_j^{VS} = q^{VS} = \frac{a-c}{2(N+1)}$, $\forall j \in \{2, ..., N\}$ (obtained by substituting $\alpha = 0$ in equations (7) or (8)). From this expression, we obtain:

$$q^{VS} - q_1^* = \frac{\alpha (N-1) [\alpha - 2 - 2(1-\alpha) N] (a-c)}{2(N+1)(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2)} < 0 \text{ if } \alpha < 2/3 \tag{15}$$

because the numerator is always negative and the denominator is positive provided $\alpha < 2/3$. We also obtain:

$$q^{VS} - q_j^* = \frac{\alpha [(2-\alpha) N + 2 + \alpha] (a-c)}{2(N+1)(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2)} > 0 \text{ if } \alpha < 2/3 \tag{16}$$

because the numerator is always positive and the denominator is positive provided $\alpha < 2/3$. Under vertical separation, we obtain $Q^{VS} = \frac{N(a-c)}{2(N+1)}$ which then yields:

$$Q^{VS} - Q^* = \frac{\alpha^2 (N+2)(N-1)(a-c)}{2(N+1)(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2)} > 0 \text{ if } \alpha < 2/3 \tag{17}$$

[18] Note that under vertical separation, firm U's finds it profit-maximizing *not* to price discriminate, that is, to charge a uniform wholesale price, w^{VS}, to all retail firms.

as the numerator is always positive and the denominator is positive provided $\alpha < 2/3$. Finally, $p^{VS} = a - Q^{VS}$ whilst $p^* = a - Q^*$. Therefore, because $Q^{VS} > Q^*$ we have $p^{VS} < p^*$. ■

As outlined above, the main rationale for this result originates in firm 1's incentive to expand its production when it acquires a share α in the capital of firm U. Given that it sets prices independently from firm 1 (a non-controlling shareholder), firm U finds it profit maximizing to charge firm 1 a higher wholesale price than that charged to its retail rivals. However, both are higher than the wholesale price which would be charged under vertical separation, thus leading to input foreclosure. Again, strategic substitutability helps to explain this result: firm 1's incentive to expand production explains why firm U increases its wholesale price (w_1^*); in turn, this helps to constrain firm 1's incentive and, thus, allows its downstream rivals to increase their production and, hence, their input demand, and firm U finds it profit-maximizing to increase the wholesale price it charges them ($\bar{w}^*$) as well. In equilibrium, firm 1 produces more than it would under vertical separation, whilst its rival firms produce less. The former has a lower magnitude than the latter and hence partial vertical integration reduces the overall quantity produced and leads to higher retail prices. Hunold et al. (2012) obtain a similar result to this one: backward partial vertical integrations clearly appear to have anti-competitive effects.

3.2 Capital share choice (first stage)

In the first stage of the game, firm 1 chooses the share α it wishes to acquire in firm U's capital. As outlined above, retail firms produce q_1^* and $q_j^*, \forall j \in \{2, ..., N\}$, given by equations (7) and (8) respectively. Firm U chooses wholesale prices w_1^* and $\bar{w}^*$ given by equations (5) and (6) respectively. Conditional on this, firm 1's profits are:

$$\begin{aligned}
\pi_{1I} &= \left(a - q_1^* - \sum_{k=2}^{N} q_k^*\right) q_1^* - w_1^* q_1^* - c q_1^* + \alpha \left(w_1^* q_1^* + \sum_{k=2}^{N} \bar{w}^* q_k^*\right) \\
&= \left(\begin{array}{c} 4 - 16\alpha + 21\alpha^2 - 9\alpha^3 + \alpha^4 + 4\alpha N + 4\alpha N^2 - 9\alpha^2 N^2 - \\ -8\alpha^2 N + 4\alpha^3 N^2 + 5\alpha^3 N + \alpha^4 N^2 - 2\alpha^4 N \end{array}\right) \cdot \\
&\quad \cdot \frac{(a-c)^2}{(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2)^2}
\end{aligned} \tag{18}$$

We thus obtain the following result:

Proposition 3 *In the first stage of the game, firm* 1 *chooses* $\alpha^* \simeq 0.55$.

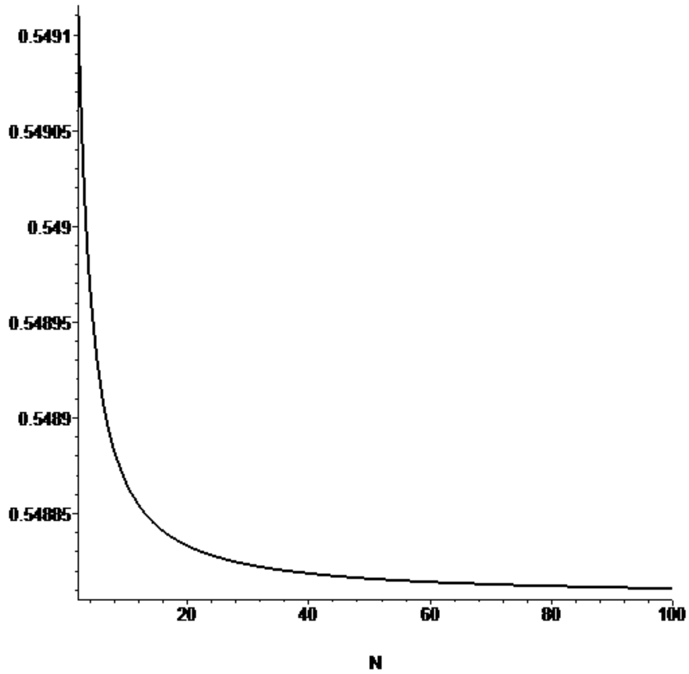

Figure 1: Numerical solution for α^* as a function of N

Proof. Firm 1 maximizes its profits (given by equation (18)) when $\partial\pi_{1I}/\partial\alpha = 0$, which is equivalent to requiring that:

$$\left[\begin{array}{c} \left(-4\alpha^4 - 18\alpha^3 + 60\alpha^2 - 56\alpha + 16\right) N^2 + \left(5\alpha^4 - 68\alpha^3 + 168\alpha^2 - 160\alpha + 48\right) N + \\ + \left(-\alpha^4 - 10\alpha^3 + 60\alpha^2 - 88\alpha + 32\right) \end{array}\right] \cdot \frac{(N-1)(a-c)^2}{\left(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2\right)^3} = 0 \tag{19}$$

The denominator $(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2)$ is positive under the restriction that $\alpha < 2/3$; $(N-1)$ is always positive; $(a-c)$ is positive by definition. Therefore, this first-order condition is satisfied when:

$$\begin{aligned} 0 \;=\; & \left(-4\alpha^4 - 18\alpha^3 + 60\alpha^2 - 56\alpha + 16\right) N^2 + \left(5\alpha^4 - 68\alpha^3 + 168\alpha^2 - 160\alpha + 48\right) N + \\ & + \left(-\alpha^4 - 10\alpha^3 + 60\alpha^2 - 88\alpha + 32\right) \end{aligned} \tag{20}$$

This equation does not have an analytical solution. However, numerically we can plot the values of α and N which satisfy it, as shown in Figure 1. Therefore, although α^* (the equilibrium first-stage choice of firm 1) depends on N, Figure 1 shows that $\alpha^* \simeq 0.55$.

■

Therefore, backward partial integration by firm 1 is profitable, i.e., by acquiring a share in firm U's capital, firm 1 obtains higher profits than under a scenario of vertical separation (where $\alpha = 0$). The rationale is straightforward and consistent with our results from Section 3.1: a share α in firm U's capital allows firm 1 to expand its production (in equilibrium) which, because of the lower equilibrium price, lowers its retail profits.[19] However, this negative effect is more than compensated by the share it receives of firm U's profits: indeed, firm 1's production expansion allows firm U to increase the wholesale prices it charges (both to firm 1 and to the remaining $j \in \{2, ..., N\}$ firms - see Proposition 2) and, thus, to increase its profits (although the total quantity sold in the retail market decreases with backward partial integration - see Proposition 2 -, firm U obtains a higher profit margin on each unit sold, and the latter effect is dominant). This result resembles that of Okamura et al. (2011), who, in a forward integration setting (where the upstream firm may acquire a share in the capital of a downstream firm), find that the acquiring firm also chooses an aggressive strategy, trading-off the profits it loses on its sales with the increased profits accruing from the capital share it acquires.

Importantly, we follow Hunold et al. (2012) in assessing whether backward partial integrations increase the combined profits of the upstream and downstream (acquiring) firms. In effect, as they note, the key condition for such acquisitions to materialize is that there are gains from trading claims on the upstream firm's profits between this firm and a downstream (acquiring) firm.

Corollary 3 *There exists a $\alpha > 0$ such that the combined profits of the upstream and downstream (acquiring) firm are higher than when $\alpha = 0$.*

Proof. In equilibrium, firm U's profits are given by:

$$\pi_U^* = \frac{(\alpha + N - \alpha N)(a-c)^2}{(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2)} \tag{21}$$

Using this equation, as well as equation (18), the combined profits of the two firms are given by:

$$\begin{aligned}(1-\alpha)\pi_U^* + \pi_{1I}^* &= \begin{pmatrix} 4 - 12\alpha + 13\alpha^2 - 4\alpha^3 + 4N + 4N^2 - 4\alpha N - 8\alpha N^2 + \\ +2\alpha^2 N^2 - 3\alpha^2 N + 2\alpha^3 N^2 + 2\alpha^3 N \end{pmatrix} \cdot \\ &\cdot \frac{(a-c)^2}{(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2)^2}\end{aligned} \tag{22}$$

[19] With the acquisition of a share α in firm U's capital, firm 1's profits are the sum of its retail profits and the share α of firm U's profits: $\pi_{1I} = \pi_1^* + \alpha\pi_U^*$.

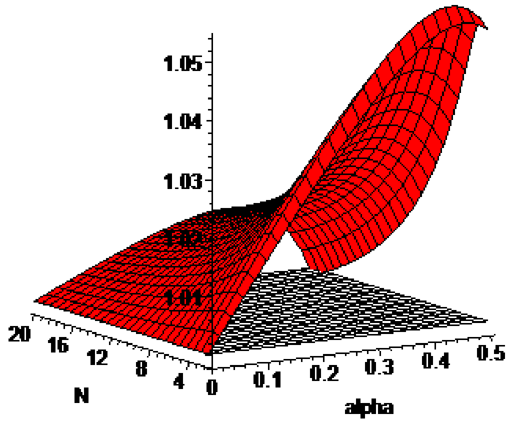

Figure 2: Graphic of $\frac{(1-\alpha)\pi_U^* + \pi_{1I}^*}{\pi_U^{VS} + \pi_1^{VS}}$ for $N \leq 20$ and $0 \leq \alpha \leq 1/2$

The combined profits under vertical separation (i.e., when $\alpha = 0$) are given by:

$$\pi_U^{VS} + \pi_1^{VS} = \frac{\left(N^2 + N + 1\right)(a-c)^2}{4\left(N+1\right)^2} \tag{23}$$

Graphically (see Figure 2), it can be shown that, for a given N, there exists a $\alpha > 0$ such that $\frac{(1-\alpha)\pi_U^* + \pi_{1I}^*}{\pi_U^{VS} + \pi_1^{VS}} > 1$.[20]

■

Therefore, regardless of the bargaining process which underlies the acquisition of a capital share in firm U, there are potential gains from trade to be realized and, therefore, backward partial integration is desirable (compared to vertical separation). This contrasts with Hunold et al. (2012), who find that not to be the case when there is an upstream monopolist.

Not surprisingly, from a social welfare viewpoint, we find that:

Proposition 4 *Backward partial integration is detrimental to social welfare (compared to vertical separation).*

Proof. Social welfare is given by: $SW = CS + \Pi$, where CS denotes consumer surplus and Π is the overall sum of firms' profits, i.e., $\Pi = (1-\alpha)\,\pi_U^* + \pi_1^* + \sum_{j=2}^{N} \pi_j^*$ (note that π_1^*

[20] Figure 2 contains only scenarios where $N \leq 20$, but the same result holds for $N > 20$.

already includes the share of firm U's profits received by firm 1: $\alpha\pi_U^*$).

Consumer surplus is given by:

$$\begin{aligned} CS &= \left(\int_0^{Q^*} a - Q - p^*\right) dQ \\ &= \frac{\left(\alpha^2 - 2\alpha N - \alpha^2 N + 2N\right)^2 (a-c)^2}{2\left(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2\right)^2} \end{aligned} \tag{24}$$

whereas firm U's profits are given by equation (21) and firm j's profits are given by:

$$\pi_j^* = \frac{(2-3\alpha)^2 (a-c)^2}{\left(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2\right)^2} \tag{25}$$

Therefore, total industry profits are given by (firm 1's profits are given by equation (18)):

$$\begin{aligned} \Pi &= (1-\alpha)\,\pi_U^* + \pi_1^* + \sum_{j=2}^{N} \pi_j^* \\ &= \frac{2(1-\alpha)(N+2)\left(\alpha^2 - 2\alpha N - \alpha^2 N + 2N\right)(a-c)^2}{\left(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2\right)^2} \end{aligned} \tag{26}$$

Social welfare thus becomes equal to:

$$\begin{aligned} SW &= CS + \Pi \\ &= \frac{\left(\alpha^2 - 2\alpha N - \alpha^2 N + 2N\right)\left(\alpha^2 - \alpha^2 N - 6\alpha N + 6N + 8 - 8\alpha\right)(a-c)^2}{2\left(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2\right)^2} \end{aligned} \tag{27}$$

The derivative of social welfare with respect to α is given by:

$$\frac{\partial SW}{\partial \alpha} = \frac{4\alpha(1-\alpha)(\alpha-2)(N-1)(N+2)^2 (a-c)^2}{\left(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 N + \alpha^2\right)^3} < 0 \tag{28}$$

Therefore, any $\alpha > 0$ leads to lower social welfare than under vertical separation. ■

Intuitively, this result is straightforward: compared to a scenario of vertical integration, Proposition 2 shows that $Q^{VS} > Q^*$ and, consequently, $p^{VS} < p^*$. Therefore, because backward partial integration leads to a price increase and an overall quantity decrease, both consumer surplus and total industry profits are necessarily lower. However, the distribution of industry profits changes: firm 1 obtains higher profits (for any $\alpha \leq \alpha^*$) and firms $j \in \{2, ..., N\}$ obtain lower profits; firm U's profits increase, but the share which is not appropriated by firm 1 (equivalent to $(1-\alpha)\,\pi_U^*$) decreases. Therefore, backward partial integration clearly benefits firm 1's shareholders, whilst all other retail firms and the remaining (controlling) shareholders of firm U are harmed.

4 Conclusion

In this paper, we have analyzed the possibility of a retail firm acquiring a partial non-controlling interest in the capital of a key input supplier (backward partial vertical integration), where the latter is then assumed to choose its wholesale prices independently from this stake and, in particular, it is allowed to price discriminate between its (now) retail shareholder and its competitors. We find that it is profit-maximizing for the upstream firm to indeed price discriminate between retail firms, but contrary to what one would probably expect, the upstream firm discriminates *against* its retail shareholder, charging it a higher wholesale price than that charged to its rivals. Increased competition at the retail level reduces all wholesale prices, but more so that which the acquiring downstream firm faces, as this increased competition has a more adverse effect on the quantity it produces than in the quantity produced by each of its rivals. We also find that, compared to a vertical separation scenario where the capital acquisition does not occur, this partial vertical integration leads to input foreclosure and ultimately to higher retail prices and lower social welfare - a result similar to that obtained by Hunold et al. (2012). However, contrary to the latter, we find that backward partial integration is desirable, as it increases the combined profits of the upstream and downstream (acquiring) firm and generates gains from trading the claims on the upstream firm's profits. From a competition policy viewpoint, and in comparison to the results of Greenlee and Raskovich (2006), our analysis suggests that the possibility for price discrimination at the wholesale level is at the root of the harm to consumers through higher retail prices and, thus, in the analysis of such partial integrations, particular care should be taken to prevent discriminatory pricing.

Whether these results are more general than in the particular setting we have analysed is clearly an important research question. For instance, can they be generalized beyond Cournot competition at the retail level (as in Greenlee and Raskovich, 2006) or beyond the assumption of a monopoly at the upstream level (as in Hunold et al., 2012)? How important is the form of competition at the retail and/or at the upstream level for these results to hold? Moreover, what would be the implications of these results both for the bargaining process underlying the capital share acquisition (i.e., the price paid by the acquiring downstream firm for the stake in the upstream firm's capital) as well as for firms' market value? The latter would, in particular, allow for the development of predictions which could be empirically tested. These are clearly important and interesting future research questions.

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