Backward partial vertical integration through private placement*

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Abstract

We analyse the market impact of a partial vertical integration whereby a subset of retail firms acquire, through a private placement operation, 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 the retail firms which (now) own a stake in its capital and all of their retail rivals. We find that price discrimination is optimal and, compared to a vertical separation scenario, there is input foreclosure, a higher retail price and lower social welfare, which suggests that, from a competition policy viewpoint, such partial vertical integrations should be analysed with particular concern. However, conducting a private placement operation of the upstream firm's capital yields gains from trade and we are able to identify the optimal characteristics of such an operation.

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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 full vertical integration, such partial vertical integrations may (i) 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), (ii) facilitate cooperation when contracts are incomplete (Allen and Phillips, 2000; Fee et al., 2006) and (iii) contribute to a reduction in the double marginalization problem.[1] The latter explanation is particularly relevant for competition policy: vertical mergers of firms with market power typically attract scrutiny from competition authorities because of 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.[2] 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.

Such acquisitions may materialise through competitive bid offerings or private placements (Smith, 1986).[3] Empirical results show that competitive bid offerings yield lower flotation costs than private placements, and yet most firms which are not obliged to proceed otherwise prefer the latter (Smith, 1986; Cronquist and Nilsson, 2005). As Wu (2004) notes, (i) high information asymmetries (Chemmanur and Fulghieri, 1999) and (ii) the need to enhance the monitoring of managers typically work in favour of private placements, although the latter appears to lack empirical support (Hertzel and Smith, 1993; Wu, 2004).[4]

This paper weds these two strands of the literature by analysing a backward partial

[1] The (relatively scarce) literature on partial vertical integrations yields results which differ somewhat from full vertical mergers, as initially suggested by Baumol and Ordover (1994). This literature can be 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 (e.g., Spiegel, 2013); 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 (e.g., Greenlee and Raskovich; 2006; Hunold et al., 2012).

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

[3] Competitive bid offerings include initial public offerings (IPO) as well as share issues (depending on whether a firm is already listed or not).

[4] Wu (2004) also observes that managers may be more capable of influencing the ownership structure through private placements, as their preferences can steer the search for investors. If that is the case, managers may be more inclined to conduct such partial integrations through private placements.

vertical integration - whereby downstream firms acquire a non-controlling share in the capital of an upstream firm - through a private placement operation. This is both a frequent and interesting phenomenon: Wu (2004) finds that 15% of private placement investors are 'strategic alliance partners', including suppliers, customers and strategic partners. Fee et al. (2006) find that partial equity stakes are more likely along the supply chain when firms are involved in formal alliance agreements and Allen and Phillips (2000) find that such acquisitions generate excess returns. In particular, Allen and Phillips (2000) find that private placements involving firms with a strategic product market relationship attract a premium (and lead to increased operating cash flows), in stark contrast with the discount generally associated with private placements (see Finnerty, 2013); moreover, Cronquist and Nilsson (2005) find empirical evidence suggesting that firms which have a strategic alliance are more likely to issue equity to their business partners through a private placement.

Our underlying supply chain setup 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 the retail firms with a non-controlling stake in the upstream firm's capital and another which contains its rivals in the downstream segment. Under this setup, we then analyse the potential profitability of a backward partial integration through a private placement operation, with the help of a financial intermediary.[5] We are particularly interested in understanding the rationale for the financial intermediary's choice of the number of retail firms to approach in the operation and we explore two different motivations underlying the private placement: a 'benevolent' motivation, which seeks to maximize gains from trade, and a 'self-interest' motivation, which aims to maximize the upstream firm's post-integration profits. To the best of our knowledge, this is one of the first papers to look at the optimal characteristics of private placements.

Under backward partial vertical integration, we find that (i) it is profit-maximizing for

[5] Sjostrom (2013) notes that issuing companies often use investment banks as placement agents, whose role is to seek interested investors, and which play an important monitoring role of the issuing firm because of informational asymmetries between managers and potential capital acquirers (Smith, 1986).

the upstream firm to price discriminate between retail firms, charging a *higher* wholesale price to the retail firms which own a non-controlling stake in its capital; (ii) compared to a scenario of vertical separation (where the partial integration does not occur), there is input foreclosure and the final retail price is higher;[6] (iii) the partial integration has a detrimental effect on social welfare but (iv) is profitable.[7] Results (i), (ii) and (iii) are similar to those obtained by Hunold et al. (2012); however, contrary to result (iv), they find that backward partial integration is only desirable if upstream competition is sufficiently intense.[8,9] Result (v) shows that private placement operations 'benevolently' motivated involve more retail firms than those motivated by self-interest.

Result (i) appears, at first glance, counterintuitive, as one would expect the upstream firm, if allowed to price discriminate, to favour the retail firms which have acquired a share in its capital.[10] Not surprisingly, this occurs in equilibrium, but in a subtle way: the capital stake held by a subset of retail firms works as a rebate to the wholesale price they face. This, in turn, induces them to expand production ('output expansion effect') and, thus, their demand for the upstream input. The upstream firm takes advantage of this increased demand and finds it profit-maximizing to charge those firms a higher 'gross' wholesale price than that which it charges their rivals, but in 'net' terms (i.e., once the share of the upstream firm's profits are considered), the wholesale price is effectively lower, as one would expect.

[6] We follow Salinger (1988) in defining input foreclosure as occurring when wholesale prices increase (in our case, compared with those charged under vertical separation).

[7] That is, there are gains from trade in the acquisition of a strictly positive share of the upstream firm's capital by a subset of retail firms.

[8] Hunold et al. (2012), Proposition 2. Their result is obtained under a Bertrand duopoly in the downstream segment (which contrasts with our N-firm Cournot competition assumption). We discuss this further in Section 3.1.

[9] The live music industry - for which, as we argue below, our model appears to be a good depiction - has several examples of (various degrees) of vertical integration (partial equity interest, lease, booking rights or ownership). For instance, AEG Live is the live-entertainment division of the Anschutz Entertainment Group (AEG), which promotes live music and entertainment events; over time, AEG has acquired or leased several venues, such as the O2 arena, Wembley Arena and Hammersmith Apollo (London, UK) (the latter two have been assessed and cleared by the OFT and Competition Commission). Live Nation Entertainment is also a promoter of live music events and has also been active in the acquisition (full or partial) or lease of venues (139 as of 2012), especially in the US and UK. Notably, Live Nation current holds both a long-term lease and a shareholding of the Ziggo Dome (Amsterdam). In Portugal, the MEO Arena (Lisbon) was acquired, in 2012, by a firm whose shareholders include two live music event promoters.

[10] A full vertical merger would typically yield such a result: the upstream firm would charge a wholesale price equal to marginal cost to its (now) downstream subsidiary and (possibly) choose to constrain input access to its rivals (Motta, 2004, p. 375; Inderst and Valletti, 2011).

Results (ii) and (iii) convey interesting competition policy implications: the output expansion effect of the upstream firm's non-controlling shareholders comes together with input foreclosure to their retail rivals, and the latter is the dominant effect, which leads to a lower total quantity, a higher final retail price and lower social welfare. This result - similar to Hunold et al. (2012) - is clearly different from Greenlee and Raskovich (2006) and from Höffler and Kranz (2011).[11,12] Therefore, a policy implication of our results is that competition authorities should analyse such partial vertical integrations with particular concern and, if possible, constrain the upstream firm's ability (post-acquisition) to price discriminate.

Result (iv) has two relevant implications: first, it justifies the role of a financial intermediary in a private placement operation; second, it is an example of a private placement operation that would justify a premium (rather than a discount), which is consistent with Allen and Phillips's (2000) results when strategic partners are involved. Finally, result (v) contains interesting and relevant insights, naturally related with results (i)-(iv). For a given non-controlling share of the upstream firm's capital to be sold, if self-interest is the primary motivation of the private placement, it is optimal to restrict it to a single investor; by contrast, if the objective is to maximize gains from trade, a financial intermediary finds it optimal *not* to be that restrictive. In particular, depending on the retail market size and the magnitude of the non-controlling share in the upstream firm, the optimal number of retail firms involved is at least one but it is never optimal to approach all retail firms. Underlying this result is the balance of the output expansion effect for a subset of retail firms with the inevitable output contraction (because of input foreclosure) of their rivals.

The paper has the following structure: section 2 describes the model; section 3 contains the main results and section 4 concludes. Three appendices contain complementary results.

[11] In Greenlee and Raskovich (2006), the upstream firm also faces increased input demand when retail firms acquire partial stakes in its capital and, thus, raises wholesale prices. But these two effects cancel out under linear and uniform wholesale prices, and total output and final consumer prices remain unaffected.

[12] Höffler and Kranz (2011) compare 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. They find that, under legal unbundling, although the vertically integrated downstream firm has incentives to expand its output and their downstream rivals reduce their output (under quantity competition), the net effect on total quantity ('downstream expansion effect') is positive (whereas in our case it is negative). The difference is explained by the fact that, in their model, the discrimination tool does not affect the upstream firm's profits directly, whereas in our case it does.

2 The model

We assume a supply chain with an 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 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 and this allows them to sell services directly to consumers.[13] In the music industry, promoters organize music concerts by essentially securing deals with musicians and booking a venue for the show.[14] 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 in each country, which promoters can book in order to sell tickets for a particular concert.[15,16]

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 $K \leq N$ retail firms acquire a sym-

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

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

[15]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 set up 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.

[16]Examples of venues with over 15,000 seats are the O2 arena in London, the Manchester Arena in Manchester, the Bercy Arena in Paris or the Lanxess Arena in Cologne.

metric non-controlling share $\alpha \in (0,1)$ in firm U's capital. We are particularly interested in symmetric share ownerships and thus assume that $\alpha = \Omega/K$, where Ω is the total share of firm U's capital acquired by K retail firms. Of critical importance to our analysis is the assumption that the share α in firm U's capital does not give any retail firm control over firm U - particularly, it does not give them control over wholesale prices. Therefore, this capital acquisition by K retail firms can be seen as a passive ownership which involves pure cash flow rights - the expectation to receive a share of firm U's profits. This setup is similar to that of Greenlee and Raskovich (2006), but differs from it in two important aspects. First, Greenlee and Raskovich (2006) only consider the acquisition of a share in firm U's capital by *all* retail firms, whilst we allow only a subset of K firms to do so; second, we allow firm U to price discriminate (in linear prices) between two groups of retail firms: its K non-controlling shareholders and their $(N-K)$ retail rivals.[17] Therefore, we assume that firm U sets a linear wholesale price w_K applicable to each of K retail firms and a (possibly different) wholesale price $\bar{w}$ for all other retail firms. Greenlee and Raskovich (2006), by contrast, assume that firm U sets a linear and uniform wholesale price. Appendix C relaxes this assumption and considers the possibility of (possibly discriminatory) two-part tariffs.

Decisions are assumed to be sequential in a three-stage game: in the second stage, firm U sets the wholesale price for the essential input and in the third stage retail firms observe it and choose the quantity they provide to final consumers (Cournot competition). In the first stage, a financial intermediary assesses the potential profitability of a backward partial vertical integration and, conditional on the capital share Ω that the upstream firm is willing to sell, decides how many K firms to approach in a private placement.

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 $j \in \{K+1, ..., N\}$ chooses a quantity q_j which maximizes its profits, $\pi_j = \left(a - \sum_{k=1}^{K} q_k - \sum_{i=K+1}^{N} q_i\right) q_j - \bar{w}q_j - cq_j$, where $\bar{w}$ is the wholesale price they face.

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

Symmetry ensures that $q_{K+1} = ... = q_N$, so each firm j has the following reaction function:

$$q_j = \frac{a - \sum_{k=1}^{K} q_k - \bar{w} - c}{1 + N - K}, \ \forall j \in \{K+1, ..., N\} \tag{1}$$

Each retail firm $k \in \{1, ..., K\}$ (denoted 'kI' to highlight that its profits are now those of a backward partially integrated firm) also chooses a quantity q_k which maximizes its profits $\pi_{kI} = \pi_k + \alpha\pi_U = \left(a - \sum_{i=1}^{K} q_i - \sum_{j=K+1}^{N} q_j\right) q_k - w_K q_k - c q_k + \alpha\left(w_K \sum_{i=1}^{K} q_i + \bar{w} \sum_{j=K+1}^{N} q_j\right)$, where the latter term represents the share of firm U's profits received by each firm k. Symmetry ensures that $q_1 = ... = q_{K,}$ so each firm k has the following reaction function:

$$q_k = \frac{a - \sum_{j=K+1}^{N} q_j - w_K - c + \alpha w_K}{K+1} \tag{2}$$

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

$$q_k = \frac{a - (1 + N - K)(1-\alpha) w_K + (N-K)\bar{w} - c}{N+1}, \ \forall k \in \{1, ..., K\} \tag{3}$$

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

In the second stage of the game, firm U in the upstream segment chooses wholesale prices w_K and $\bar{w}$ to maximize $\pi_U = w_K \sum_{k=1}^{K} q_k + \bar{w} \sum_{j=K+1}^{N} q_j$. In equilibrium, we obtain:

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

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

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

$$q_k^* = \frac{(1-\alpha)(\alpha N - \alpha K + 2)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2}, \ \forall k \in \{1, ..., K\} \tag{7}$$

$$q_j^* = \frac{(2 - 2\alpha - \alpha K)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2}, \ \forall j \in \{K+1, ..., N\} \tag{8}$$

Total quantity produced is given by $Q^* = \sum_{k=1}^{K} q_k^* + \sum_{j=K+1}^{N} q_j^* = \frac{\left(\alpha^2 K^2 - 2\alpha N - \alpha^2 NK + 2N\right)(a-c)}{4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2}$ and the equilibrium retail price is $p^* = a - Q^*$.

Parameter restrictions: Two restrictions ensure that all retail quantities produced are strictly positive and that all downstream firms are active. First, in order for $q_k^* > 0$, we need $(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2) > 0$, which is equivalent to requiring that $\alpha < \tilde{\alpha} = \frac{-2\left[N+1-(N+1)^{1/2}(K+1)^{1/2}(1+N-K)^{1/2}\right]}{K(N-K)}$.[18] Second, in order for $q_j^* > 0$, in addition to the previous restriction we must have that $(2 - 2\alpha - \alpha K) > 0$, which is equivalent to requiring that $\alpha < \frac{2}{2+K}$. This second restriction is more stringent than the first, and hence provided $\alpha < \frac{2}{2+K}$, both q_k^* and q_j^* $(\forall k \in \{1, ..., K\}, \forall j \in \{K+1, ..., N\})$ are always positive.[19]

With this setup, we obtain the following results:

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

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

By acquiring a share α of firm U's capital, the profit function of each firm $k \in \{1, ..., K\}$ becomes different from that of firms $j \in \{K+1, ..., N\}$. In particular, each firm k effectively receives a 'rebate' or 'discount' in the wholesale price it pays firm U. This is equivalent to saying that each firm k's marginal cost becomes, in effect, lower than that of firms $j \in \{K+1, ..., N\}$. As is standard in a Cournot setting with asymmetric costs, this induces K firms to expand their production ('output expansion effect') and their $(N-K)$ competitors, because of strategic substitutability, to lower their production (given wholesale prices) . Firm U, however, when deciding which wholesale prices to set, takes this asymmetry into account and, because it defines prices independently, finds it profit-maximizing to extract rent from the K retail firms with higher input demands, thus charging them a higher wholesale price and effectively moderating their incentive to expand production (which, in any case, occurs in

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

[19] A more detailed analysis of the implications of this parameter restriction would certainly be very interesting, although we do not pursue it. In general across jurisdictions, a majority shareholding (51 per cent) is sufficient to ensure corporate control. Therefore, this parameter restriction suggests that whenever $K \geq 2$, the acquisition by K firms of a shareholding in firm U's capital entails an individual shareholding of $\alpha \leq 0.5$, consistent with it being a non-controlling shareholding and with the interior solutions we are interested in.

equilibrium). At a first glance, it appears almost counterintuitive that firm U discriminates *against* its new shareholders - the K retail firms -, but it is crucial to understand that firm U sets (wholesale) prices in an independent and profit-maximizing manner. Also, although $\bar{w}^* < w_K^*$ in equilibrium, the 'net' or 'effective' input price paid by each firm $k \in \{1, ..., K\}$ (because of their α-share in firm U's capital) is $(1-\alpha) w_K^* < \bar{w}^*$, which explains why, in equilibrium, K firms choose higher production levels than their retail competitors.[20]

These results yield interesting comparative statics which we discuss in detail in Appendix A. In particular, we find that (i) both wholesale prices decrease with N but $|\partial w_K^*/\partial N| > |\partial \bar{w}^*/\partial N|$ (increased wholesale price asymmetry as N increases); and (ii) an increase in α increases both wholesale prices, but $|\partial w_K^*/\partial \alpha| > |\partial \bar{w}^*/\partial \alpha|$ (increased wholesale price asymmetry as α increases).

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 U sets a uniform wholesale price w^{VS} ('VS' stands for vertical separation) and N firms compete on quantities in the downstream segment.[21] This is equivalent to setting $\alpha = 0$ in our model. We obtain the following result:

Proposition 2 *Provided* $\alpha < \frac{2}{2+K}$, *and in comparison to a vertical separation scenario, backward partial vertical integration with price discrimination leads to input foreclosure and higher retail prices:* $w^{VS} < \bar{w}^* < w_K^*$, $q_j^* < q_i^{VS} < q_k^*$, $\forall k \in \{1, ..., K\}$, $\forall j \in \{K+1, ..., N\}$, $\forall i \in \{1, ..., N\}$, $Q^{VS} > Q^*$ *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 $w^{VS} - \bar{w}^* = -\frac{\alpha K[2+\alpha(N-K)](a-c)}{2(4N-4\alpha N+4-4\alpha-\alpha^2 NK+\alpha^2 K^2)} < 0$ if $\alpha < \frac{2}{2+K}$. Similarly, under vertical separation, $q_k^{VS} = q_j^{VS} = q^{VS} = \frac{a-c}{2(N+1)}$, $\forall k \in \{1, ..., K\}$, $\forall j \in \{K+1, ..., N\}$ (obtained by substituting $\alpha = 0$ in equations (7) or (8)). From this expression, we obtain:

[20] From equations (5) and (6), we find that $(1-\alpha) w_K^* = \frac{(1-\alpha)(2N-\alpha N+2+\alpha K)(a-c)}{4N-4\alpha N+4-4\alpha-\alpha^2 NK+\alpha^2 K^2} < \bar{w}^* = \frac{(2N-2\alpha N+2-2\alpha+\alpha K)(a-c)}{4N-4\alpha N+4-4\alpha-\alpha^2 NK+\alpha^2 K^2}$ for $\alpha < 2/(2+K)$.

[21] 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.

$$q^{VS} - q_k^* = \frac{\alpha (N-K) [-2N(1-\alpha) - 2 + \alpha (2-K)] (a-c)}{2(N+1)(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2)} < 0 \text{ if } \alpha < \frac{2}{2+K} \quad (9)$$

because the numerator is always negative and the denominator is positive provided $\alpha < \frac{2}{2+K}$. We also obtain:

$$q^{VS} - q_j^* = \frac{\alpha K [(2-\alpha) N + 2 + \alpha K] (a-c)}{2(N+1)(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2)} > 0 \text{ if } \alpha < \frac{2}{2+K} \quad (10)$$

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

$$Q^{VS} - Q^* = \frac{\alpha^2 K (N+2)(N-K)(a-c)}{2(N+1)(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2)} > 0 \text{ if } \alpha < \frac{2}{2+K} \quad (11)$$

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

As outlined above, the main rationale for this result originates in K firms' output expansion effect. Firm U sets prices independently from its K non-controlling shareholders and finds it profit maximizing to charge these K firms a higher (gross) wholesale price than that charged to their retail rivals. This wholesale price increase is insufficient to curb the output expansion effect, which occurs in equilibrium. And this increased wholesale price (w_K) applicable to the K firms also induces their $(N-K)$ rivals to demand more input. In this case, the upstream firm finds it profitable to also increase their wholesale price ($\bar{w}$), reducing, in equilibrium, those firms' demand. In other words, the output expansion effect of K firms (and the output reduction of their $(N-K)$ rivals for given wholesale prices - a strategic substitutability effect) is incorporated into the upstream firm's decisions, which finds it profitable to increase w_K, thus taking advantage of the output expansion effect, and also to increase $\bar{w}$, thus taking advantage of the fact that $(N-K)$ would produce more as w_K increases.[22] In effect, the upstream profits accruing from the K firms are higher than under vertical separation (higher wholesale price and increased quantity sold) and those coming

[22]It is interesting to analyse the differences between our results and a setting where K firms have a lower marginal cost than the remaining $(N-K)$ firms, which we explore in detail in Appendix B. In that

from their $(N-K)$ rivals are lower (higher wholesale price and decreased quantity sold, but the latter dominates); therefore, the upstream monopolist finds it optimal to trade-off lower profits coming from $(N-K)$ firms with increased profits coming from K firms, and this allows it to increase its overall profits vis-a-vis vertical separation. Therefore, both wholesale prices under partial vertical integration are higher than the wholesale price charged under vertical separation, thus leading to input foreclosure. In equilibrium, the output expansion effect of the K firms is insufficient to compensate the input foreclosure effect for their $(N-K)$ rivals and, therefore, 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.

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

Proposition 3 *Provided $\alpha < \frac{2}{2+K}$, 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., $\Pi = (1-\alpha K)\,\pi_U^* + \sum_{k=1}^{K} \pi_{kI}^* + \sum_{j=K+1}^{N} \pi_j^*$.[23]

Consumer surplus is given by:

$$
\begin{aligned}
CS &= \left(\int_0^{Q^*} a - Q - p^* \right) dQ \\
&= \frac{\left(\alpha^2 K^2 - 2\alpha N - \alpha^2 NK + 2N\right)^2 (a-c)^2}{2\left(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2\right)^2}
\end{aligned}
\tag{12}
$$

Total industry profits are given by:

situation, K firms have incentives to increase their output (output expansion effect) and their rivals will reduce theirs (through strategic substitutability, given wholesale prices). In this case, however, the upstream firm needs to increase the wholesale price w_K by *less* than in the partial vertical integration case. This lower wholesale price increase (naturally) has a less significant impact in moderating the output expansion effect; in addition, its impact on the production levels of the $(N-K)$ rivals is profitable for the upstream firm, which chooses not to change $\bar{w}$ (in equilibrium, it charges $(N-K)$ rivals the same wholesale price as under vertical separation). The combination of these two effects actually leads to an overall output expansion, compared to the output reduction we observe under partial vertical separation.

[23] Note that π_{kI}^* already includes the share of firm U's profits received by each firm k: $\alpha\pi_U^*$.

$$
\begin{aligned}
\Pi &= (1-\alpha K)\,\pi_U^* + \sum_{k=1}^{K} \pi_{kI}^* + \sum_{j=K+1}^{N} \pi_j^* \\
&= \frac{2\,(1-\alpha)\,(N+2)\,(\alpha^2K^2 - 2\alpha N - \alpha^2 NK + 2N)\,(a-c)^2}{(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2)^2} \qquad (13)
\end{aligned}
$$

Social welfare thus becomes equal to:

$$
\begin{aligned}
SW &= CS + \Pi \\
&= \frac{(\alpha^2K^2 - 2\alpha N - \alpha^2 NK + 2N)\,(\alpha^2K^2 - \alpha^2 NK - 6\alpha N + 6N + 8 - 8\alpha)\,(a-c)^2}{2\,(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2)^2} \\
& \qquad (14)
\end{aligned}
$$

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

$$
\frac{\partial SW}{\partial \alpha} = \frac{4\alpha K\,(1-\alpha)\,(\alpha-2)\,(N-K)\,(N+2)^2\,(a-c)^2}{(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2)^3} < 0 \text{ if } \alpha < \frac{2}{2+K} \qquad (15)
$$

Hence, any $0 < \alpha < \frac{2}{2+K}$ leads to lower social welfare than under vertical separation. ■

Intuitively, this result is straightforward: compared to vertical separation, 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: K firms obtains higher profits and $(N-K)$ firms obtain lower profits.

An interesting question is whether these results hold if there is Bertrand (rather than Cournot) competition in the downstream segment.[24] With that objective in mind, we have solved the model assuming a linear demand function similar to that of Greenlee and Raskovich (2006): $q_j(\mathbf{p}) = d - p_j + \gamma \sum_{i \neq j} p_i$, $i = 1, ..., N$, $0 < \gamma < 1/(N-1)$.[25] Our key findings are: (i) given wholesale prices, the non-controlling stake α also works as a rebate and induces K firms to expand their production (similar to our results under Cournot competition) as well as their $(N-K)$ rivals, because of the strategic complementarity which is

[24] Hunold et al. (2012), for example, assume Bertrand competition in the downstream segment and Greenlee and Raskovich (2006) also explore this setup in addition to Cournot competition.

[25] In Greenlee and Raskovich (2006), the demand function is firm-specific, as it includes the term d_j (rather than d). We have chosen to solve the model under a simpler and symmetric demand function.

typical of Bertrand competition (and this is clearly different from our results under Cournot competition); (ii) the upstream firm takes advantage of the output expansion effect of K firms and chooses to raise the wholesale price they face (w_K); (iii) by doing so, the upstream firm is also raising the retail price chosen by $(N - K)$ firms, so it finds it optimal to *lower* $\bar{w}$ to compensate; (iv) in equilibrium, K firms produce less than they would under vertical separation and their $(N - K)$ rivals produce more;[26] (v) the overall quantity produced actually increases (that is, the output reduction of K firms is more than compensated by the output increase of their $(N - K)$ rivals), so that a partial vertical integration in this setup is less worrisome, from a welfare perspective, than under Cournot competition; (vi) but a partial vertical integration does not yield gains from trade (as is the case in Hunold et al., 2012, when there is an upstream monopolist), and so it would be unlikely to materialise.[27] In summary, although the output expansion effect also exists under Bertrand competition, strategic complementarity leads to very different results and, ultimately, although they yield benefits from a welfare perspective, partial vertical integrations would be unlikely to emerge as they fail to generate gains from trade between the interested parties.

3.2 Optimal private placement

In the first stage of the game, a financial intermediary must assess the potential profitability of a backward partial vertical integration and choose the optimal characteristics of a private placement operation for firm U's capital. Therefore, the natural first step is to look at the potential gains from trade of such an operation. 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.

First, take the combined profits of firm U and K retail firms, given by $(1 - \alpha K)\,\pi_U^* + K\pi_{kI}^*$, which are obtained when we substitute w_K^*, $\bar{w}^*$, q_k^* and q_j^* in the profit functions of

[26] That is, the increase in w_K is very significant and actually increases the net wholesale price faced by K firms. In other words, the upstream firm truly discriminates against its (now) non-controlling shareholders.

[27] Note that these results are different from those obtained by Hunold et al. (2012), and this is explained by three features of their model: first, they assume an upstream duopoly (whereas we assume an upstream monopolist); second, they assume a downstream duopoly (whereas we assume downstream competition among N firms); third, they assume that all downstream firms acquire a non-controlling stake in the upstream firm (whereas we assume that only K firms do).

firm U and each of the $k \in \{1, ..., K\}$ retail firms. Note that:

$$\left.\frac{\partial\left[(1-\alpha K)\,\pi_U^* + K\pi_{kI}^*\right]}{\partial\alpha}\right|_{\alpha=0} = \frac{(N-K)\,K}{N+N^2+K} > 0 \qquad (16)$$

Therefore, compared to a vertical separation scenario ($\alpha = 0$), combined profits are higher when $\alpha > 0$, that is, 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). The rationale is straightforward and consistent with our results from Section 3.1: a share α in firm U's capital allows K firms to expand their production (in equilibrium) which lowers their retail-related profits.[28] However, this negative effect is more than compensated by the share they receive of firm U's profits: indeed, these K firms' production expansion allows firm U to increase the wholesale prices it charges (both to these K firms and to the remaining $(N-K)$ firms - see Proposition 2) and, thus, to increase its profits.[29] 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. Moreover, this result contrasts with Hunold et al. (2012), who find that not to be the case when there is an upstream monopolist.

In addition, this contributes towards justifying the role of a financial intermediary in the private placement, insofar as the increased combined profits may be used to cover the cost of the operation.[30] We explore two scenarios, both of which assume that the financial intermediary acts as a perfect agent for the upstream firm. In a first scenario, we posit that the financial intermediary maximizes gains from trade, which is equivalent to maximizing the difference between the combined profits of firm U and K retail firms under vertical separation

[28] Looking only at retail segment profits, the output expansion effect and the retail price increase contribute towards increased revenues; however, the gross wholesale price increase leads to increased costs, and the latter effect dominates.

[29] 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.

[30] We do not explore in full the trade-off between increased combined profits and the private placement's cost, but clearly, for any positive cost, one would find that not all backward partial integrations (namely those where α is very close to 0) would yield net positive combined profits. This is consistent with empirical evidence by Allen and Phillips (2000), who report a mean (median) for the fraction of equity acquired of 20% (14%) (all acquisitions).

and under partial vertical integration. This is somewhat equivalent to viewing the financial intermediary as 'benevolent', insofar as it maximizes the overall combined profits (post-integration) regardless of how they would be split between the upstream and downstream acquiring firms. In this scenario, the financial intermediary's objective function is given by:

$$\Gamma = \frac{(1 - \alpha K)\, \pi_U^* + K\pi_{kI}^*}{\pi_U^{VS} + K\pi_k^{VS}} \tag{17}$$

In a second scenario, we assume that the financial intermediary maximizes the difference between the upstream firm's post- and pre-integration profits (π_U^*/π_U^{VS}). This is somewhat equivalent to assuming self-interest, by the upstream firm's shareholders, in the private placement operation, insofar as they are more concerned with their firm's post-integration profits than with the acquiring firms' profits. In other words, whilst in the first scenario the way the gains from trade are split between the upstream and the acquiring downstream firms are not considered, in this second scenario we look at one extreme split of those gains from trade - one in which the upstream firm captures the largest possible share of those gains.

Recall that the share of capital firm U is willing to sell is Ω, and this is assumed to be an exogenous variable.[31] Firms $k \in \{1, ..., K\}$ acquire a symmetric share $\alpha = \Omega/K$ of firm U's capital.[32] In this context, the financial intermediary chooses K, that is, the number of firms which will acquire a symmetric share of firm U's capital in a private placement operation. In the first scenario, the intermediary acts benevolently (denoted with superscript 'b') and maximizes gains from trade by choosing K^b, whilst in the second scenario the intermediary acts in the upstream firm's self-interest (denoted with superscript 'si') and maximizes its post-integration profits by choosing K^{si}. We find that:

Proposition 4 *Provided $\alpha < \frac{2}{2+K} \Leftrightarrow \Omega < \frac{2K}{2+K}$, a private placement operation which maximizes gains from trade involves more retail firms than one which maximizes the upstream firm's post-integration profits, that is, $K^b \geq K^{si}$.*

Proof. Looking first at the self-interest scenario, in equilibrium we obtain:

[31] In effect, this can be seen as a restriction for the financial intermediary, decided by the shareholders of firm U, and is consistent with reality, insofar as a firm typically does not delegate in a financial intermediary the decision of the total share of capital to be relinquished by shareholders.

[32] It is natural to think of a symmetric share allocation given that the retail segment is also symmetric.

$$\frac{\pi_U^*}{\pi_U^{VS}} = \frac{4(N+1)(NK - N\Omega + K\Omega)}{N(4K - 4\Omega + 4NK - 4N\Omega + K\Omega^2 - N\Omega^2)} \tag{18}$$

It is easily checked that $\pi_U^*/\pi_U^{VS}\big|_{\Omega=0} = 1$, that is, when $\Omega = 0$, pre- and post-integration upstream profits are equal. Moreover, we find that:

$$\frac{\partial\left(\pi_U^*/\pi_U^{VS}\right)}{\partial\Omega} = \frac{4(N+1)(2NK + 2K + K\Omega - N\Omega)(N\Omega - K\Omega - 2K)}{N(4K - 4\Omega + 4NK - 4N\Omega + K\Omega^2 - N\Omega^2)^2} > 0 \tag{19}$$

Therefore, any $\Omega > 0$ increases post-integration upstream profits (compared to vertical separation). We also find that:

$$\frac{\partial\left(\pi_U^*/\pi_U^{VS}\right)}{\partial K} = -\frac{4(N+1)(N+2)^2\Omega^2}{N(4K - 4\Omega + 4NK - 4N\Omega + K\Omega^2 - N\Omega^2)^2} < 0 \tag{20}$$

This implies that, for any given $\Omega > 0$, K^{si} must be as low as possible to maximize π_U^*/π_U^{VS} $(\forall N)$.

Now turning our attention to the benevolent scenario, in equilibrium we obtain $\Gamma|_{\Omega=0} = 1$ (when $\Omega = 0$, pre- and post-integration combined profits are equal) and:[33]

$$\left.\frac{\partial\Gamma}{\partial\Omega}\right|_{\Omega=0} = \frac{N-K}{N^2+N+K} > 0 \tag{21}$$

Therefore, any $\Omega > 0$ generates gains from trade. Unfortunately, maximizing Γ (equation (17)) with respect to K does not yield a tractable analytical solution. Therefore, we have focused our attention in numerical simulations of that solution for 3 possible values of N: 10, 50 and 100.[34] For these three different values of N, we maximized equation (17) and obtained the corresponding optimal value K^b, which is a function of Ω, and plotted it in Figure 1 (left). It is now straightforward to see that $K^b \geq K^{si}$.[35] ■

The rationale for this result is the following: in the self-interest scenario, the upstream firm finds it profitable to sell a share $\Omega > 0$ of its capital. However, in order to capture as large a share as possible of the associated gains from trade, it prefers to sell that share to as few retail firms as possible, as it finds it more profitable to concentrate (in the smallest possible

[33] The expression for Γ is quite cumbersome and we have chosen not to include it here.

[34] We have conduced simulations for more values of N, but the results are similar to those presented here.

[35] We have not restricted K^b or K^{si} to be integers; instead, we have focused on obtaining real (equilibrium) values for K^b or K^{si}. However, introducing such an integer restriction does not change our results: in that case, $K^{si} = 1$ (the lowest possible positive integer) and $K^b \geq 1$, for $\forall N$, $\forall\Omega \in (0, 1]$.

number of firms) the output expansion effect. The intuition is straightforward: an increase in K 'dilutes' the share Ω across a larger number of firms, which will individually have a lower output expansion effect (because the stake they hold in the upstream firm is lower); in equilibrium, this leads the upstream firm to *lower* both wholesale prices which ultimately leads to lower profits. Therefore, the upstream firm finds it preferable to concentrate (in the smallest possible number of firms) the output expansion effect, as this yields higher profits.

By contrast, when the objective is to maximize gains from trade, it is preferable to 'spread' the output expansion effect among more retail firms, as their profits are also considered in Γ (equation (17)). Although a higher K results in profits, for the upstream firm, which are lower that when K is minimal, more retail firms are able to benefit from increased profit levels which ultimately generate gains from trade (that is, the latter effect outweighs the former). In other words, a 'concentrated' output expansion effect would increase the combined profits of *too few* retail firms and this would not maximize the integration's gains from trade.

Looking more closely at the results from the gains from trade scenario, we can see in Figure 1 (left) that K^b is increasing with Ω and with N, which results in (see Figure 1 (right)) an individual share $\alpha^b = \Omega/K^b$ that is decreasing with Ω and K^b. Therefore, in a private placement operation motivated by gains from trade, these are maximized when only a subset of $K^b < N$ retail firms acquire a symmetric share in firm U's capital. The rationale is straightforward: as suggested in Proposition 1, price discrimination incentives are retained even when $K = N$, but in this case all retail firms would benefit from the output expansion effect (associated with a lower net wholesale price). Although this would increase firm U's profits, increased retail competition would work in the opposite direction, thus yielding overall industry profits equal to those obtained under vertical separation. Therefore, it is preferable that only a subset K^b of retail firms acquire an individual share α^b in firm U's capital. As Ω increases, the financial intermediary finds it optimal to increase K^b.

Figure 2 (left) displays the optimal 'market coverage' in the private placement operation motivated by gains from trade, that is, the overall market share (prior to the operation) of the K^b firms which the financial intermediary will approach. This market coverage is increasing with Ω but decreasing with N, that is, a more competitive retail segment (with more firms) will lead the financial intermediary to approach a subset of K^b firms which,

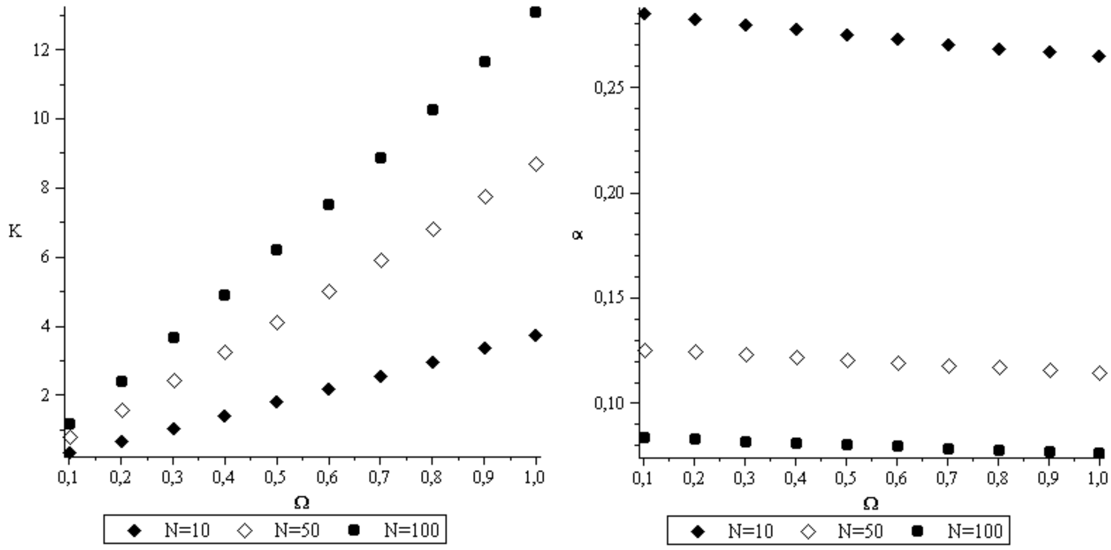

Figure 1: Optimal choice of K^b (left) and equilibrium values of $\alpha^b = \Omega/K^b$ (right)

in aggregate, have a smaller market share. Again, this is consistent with our results. With more competition in the retail segment (and thus lower retail profits), it is sufficient for a proportionally lower subset of K^b to benefit from the output expansion effect. Finally, Figure 2 (right) displays the gains from trade (Γ^b) which result from a private placement operation with K^b firms. Note that these gains from trade are decreasing with N and do not appear to follow a monotonic relationship with Ω (although it is increasing for most values of Ω).

4 Conclusion

In this paper, we have analysed the possibility that a subset of retail firms acquire, through a private placement operation, 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 and, in particular, it is allowed to price discriminate between its (now) retail shareholders and their competitors. We find that it is profit-maximizing for the upstream firm to indeed price discriminate between retail firms, subtly favouring its shareholders through a lower net wholesale price which allows them to expand production. We also find that, compared to vertical separation, 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

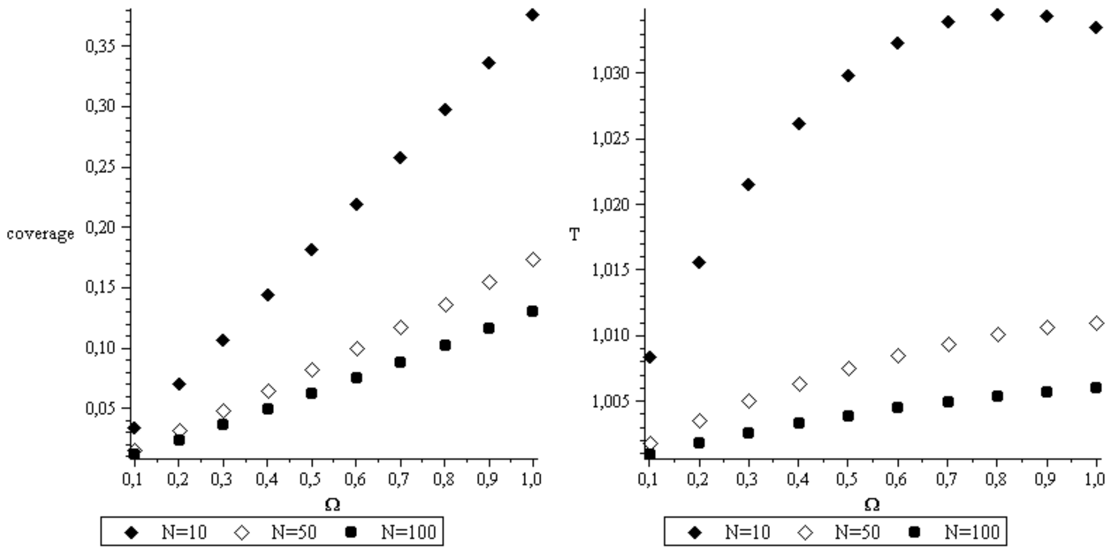

Figure 2: Optimal market coverage (K^b/N) (left) and gains from trade (Γ^b) (right)

that backward partial integration is desirable, as it increases the combined profits of the upstream and downstream (acquiring) firms. This result also justifies the role of a financial intermediary in a private placement operation for the sale of a share in the upstream firm's capital and we explore two underlying motivations: a benevolent motivation which seeks to maximize gains from trade and a self-interest motivation with the objective of maximizing the upstream firm's post-integration profits. We find that the number of firms approached to take part in the private placement under a benevolent motivation is always higher than under a self-interest motivation. We also find our results to be robust to the introduction of (possibly discriminatory) two-part tariffs by the upstream firm.[36]

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. From a practical viewpoint, we are able to understand the drivers underlying the search for investors by financial intermediaries in private placement operations. Moreover, our results are amenable to empirical testing, in line with previous research by Allen and Phillips (2000) and Fee et al. (2006). First, in sectors similar to our model

[36]See Appendix C.

setup, backward partial integration should increase the market value of the upstream firm and of the acquiring retail firms (because of expected higher future profits) and reduce the market value of the remaining retail firms. Moreover, the number of retail firms involved in such private placements may reveal their underlying motivation.

Whether these results are more general than in the particular setting we have analysed is a relevant research question. Clearly, as we discuss at the end of Section 3.1 by looking at what would happen under Bertrand competition, the form of competition at the retail segment is important for our results to hold. Can the same be said for upstream competition? That is, could these results be generalised beyond the upstream monopoly assumption (as in Hunold et al., 2012)? Moreover, we assume both a symmetric retail segment and a symmetric allocation of non-controlling stakes in the upstream firm's capital; how would our results change in an asymmetric environment? These are clearly important and interesting future research questions.

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A Appendix - Comparative statics of equilibrium wholesale prices

The equilibrium wholesale prices obtained in Proposition 1 depend on N, K and α and yield interesting comparative statics. First, both wholesale prices decrease with N but $|\partial w_K^*/\partial N| > |\partial \bar{w}^*/\partial N|$.[37] 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 both wholesale prices, although it is profit-maximizing to reduce w_K^* more than $\bar{w}^*$ (thus reducing the asymmetry between wholesale prices) because firm k's production ($k \in \{1, ..., K\}$) decreases more than that of its rivals when the number of firms increases.

Second, an increase in K increases both wholesale prices, but $\partial w_K^*/\partial K > \partial \bar{w}^*/\partial K$ when $K < N/2$ (increased asymmetry as K increases) and $\partial w_K^*/\partial K < \partial \bar{w}^*/\partial K$ when $K > N/2$ (decreased asymmetry as K increases).[38] Increased wholesale prices following an increase in K imply a real increase in K firms' input costs, which induces them to reduce the individual quantity produced (q_k^*); however, the overall quantity produced by these K firms increases (because K increases) and this leads firm U to increase the wholesale price it charges them. Strategic substitutability explains why the wholesale price charged to other firms increases as well: the higher wholesale price charged to K firms effectively reduces their input demand and, thus, increases that of their rivals. When K is low, the aggregate output expansion of these K firms is very significant (compared to the aggregate output reduction of $N - K$ firms) and firm U finds it profit maximizing to increase the asymmetry in wholesale prices.[39]

[37] From equations (5) and (6), we obtain $\frac{\partial w_K^*}{\partial N} - \frac{\partial \bar{w}^*}{\partial N} = \frac{\alpha(2+\alpha K)(2\alpha-2+\alpha K)(a-c)}{(4N-4\alpha N+4-4\alpha-\alpha^2 NK+\alpha^2 K^2)^2}$, which is negative for $\alpha < 2/(2+K)$.

[38] From equations (5) and (6), we obtain $\frac{\partial w_K^*}{\partial K} - \frac{\partial \bar{w}^*}{\partial K} = \frac{\alpha^3(N+2)(N-2K)(a-c)}{(4N-4\alpha N+4-4\alpha-\alpha^2 NK+\alpha^2 K^2)^2}$, which is positive when $K < N/2$ and negative otherwise.

[39] In equilibrium, when $K < N/2$, the wholesale price increase effectively moderates the K firms' output

Third, an increase in α increases both wholesale prices, but $|\partial w_K^*/\partial\alpha| > |\partial\bar{w}^*/\partial\alpha|$.[40] An increase in α, from firms $k \in \{1, ..., K\}$ perspective, increases the 'rebate' they benefit from and this further induces them to expand production. In this context, firm U finds it profit-maximizing to further increase the wholesale price it charges them. Strategic substitutability explains why firm U is able to also charge a higher wholesale price to other firms, although this increase is lower than that in firms' $k \in \{1, ..., K\}$ wholesale price.

B Appendix - Asymmetries in marginal costs

This Appendix contains the equilibrium results in a situation where K firms benefit from a lower marginal cost than their $(N - K)$ rivals. This allows us to analyse the magnitude of the output expansion effect of those K firms and its equilibrium implications and also to compare them with our results under partial vertical integration (which also entails an output expansion effect for K firms who acquire a non-controlling share in the upstream firm's capital). Let us assume that K downstream firms have a marginal cost $c - \varepsilon$, with $\varepsilon > 0$, whilst their $(N - K)$ rivals have a marginal cost of c. All firms are assumed to be independent (vertical separation). The timing of decisions and all other assumptions are similar to Section 2. In particular, the upstream firm is allowed to price discriminate between those two groups of firms.

The subgame-perfect equilibrium is obtained by backward induction. In the final stage of the game, each retail firm maximizes its profits:

$$\begin{aligned} \pi_k &= \left(a - \sum_{i=1}^{K} q_i - \sum_{j=K+1}^{N} q_j\right) q_k - w_K q_k - (c - \varepsilon)\, q_k, \ \forall k \in \{1, ..., K\} \\ \pi_j &= \left(a - \sum_{k=1}^{K} q_k - \sum_{i=K+1}^{N} q_i\right) q_j - \bar{w} q_j - c q_j, \ \forall j \in \{K+1, ..., N\} \end{aligned} \tag{22}$$

In a Cournot-Nash equilibrium, we have:

expansion and leads to $\partial Q^*/\partial K < 0$; by contrast, when $K > N/2$, $\partial Q^*/\partial K > 0$.

[40] From equations (5) and (6), we obtain $\frac{\partial w_K^*}{\partial \alpha} - \frac{\partial \bar{w}^*}{\partial \alpha} = \frac{\left(\alpha^2 KN + 4N + 4 - \alpha^2 K^2\right)(N+2)(a-c)}{(4N - 4\alpha N + 4 - 4\alpha - \alpha^2 NK + \alpha^2 K^2)^2} > 0$.

$$q_k = \frac{a - (1+N-K)(w_K - \varepsilon) + (N-K)\bar{w} - c}{N+1}, \ \forall k \in \{1, ..., K\} \tag{23}$$

$$q_j = \frac{a + K(w_K - \varepsilon) - (K+1)\bar{w} - c}{N+1}, \ \forall j \in \{K+1, ..., N\} \tag{24}$$

In the previous stage of the game, firm U in the upstream segment chooses wholesale prices w_K and $\bar{w}$ to maximize $\pi_U = w_K \sum_{k=1}^{K} q_k + \bar{w} \sum_{j=K+1}^{N} q_j$. In equilibrium, we obtain:

$$w_K^* = \frac{(a - c + \varepsilon)}{2} \tag{25}$$

$$\bar{w}^* = \frac{(a-c)}{2} \tag{26}$$

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

$$q_k^* = \frac{(a-c) + (1+N-K)\varepsilon}{2(N+1)}, \ \forall k \in \{1, ..., K\} \tag{27}$$

$$q_j^* = \frac{(a - c - K\varepsilon)}{2(N+1)}, \ \forall j \in \{K+1, ..., N\} \tag{28}$$

Total quantity produced is given by $Q^* = \sum_{k=1}^{K} q_k^* + \sum_{j=K+1}^{N} q_j^* = \frac{N(a-c)+K\varepsilon}{2(N+1)}$.

Faced with a lower marginal cost, and for given wholesale prices, K firms have incentives to increase their production (output expansion effect), whilst their $(N-K)$ rivals (because of strategic substitutability) decrease their production. The upstream firm finds it profitable to increase w_K, thus curtailing those K firms' output expansion (which nevertheless occurs in equilibrium). Simultaneously, the upstream firm sees no need to change $\bar{w}$: indeed, the increase in w_K also contributes towards an increase of the output levels of the remaining $(N-K)$ retail firms. Therefore, with asymmetric costs, the upstream firm makes use of a single tool to maximize profits: w_K, the wholesale price charged to the K firms with lower marginal cost. A change in this wholesale price is sufficient to maximize profits (compared with the symmetric costs scenario). Importantly, the net impact on total quantity is positive.

There are many similarities between this simple setup and our results under partial vertical integration (section 3.1), but also important differences. The non-controlling share in the upstream firm's capital is effectively a rebate in the wholesale price paid by K firms, which is equivalent to saying that their marginal cost becomes lower than that of their $(N-K)$ rivals. The output expansion effect of these K firms and the output reduction (through strategic substitutability, for given wholesale prices) of their $(N-K)$ rivals is similar to that observed above under asymmetric marginal costs. However, for the upstream firm, the effectiveness of its pricing decisions in influencing downstream quantities is clearly different. Under asymmetric costs, we have:

$$\frac{\partial q_k}{\partial w_K} = -\frac{(1+N-K)}{N+1} \tag{29}$$

whereas under partial vertical integration we obtain:

$$\frac{\partial q_k}{\partial w_K} = -\frac{(1+N-K)(1-\alpha)}{N+1} \tag{30}$$

Under partial vertical integration, the wholesale price w_K is a less effective tool to moderate K firms' output because any given increase in that wholesale price is partially appropriated by those K firms through their non-controlling share in the upstream firm. Therefore, in order to achieve a given output reduction, the upstream firm must increase w_K significantly (compared to the asymmetric costs situation). And this very significant increase in w_K also induces $(N-K)$ to increase their production levels very significantly, which then 'forces' the upstream firm to increase the other wholesale price ($\bar{w}$). In turn, this explains why under asymmetric costs we observe an increase in total quantity produced whereas the opposite is true under partial vertical integration.

C Appendix - Two-part tariffs

One of our model assumptions is that, under partial vertical integration, wholesale prices may be discriminatory but are restricted to be linear. We now look at the possibility that the upstream firm charges discriminatory two-part tariffs, that is, the upstream firm sells its output at a tariff $\{f_K^{TPT}, w_K^{TPT}\}$ to K downstream firms, where f_K^{TPT} is a fixed fee and w_K^{TPT} is the marginal input price ('TPT' stands for two-part tariffs), and a tariff $\{f^{TPT}, \bar{w}^{TPT}\}$ to all other retail firms. Under vertical separation, a TPT 'solves' the double marginalization problem: the upstream firm, by choosing the optimal TPT, induces downstream firms to produce the same quantity that they would produce under full vertical integration; in addition, as one would expect, optimal TPT allow the upstream firm to capture all industry profits. Could the same be said in the context of our model, where K downstream firms own a non-controlling share of the upstream firm? Yes, but with a significant caveat: linear wholesale pricing may, under some circumstances, yield higher profits than TPT. Therefore, one would expect the upstream firm not to use TPT even if it had the possibility to do so, a result which is similar to that obtained by Hunold et al. (2012) (Proposition 4).

Under TPT, the upstream firm chooses w_K^{TPT} and $\bar{w}^{TPT}$ so as to maximize total industry profits: $\Pi = (1-\alpha K)\,\pi_U^* + \sum_{k=1}^{K} \pi_{kI}^* + \sum_{j=K+1}^{N} \pi_j^*$ (the fixed fee is then used to extract rent from each group of downstream firms). In equilibrium, although it is free not to do so, the upstream firm chooses symmetric wholesale prices: $w_K^{TPT} = \bar{w}^{TPT} = \frac{1}{2}\frac{(N-1)}{(N-\alpha K)}(a-c)$. Importantly, $w_K^{TPT} = \bar{w}^{TPT} < \bar{w}^* < w_K^*$. Therefore, the output expansion effect of K firms is much more pronounced than under linear and discriminatory wholesale pricing; in addition, despite the fact that $\bar{w}^{TPT} < \bar{w}^*$, the output of $(N-K)$ firms is lower than under linear and discriminatory wholesale pricing (again, strategic substitutability explains this) but overall output is higher (and equivalent to that which would be produced under full vertical integration).[41] At these wholesale prices, downstream profits are given by:[42]

$$
\begin{aligned}
\pi_k^{TPT} &= \frac{1}{4}\frac{(1-\alpha K)\left[\alpha(N-K)+1-\alpha\right]}{(N-\alpha K)^2}(a-c)^2, \ \forall k \in \{1,...,K\} \\
\pi_j^{TPT} &= \frac{1}{4}\frac{(1-\alpha K)^2}{(N-\alpha K)^2}(a-c)^2, \ \forall j \in \{K+1,...,N\}
\end{aligned}
\tag{31}
$$

Therefore, the optimal fixed fee charged by the upstream firm would be $f_K^{TPT} = \pi_k^{TPT}$ and $f^{TPT} = \pi_j^{TPT}$. Under the optimal TPT, the upstream firm's profits would be equivalent to total industry profits and to those it would obtain under full vertical integration: $\pi_U^{TPT} = \frac{1}{4}(a-c)^2$. Comparing this profit level with the one obtained under linear and discriminatory wholesale pricing (π_U^*), and taking into account that $\alpha = \Omega/K$, we find that:

[41] In particular, $q_k^{TPT} = \frac{1}{2}\frac{\alpha(N-K)+1-\alpha}{N-\alpha K}(a-c)$, $q_j^{TPT} = \frac{1}{2}\frac{1-\alpha K}{N-\alpha K}(a-c)$ and $Q^{TPT} = \frac{(a-c)}{2}$.

[42] The profit levels for K downstream firms are net of the share of the upstream firm's profits they will receive. It makes sense that the upstream firm charges the fixed fee *before* it distributes profits to shareholders - an assumption which is important under TPT but which was unnecessary under linear pricing.

$$\frac{\pi_U^{TPT}}{\pi_U^*} = \frac{1}{4}\frac{(4NK - 4N\Omega + 4K - 4\Omega - \Omega^2 N + \Omega^2 K)}{NK - \Omega(N - K)} \tag{32}$$

Depending on the particular values of N, K and Ω, TPT may or may not be more profitable than linear and discriminatory wholesale pricing. But it is possible to show that given Ω and under a benevolent motivation for the private placement, the optimal number of retail firms (K^b) to be involved in the operation renders TPT less profitable than linear and discriminatory wholesale pricing. Moreover, given N and under a self-interest motivation, it always possible to find a share Ω to be sold to a single downstream firm which also leads to higher upstream profits under linear and discriminatory wholesale pricing. In either case, it is then sensible to conclude that even if the upstream firm could implement a TPT, it would prefer not to do so under the two motivations we look at for the private placement. This finding lends some further robustness to the results we have obtained under linear and discriminatory wholesale prices.