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On the Welfare Effects of Exclusive Distribution Arrangements

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Abstract

The regulation of vertical relationships between firms is the subject of persistent legal and academic controversy. The literature studying vertical trade relationships seems to assume that an upstream monopolist prefers downstream competition over exclusive distribution arrangements. We derive precise conditions for when an upstream monopolist prefers competing distribution systems over exclusive distribution in the downstream market. We also show that the welfare effects of downstream competition are ambiguous. A downstream oligopoly may have negative welfare properties compared to a downstream monopoly.

JEL Classification: D43; L13; L40

Keywords: Exclusive distribution; Competing distribution; Vertical foreclosure; Cournot competition

1 Introduction

The regulation of vertical relationships between firms is a highly controversial issue for international economists and antitrust authorities (GANSLANDT AND MASKUS, 2007; MASKUS AND CHEN, 2004; RICHARDSON, 2004). At the heart of this debate is the ambiguous nature of the effects of exclusive distribution arrangements on upstream producers, downstream traders, and consumers. For instance, Apple's shift from exclusive arrangements with national carriers for the initial distribution of the iPhone (e.g., AT&T in the United States and T-Mobile

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in Germany) to competing distribution systems in 2010 has recently attracted widespread attention (DE FONTENAY ET AL., 2010; EHRLICH ET AL., 2010).[2] In addition, car manufacturers often maintain exclusive distribution channels in each country in order to vertically control the operations of their local distributors (LUTZ, 2004).

One puzzle in the literature on vertically organized markets is the challenge to explain the widespread use of exclusive contracts in downstream markets despite the obvious disadvantages of double marginalization. For an upstream monopolist, exclusive contracts are favorable if the monopoly rents of the downstream monopolist can be extracted, e.g., by auctioning off the rights to exclusive dealings. Vertical restraints, however, such as non-linear (two-part) tariffs, resale price maintenance, or tie-in provisions are often illegal because they either restrict competition or constitute an abuse of dominant position, e.g., according to Sections 1 and 2 of the U.S. Sherman Antitrust Act or Articles 101 and 102 of the Treaty on the Functioning of the European Union, respectively. If the complete extraction of monopoly rents is impossible, perfect downstream competition appears to be the best alternative because downstream sellers would charge prices at the marginal costs determined by the upstream monopolist's prices.

Most of the literature regarding vertical market integration seems to (implicitly) assume that an upstream monopolist prefers downstream competition over exclusive distribution under linear pricing (DURHAM, 2000; POLASKY, 1992; REY AND STIGLITZ, 1995). In addition, oligopolistic upstream firms opt for competition between their divisions in the downstream market (BAYE ET AL., 1996). Similarly, in modeling oligopolistic intrabrand and interbrand competition with two upstream firms and two-part tariffs consisting of a fixed fee and a per-unit payment (royalty), SAGGI AND VETTAS (2002, P. 198) suggest:

> *"In the case of royalty-only contracts, each upstream firm prefers to increase its number of downstream firms, as long as the rival number of firms are not too large."*

We will show that this assertion is correct if the cost difference between the downstream firms is not too large. However, we will also derive precise conditions under which this assertion

[2] The iPhone is now distributed by two exclusive retailers in the U.S., namely, AT&T and Verizon, and three exclusive retailers in Germany, namely, T-Mobile, Vodafone, and O_2.

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does not generally hold. REY AND VERGÉ (2008), in a recent overview of the literature on the economics of vertical restraints, state on page 361:

> *"Notice that vertical restraints are not necessarily needed to solve the double-marginalization problem. Introducing strong intra-brand competition (using several perfectly substitutable retailers) would remove the retail markup. The manufacturer could then set the wholesale price equal to (...) the monopoly price (...)."*

To the best of our knowledge, there is no formal paper that explicitly investigates this intuition. We derive precise conditions for when a downstream oligopoly of traders yields higher profits for the upstream producer than a downstream monopoly. We show that the welfare effects of downstream competition are ambiguous. A downstream oligopoly may have negative welfare properties compared to a downstream monopoly.

2 A simple model

There is a single Producer P of a product x with a linear cost function $c(x) = c \cdot x$. Demand for the product is given by $P(x) = a - bx$. The producer cannot access the market directly but sells the product through either

- *Exclusive distribution:* a single trader, Trader α, or
- *Competing distribution:* a (finite) set of competing traders $J = \{1, 2, ..., n\}$.

To provide a real-world example, let the producer be an upstream gasoline refiner that influences the retail prices of vertically integrated gasoline stations through station-specific wholesale prices (HASTINGS AND GILBERT, 2005). Traders (gasoline stations) $j \in J$ may differ in their constant marginal cost of delivery k_j. Without loss of generality, the traders are ranked by: $k_1 \leq k_2 \leq ...k_j \leq k_{j+1} \leq ... \leq k_n$. As the producer's supply prices cannot be lower than the marginal cost of production c, a trader with local costs $k_j \geq a - c$ would not supply.

Assumption 2.1

(a) increasing local costs: $k_1 \leq k_2 \leq ...k_j \leq k_{j+1} \leq ... \leq k_n$;

(b) potential traders: $a - c - k_n > 0$.

Assumption 2.1 implies that all traders provide some potential for the producer to earn profits.

3 Exclusive distribution: double marginalization

Trader α has a viable downstream monopoly, $a > c + k_\alpha$. Given the price charged by the producer q, Trader α chooses x to maximize $\pi_\alpha = P(x) \cdot x - (q + k_\alpha) \cdot x$. We obtain

- $x_\alpha(q) := \max\left\{0, \frac{1}{2b}(a - q - k_\alpha)\right\}$,
- $p_\alpha(q) := \frac{1}{2}(a + q + k_\alpha)$,
- $\pi_\alpha(q) := \frac{1}{4b}(a - q - k_\alpha)^2$.

The producer sets q to maximize $\pi = (q - c) \cdot x_\alpha(q)$, yielding the optimal strategy

$$q^M := \frac{a + c - k_\alpha}{2}.$$

Summarizing, if the downstream monopoly is viable, $a > c + k_\alpha$, then $q^M > c$ and we obtain

- supply price: $q^M = \frac{1}{2}(a + c - k_\alpha)$,
- quantity supplied: $x^M := x_\alpha(q^M) = \frac{1}{4b}(a - c - k_\alpha)$,
- price: $p^M := p_\alpha(q^M) = \frac{1}{4}(3a + c + k_\alpha)$,
- Trader α's profit: $\pi_\alpha^M := \pi_\alpha(q^M) = \frac{1}{16b}(a - c - k_\alpha)^2$,
- producer's profit: $\pi^M := \pi(q^M) = \frac{1}{8b}(a - c - k_\alpha)^2$,
- consumer surplus: $S^M := S(q^M) = \frac{1}{2}\left[a - p^M\right] \cdot x^M = \frac{1}{32b}(a - c - k_\alpha)^2$,
- aggregate profit: $\Pi^M := \pi^M + \pi_\alpha^M = \frac{3}{16b}(a - c - k_\alpha)^2$,
- welfare: $W^M := \Pi^M + S^M = \frac{7}{32b}(a - c - k_\alpha)^2$.

4 Downstream Cournot competition

Before turning to the case of an arbitrary number of potential traders, consider the duopoly case.

4.1 The two-trader case

Consider two potential traders, α and β, with $k_\alpha \leq k_\beta$. For instance, downstream traders may differ in per unit costs, due to different levels of customer service (SPIEGEL AND YEHEZKEL, 2003).[3] Figure 1 illustrates this situation.

Each trader $j \in \{\alpha, \beta\}$ chooses x_j to maximize $\pi_j = P(x_j + x_{-j}) \cdot x_j - (q_j + k_j) \cdot x_j$. Trader j's best response is given by $r_j(x_{-j}) = \max\left\{0, \frac{a - bx_{-j} - q_j - k_j}{2b}\right\}$. The Nash equilibrium quantities

[3] In contrast to our model, SPIEGEL AND YEHEZKEL (2003) consider consumers who are heterogeneous in terms of willingness to pay for customer services. They find that a single upstream producer may foreclose the (low-cost) retailer who provides low-level customer services to protect the high-quality retailer from competitive pressure.

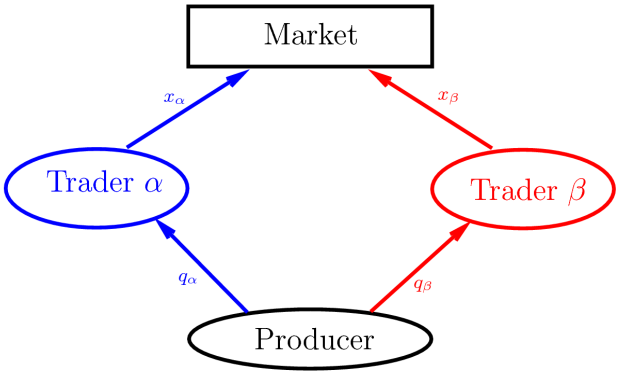

Figure 1. Traders and market

$x_\alpha(q_\alpha, q_\beta)$ and $x_\beta(q_\alpha, q_\beta)$ which depend on the supply price policy of the producer are

$$x_\alpha(q_\alpha, q_\beta) = \min\left\{\max\left\{0, \frac{a + (q_\beta + k_\beta) - 2\,(q_\alpha + k_\alpha)}{3b}\right\}, \max\left\{0, \frac{a - (q_\alpha + k_\alpha)}{2b}\right\}\right\},$$

$$x_\beta(q_\alpha, q_\beta) = \min\left\{\max\left\{0, \frac{a + (q_\alpha + k_\alpha) - 2\,(q_\beta + k_\beta)}{3b}\right\}, \max\left\{0, \frac{a - (q_\beta + k_\beta)}{2b}\right\}\right\}.$$

Notice that the producer's supply price policy could be such that only one trader serves the market. Hence, exclusive trading can be induced by the producer via price differentiation between the traders. Figure 2 illustrates two cases. The producer sets prices (q_α, q_β) to maximize profit

$$\pi = (q_\alpha - c) \cdot x_\alpha(q_\alpha, q_\beta) + (q_\beta - c) \cdot x_\beta(q_\alpha, q_\beta). \tag{1}$$

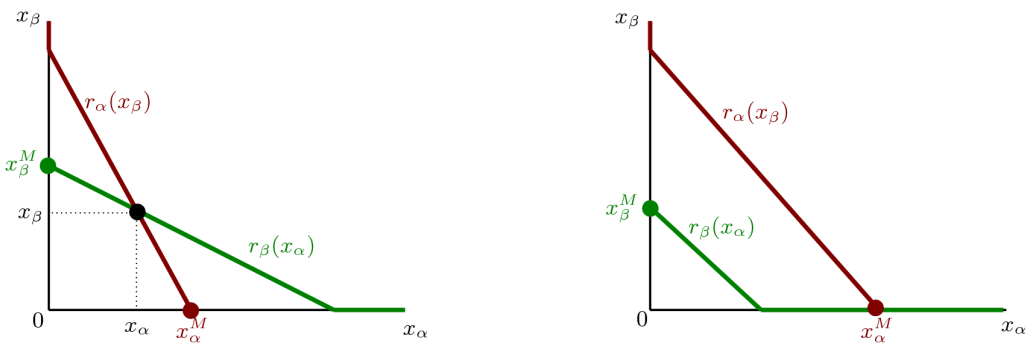

Figure 2. Types of downstream Nash equilibria

The Nash equilibrium quantities $x_\alpha(q_\alpha, q_\beta)$ and $x_\beta(q_\alpha, q_\beta)$ are neither concave nor convex functions. This property complicates the solution of the producer's problem considerably. The Nash equilibrium quantities are, however, piecewise linear functions of (q_α, q_β). Moreover, for any

$j = \alpha, \beta$, one can easily confirm that $x_j(q_\alpha, q_\beta) = x_j(q_j)$ if and only if $x_{-j}(q_\alpha, q_\beta) = 0$. Indeed, this finding is obvious from Figure 2. Hence, one can divide the set of supply prices (q_α, q_β) into four regions, which are depicted in Figure 3:

(i)	$x_\alpha(q_\alpha, q_\beta) \leq x_\alpha(q_\alpha)$	and	$x_\beta(q_\alpha, q_\beta) \leq x_\beta(q_\beta)$,
(ii)	$x_\alpha(q_\alpha, q_\beta) = x_\alpha(q_\alpha)$	and	$x_\beta(q_\alpha, q_\beta) = 0$,
(iii)	$x_\alpha(q_\alpha, q_\beta) = 0$	and	$x_\beta(q_\alpha, q_\beta) = x_\beta(q_\beta)$,
(iv)	$x_\alpha(q_\alpha, q_\beta) = 0$	and	$x_\beta(q_\alpha, q_\beta) = 0$.

Figure 3 shows the iso-profit lines for the profit function of the producer (Equation 1).

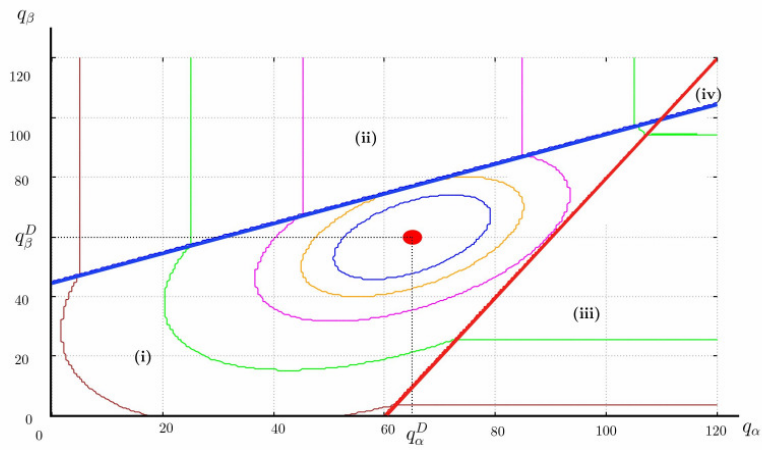

Figure 3. Iso-profit lines of the producer

The blue line satisfies $x_\alpha(q_\alpha, q_\beta) = x_\alpha(q_\alpha)$, and the red line satisfies $x_\beta(q_\alpha, q_\beta) = x_\beta(q_\beta)$. The profit function (Equation 1) is concave within each region. In Region (ii) [(iii)] Trader α [β] holds exclusive rights.[4] The optimal solution for case (i) can be derived from

$$\begin{aligned} \max_{q_\alpha, q_\beta} \pi \quad = \quad & \frac{1}{3b} \{ (q_\alpha - c) \cdot [a + (q_\beta + k_\beta) - 2 (q_\alpha + k_\alpha)] \\ & + (q_\beta - c) \cdot [a + (q_\alpha + k_\alpha) - 2 (q_\beta + k_\beta)] \} . \end{aligned}$$

Straightforward computations yield the solution, which is summarized in Lemma 4.1:

[4] In Region (iv), no trader supplies the commodity.

Lemma 4.1 *Suppose there is an equilibrium in which the optimal supply price policy* $\left(q_\alpha^D, q_\beta^D\right)$ *is such that both traders supply the commodity. The following solution holds:*

- *traders' supply prices:* $q_\alpha^D = \frac{1}{2}\left(a + c - k_\alpha\right), \qquad q_\beta^D = \frac{1}{2}\left(a + c - k_\beta\right),$
- *downstream quantities:* $x_\alpha^D = \max\{0, \frac{1}{6b}\left(a - c - 2k_\alpha + k_\beta\right)\},$
  $x_\beta^D = \max\{0, \frac{1}{6b}\left(a - c + k_\alpha - 2k_\beta\right)\},$
- *aggregate supply:* $x^D := x_\alpha^D + x_\beta^D = \frac{1}{6b}\left(2\left(a - c\right) - k_\alpha - k_\beta\right),$
- *downstream price:* $p^D = \frac{1}{6}\left(4a + 2c + k_\alpha + k_\beta\right),$
- *traders' profit:* $\pi_\alpha^D = \frac{1}{36b}\left[\left(a - c - k_\alpha\right) - \left(k_\alpha - k_\beta\right)\right]^2,$
  $\pi_\beta^D = \frac{1}{36b}\left[\left(a - c - k_\beta\right) + \left(k_\alpha - k_\beta\right)\right]^2,$
- *producer's profit:* $\pi^D = \frac{1}{12b}\left[\left(a - c - k_\alpha\right)^2 + \left(a - c - k_\beta\right)^2 + \left(k_\alpha - k_\beta\right)^2\right].$

Proofs are provided in the appendix. However, straightforward proofs are omitted. Comparing the profits obtained from exclusive contracts reveals that an exclusive contract with the low-cost Trader α is more profitable for the producer than one with Trader β. The producer chooses a supply price policy that

- either makes it unprofitable for the high-cost trader to participate in the downstream market (an exclusive contract with α),
- or that has both players supply the commodity (non-exclusive trade).

In Figure 3, the producer chooses supply prices in Regions (i) or (ii) but never in Region (iii). The following proposition characterizes these cases.

Proposition 4.2 Non-exclusive trade condition
An equilibrium with non-exclusive downstream trade is optimal for the producer if

$$\left(a - c - k_\beta\right) > \left(k_\beta - k_\alpha\right). \tag{2}$$

Proposition 4.2 shows that the producer chooses non-excluding supply prices if the costs of the high-cost Trader β do not exceed the costs of Trader α by an excessive amount. For $k_\beta > k_\alpha$, the producer subsidizes β to keep him in the market,

$$q_\alpha^D = \frac{1}{2}\left(a + c - k_\alpha\right) > \frac{1}{2}\left(a + c - k_\beta\right) = q_\beta^D.$$

Condition (2) can be viewed as an upper limit for this type of subsidization. The following proposition summarizes the welfare implications of non-exclusive trade.

Proposition 4.3 *Suppose there is an equilibrium where the optimal supply price policy is such that both traders supply the commodity. One obtains the following welfare level:*

- *aggregate profit:* $\Pi^D = \pi^D + \pi^D_\alpha + \pi^D_\beta$
$$= \frac{1}{36b}\left[4\left(a-c-k_\alpha\right)^2 + 4\left(a-c-k_\beta\right)^2 + 7\left(k_\alpha - k_\beta\right)^2\right],$$
- *consumer surplus:* $S^D = \frac{1}{72b}\left[\left(a-c-k_\alpha\right) + \left(a-c-k_\beta\right)\right]^2,$
- *welfare:* $W^D = \Pi^D + S^D$
$$= \frac{1}{72b}\left[20\left(a-c\right)^2 - 20(k_\alpha + k_\beta)\left(a-c\right) + 10\left(\left(k_\alpha\right)^2 + \left(k_\beta\right)^2\right) + 13\left(k_\alpha - k_\beta\right)^2\right].$$

Welfare conditions are harder to interpret because there is a trade-off between more efficient downstream trade and inefficient cost effects.

Proposition 4.4 Welfare effects of non-exclusive trade
Non-exclusive trade will
(i) increase consumer surplus if
$$a - c > 2k_\beta - k_\alpha;$$
(ii) increase aggregate profits if
$$16\left(a-c-k_\beta\right)^2 + 28\left(k_\alpha - k_\beta\right)^2 > 11\left(a-c-k_\alpha\right)^2;$$
(iii) increase welfare if
$$136\left(a-c\right)^2 + 368\left(a-c\right)k_\alpha + 320\left(k_\beta\right)^2 + 416\left(k_\alpha - k_\beta\right) > 640\left(a-c\right)k_\beta + 184\left(k_\alpha\right)^2.$$

The conditions on the exogenous parameters $(a, c, k_\alpha, k_\beta)$ that are listed in Proposition 4.4 are necessary and sufficient conditions for welfare gains from non-exclusive trade. Most of these conditions are not intuitive because they reflect the trade-off between gains in consumer surplus and the production inefficiencies resulting from the inclusion of traders with higher costs. By Proposition 4.2, gains in consumer surplus are achieved whenever there are non-exclusive trade contracts. This is only the case if the high trading costs do not exceed the low costs by too much, e.g., $k_\alpha = k_\beta$. The greatest gain in consumer surplus is realized if $k_\alpha = k_\beta = 0$. Aggregate profits increase for $k_\alpha = k_\beta$, which is obvious from Proposition 4.4 (ii). Hence, we can conclude that non-exclusive trade is unambiguously welfare-enhancing if the local costs of the traders are equal. Indeed, by continuity of the conditions in Proposition 4.4, this result remains true for local costs that do not differ by too much.

4.2 The n-trader case

Consider a set of n potential downstream traders who differ in k_j. Denoting $X = \sum_{k \in J} x_k$ as the aggregate downstream supply and $X_{-j} := \sum_{j \neq k \in J} x_k$ as the aggregate supply of the competing traders other than j, one can write the profit of Trader j as $\pi_j = P(X_{-j} + x_j) \cdot x_j - (q_j + k_j) \cdot x_j$. Straightforward optimization with respect to the quantity x_j yields $r_j(X_{-j}) = \max\left\{0, \frac{a - bX_{-j} - q_j - k_j}{2b}\right\}$.

Lemma 4.5 *Given an array of prices $q = (q_1, ..., q_n)$ charged by the producer, the* Cournot equilibrium with n potential traders *is*

- *aggregate supply:* $X^C(q) = \frac{1}{(n+1)b}\left(na - \sum_{j=1}^{n}(q_j + k_j)\right)$,
- *market price:* $p^C(q) = \frac{1}{(n+1)}\left(a + \sum_{k=1}^{n}(q_k + k_k)\right)$,
- *supply of Trader $j \in J$:* $x_j^C(q) = \max\left\{0, \frac{1}{(n+1)b}\left(a + \sum_{\substack{k=1 \\ k \neq j}}^{n}(q_k + k_k) - n(q_j + k_j)\right)\right\}$,
- *profit of Trader $j \in J$:* $\pi_j^C(q) = \frac{1}{(n+1)^2 b}\left(a + \sum_{\substack{k=1 \\ k \neq j}}^{n}(q_k + k_k) - n(q_j + k_j)\right)^2$.

The producer chooses prices $(q_j)_{j \in J}$ to maximize

$$\pi(q) := \sum_{j=1}^{n}(q_j - c)\, x_j^C(q) = \frac{1}{(n+1)b}\sum_{j=1}^{n}(q_j - c)\left(a + \sum_{\substack{k=1 \\ k \neq j}}^{n}(q_k + k_k) - n(q_j + k_j)\right).$$

Proposition 4.6 shows the solution to this problem.

Proposition 4.6 *For a set of n potential traders, we obtain in equilibrium:*

- *traders' supply prices:* $q_j^C = \frac{1}{2}(a + c - k_j)$,
- *downstream quantities:* $x_j^C = \max\left\{0, \frac{1}{2(n+1)b}\left(a - c + \sum_{k=1}^{n} k_k - (n+1)\, k_j\right)\right\}$,
- *aggregate supply:* $X^C = \frac{1}{2(n+1)b}\left(n(a - c) - \sum_{k=1}^{n} k_k\right)$,
- *downstream price:* $p^C = \frac{1}{2(n+1)}\left((n+2)a + nc + \sum_{k=1}^{n} k_k\right)$,
- *traders' profit:* $\pi_j^C = \frac{1}{4(n+1)^2 b}\left(a - c + \sum_{k=1}^{n} k_k - (n+1)\, k_j\right)^2$,
- *producer's profit:* $\pi^C = \frac{1}{4(n+1)b}\left[\sum_{j=1}^{n}(a - c - k_j)^2 + n\sum_{k=1}^{n} k_k^2 - \left(\sum_{k=1}^{n} k_k\right)^2\right]$.

The optimal supply prices are the same as under the respective monopolies.[5] The number of active traders in a Nash equilibrium depends on the supply price vector $q = (q_1, ..., q_n)$. Suppose that there is a trader $m \leq n$ who does not offer the producer's product given the equilibrium supply prices. By Assumption 2.1(a), traders $m + i$ for $i = 1, .., n - m$ also do not trade the product. The following proposition gives the condition for traders to be active in the downstream market.

Proposition 4.7 *There exists a trader $m \in I$ such that all traders $j < m$ supply and all traders $j \geq m$ do not supply. Trader m is determined by*

$$k_{m+1} > k_m \geq \frac{1}{n+1}\left(a - c + \sum_{k=1}^{n} k_k\right) > k_{m-1}.$$

Proposition 4.7 is the analogue of Proposition 4.2 for the n-trader case. With differing trading costs, not all traders are necessarily active at the Nash equilibrium supply prices $q^C = (q_1^C, ..., q_n^C)$. However, given Assumption 2.1 (b), it is possible that all n traders are active, $k_j < \frac{1}{n+1}\left(a - c + \sum_{k=1}^{n} k_k\right)$ for all $j \in J$. It is also possible to provide sufficient conditions for the welfare effects of an increase in the number of active traders in the downstream market. Consumer surplus is strictly increasing in the amount of the product traded downstream. By setting $X_{n+1}^C \geq X_n^C$, we derive sufficient conditions under which the aggregate quantity traded X^C increases if the number of active traders increases:

$$a - c \geq (n+1)\, k_{n+1} - \sum_{j=1}^{n} k_j.$$

From X^C (Proposition 4.6), it is clear that this depends on whether the demand effect $(a - c)$ of an additional trader outweighs the additional costs k_{n+1} introduced by this trader. A more clear-cut result is possible for symmetric local costs.

4.2.1 Symmetric local costs

Let $k_j = k$ for all $j \in J$. By Proposition 4.7, it is optimal for the producer to have all n traders active. In this special case, we can consider the limit if the number of traders increases.

[5] This is a useful property of the linear demand function in combination with linear cost functions, which makes the explicit derivation of a solution possible.

Proposition 4.8 *Assume $k_j = k$ for all $j = 1, 2, ..., n$. As $n \to \infty$, we obtain in equilibrium:*

- *traders' supply prices:* $q_j^C = \frac{1}{2}(a + c - k)$,
- *downstream quantities:* $\lim_{n\to\infty} x_j^C(n) = \lim_{n\to\infty} \max\left\{0, \frac{1}{2(n+1)b}(a - c - k)\right\} = 0$,
- *aggregate supply:* $\lim_{n\to\infty} X^C(n) = \lim_{n\to\infty} \frac{n}{2(n+1)b}(a - c - k) = \frac{1}{2b}(a - c - k)$,
- *downstream price:* $\lim_{n\to\infty} p^C(n) = \lim_{n\to\infty} \frac{n}{2(n+1)}\left(\frac{(n+2)}{n}a + c + k\right) = \frac{1}{2}(a + c + k)$,
- *traders' profit:* $\lim_{n\to\infty} \pi_j^C(n) = \lim_{n\to\infty} \frac{1}{4(n+1)^2 b}(a - c - k)^2 = 0$,
- *producer's profit:* $\lim_{n\to\infty} \pi^C(n) = \lim_{n\to\infty} \frac{n}{4(n+1)b}(a - c - k)^2 = \frac{1}{4b}(a - c - k)^2$.

An individual trader's supply vanishes in the limit, traders' profit is driven to zero, and the producer extracts the full monopoly rent. This result appears to be the scenario that most of authors who were cited in the introduction have in mind. In the symmetric case, each additional trader increases the aggregate downstream supply and social surplus. The limiting maximal aggregate supply corresponds to the case in which the producer acts as a direct downstream monopoly. This maximal supply defines the upper limit of social surplus. In conclusion, for symmetric local costs, each additional trader reduces the double marginalization problem unambiguously and leads to a higher profit for the monopolist and a higher consumer surplus.

5 Conclusion

We study Cournot quantity setting competition among traders of a homogeneous product in the downstream market of a single producer. Without detailed analysis, the literature seems to assume that, in the absence of vertical restraints, downstream competition is always beneficial to an upstream monopolist because it counterbalances the double marginalization problem he would otherwise face. Our analysis confirms this intuition for a large number of downstream traders *with identical local costs*. If downstream traders have differing local costs, such a result does not hold true in general. It is in this respect that we believe our analysis is different from existing works, such as those of Rey and Vergé (2008) and Saggi and Vettas (2002). In addition, we investigate the welfare effects of non-exclusive trade. We find that the upstream monopolist differentiates supply prices to keep as many traders as feasible in the downstream market. This may, however, reduce consumer surplus compared to exclusive downstream trade.

Appendix

Proof of Proposition 4.2. We consider π^M under a monopoly of low-cost Trader α because this yields higher profits for the producer than a monopoly of β:

$$\begin{aligned}\pi^D - \pi^M &= \frac{1}{12b}\left[(a-c-k_\alpha)^2 + (a-c-k_\beta)^2 + (k_\alpha - k_\beta)^2\right] - \frac{1}{8b}(a-c-k_\alpha)^2 \\ &= \frac{1}{24b}(a-c+k_\alpha-2k_\beta)^2 \geq 0.\end{aligned}$$

By continuity of the producer's profit function, $\pi^D = \pi^M$ when $x_\beta^D = 0$. For $\pi^D = \pi^M$, α is a downstream monopolist,

$$x_\beta^D = \max\{0, \frac{1}{6b}(a-c+k_\alpha-2k_\beta)\} = 0,$$

if and only if $a - c + k_\alpha - 2k_\beta \leq 0$. There is non-exclusive downstream trade if and only if $(a-c-k_\beta) > (k_\beta - k_\alpha)$. ■

Proof of Proposition 4.4.

(i): *Consumer surplus*

$$S^D = \frac{1}{72b}\left[(a-c-k_\alpha)+(a-c-k_\beta)\right]^2 > \frac{1}{32b}(a-c-k_\alpha)^2 = S^M \iff a-c > 2k_\beta - k_\alpha.$$

(ii): *Aggregate profits*

$$\begin{aligned}\Pi^D &= \pi^D + \pi_\alpha^D + \pi_\beta^D \\ &= \frac{1}{36b}\left[4(a-c-k_\alpha)^2 + 4(a-c-k_\beta)^2 + 7(k_\alpha-k_\beta)^2\right] > \frac{3}{16b}(a-c-k_\alpha)^2 = \Pi^M \\ &\iff 16(a-c-k_\beta)^2 + 28(k_\alpha-k_\beta)^2 > 11(a-c-k_\alpha)^2.\end{aligned}$$

(iii): *Welfare*

$$\begin{aligned}W^D &= \frac{1}{72b}\left[20(a-c)^2 - 20(k_\alpha+k_\beta)(a-c) + 10\left((k_\alpha)^2+(k_\beta)^2\right) + 13(k_\alpha-k_\beta)\right] \\ &> \frac{7}{32b}(a-c-k_\alpha)^2 = W^M \\ &\iff 136(a-c)^2 + 368(a-c)k_\alpha + 320(k_\beta)^2 + 416(k_\alpha-k_\beta) > 640(a-c)k_\beta + 184(k_\alpha)^2.\end{aligned}$$

■

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