

Bargaining, mergers, and technology choice in bilaterally oligopolistic industries

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We analyze up- and downstream market structure and the choice of technology in a bilaterally oligopolistic industry. The distribution of industry profits between up- and downstream firms is determined by a procedure of bilateral negotiations, which is shown to generate the Shapley value. Incentives for downstream mergers depend on whether upstream firms have increasing or decreasing unit costs, while incentives for upstream mergers depend on whether products are substitutes or complements. Incentives for upstream firms to reduce marginal costs increase with a downstream merger and decrease with an upstream merger. Finally, downstream firms may strategically choose a particular market structure to affect upstream technology choice.

1. Introduction

■ Since the emergence of large retail chains, buying power has become a key feature in the relationship between manufacturers and retailers.¹ Although economic analysis has traditionally viewed retailers as lacking influence on wholesale markets, recent consolidation in the retailing

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¹ For example, Dell (1996) reports that in the United Kingdom and France, the number of outlets per capita has fallen to one-fifth the level of thirty years ago, and 2% of stores now account for over half of all grocery sales. In the United States, the supermarket industry is in the midst of an unprecedented merger wave. Recent examples include Safeway and

sector has created market structures characterized by bilateral oligopolies, where each retailer accounts for a relatively large share of each supplier's sales.² Furthermore, retailers often enjoy considerable market power at their outlets, caused by consumers' preferences for one-stop shopping and an increasing segmentation of retail formats (see OECD, 1999).³

Buyer power has also become an important issue in competition policy.⁴ In the United States, buyer power enters merger control as an efficiency defense via the 1992 Horizontal Merger Guidelines, with the revisions to Section 4 on efficiencies in 1997.⁵ The buyer-power defense has also been made explicit in the 1998 Competition Act of the United Kingdom. The buyer-power defense asserts that lower input prices due to higher purchasing power are passed (partially) on to consumers. As we shall discuss in more detail below, such a conclusion has only been theoretically sustained if supply contracts are linear and retailers compete in local outlet markets. Hence, at first sight consumers should be unaffected if retailers with previously independent markets merge. This applies, in particular, to the increasing number of *cross-country* mergers, takeovers, or alliances between retail chains.⁶ According to an often expressed (but hitherto not formalized) view, excessive purchasing power may, however, damage the long-term viability of producers and could therefore indirectly affect consumer rents and overall welfare. For example, Dobson, Waterson, and Chu (1998, p. 16) argue that retailer concentration "can have an economic impact when . . . buyer power reduces prices for suppliers, and thus their income, making it difficult for them to finance required investments, which might then be postponed or even forgone completely."

This article presents a model of input price determination in a bilateral oligopolistic industry that allows us to address the following two questions. First, what are the strategic incentives for horizontal mergers if pricing behavior on the final goods market is not affected? Second, what (if any) are the welfare implications of horizontal mergers in a bilaterally oligopolistic industry? One contribution of this article is to qualify the above view that increased retailer concentration reduces welfare by reducing suppliers' investment incentives. Following a merger between retailers, suppliers have to bear relatively more of their marginal and relatively less of their inframarginal costs. Consequently, a reduction of marginal costs becomes more attractive. As consumers benefit from the resulting lower prices and higher quantities, a more concentrated downstream market may raise welfare.

Our model builds on the presumption that input prices between a limited number of upstream and downstream firms are determined by bilateral negotiations. Precisely, our bargaining concept contains three major ingredients. First, bargaining is efficient as the two sides can write nonlinear supply contracts. Second, bargaining between all parties proceeds simultaneously, which deprives any party of a first-mover advantage. Third, bilateral contracts can be sufficiently complex to allow some flexibility if negotiations with other parties are not successful. We show that under these conditions, industry profits are distributed according to the Shapley value.

Focusing on the impact of market structure on the distribution of rents, we derive exact conditions under which up- and downstream firms prefer to merge. Among other things, we find

Dominick's, Kroger and Fred Meyer, and Ahold and Giant Food. For an overview of recent concentration changes in the retailing sector, also see Dobson and Waterson (1999) and OECD (1999).

² At the EU level, retailer concentration is further strengthened by cross-border alliances such as Associated Marketing Services, Euro Buying, or Buying International Group (see Robinson and Clarke-Hill, 1995).

³ For instance, in the recent *United States v. Toys "R" Us* case it was ascertained that it would be very difficult for manufacturers to replace the 30% of their sales accounted for by Toys "R" Us (see FTC, 1997).

⁴ The growing concern about buying power in the legal debate in the United States and the European Union is documented in, e.g., OECD (1999).

⁵ Several courts have already considered such claims (see Balto, 1999). In the prominent case *FTC v. Staples, Inc.* (970 F.Supp 1066–D.D.C. 1997), the principal efficiency claim of the proposed merger between Staples and Office Depot was based on enhanced buyer power (for an assessment from the Federal Trade Commission's perspective, see Pitofsky, 1998).

⁶ Examples for cross-country activities are the takeover of Spar (Germany) by Intermarché's (France), SHG Makro (Netherlands) by Metro AG (Germany) in 1997, or the takeover of BML (Austria) by REWE (Germany) a year earlier. That this process is not confined to a pan-European realm is documented by Wal-Mart's acquisition of Wertkauf (Germany).

that downstream firms merge if the upstream production technologies exhibit strictly increasing unit costs, while upstream firms merge if their outputs are substitutes. We next extend the analysis and introduce a (noncontractible) technology choice by suppliers. The structures of both the upstream and the downstream market affect the suppliers' tradeoffs between inframarginal cost savings and cost savings "on the margin." By studying the case of linear demand and cost functions, we can make this tradeoff fully explicit. Incentives to adopt a technology with lower marginal costs are higher if upstream firms stay separated and downstream firms merge. In a final step, we analyze the case where both market structure and technology choice are endogenous and mutually dependent. We show that downstream firms may strategically merge to affect upstream technology choice. In this case a merger of downstream firms may benefit *all* market participants, including consumers. However, we also find incidences in which a regulator would prefer to implement a different market structure from that arising in equilibrium.

Our article extends the positive and normative analysis of mergers. In bilaterally oligopolistic industries, firms may choose to merge either to enhance their bargaining power or to affect some (noncontractible) choice of their suppliers. This contrasts with more standard merger analysis in which firms merge either to monopolize the final good market (e.g., Salant, Switzer, and Reynolds, 1983) or to realize synergies within the merged firm (e.g., Farrell and Shapiro, 1990). From a normative perspective, our argument that buyer power matters as it affects upstream technology choice fits well into the perspective of "innovative markets," which emphasizes the impact on innovative activities.⁷ Though this question has a long history, it has recently gained much importance in antitrust policy.⁸ So far this approach has only considered concentration and investment at the same market "level." In contrast, our article suggests a broader view incorporating the fact that downstream mergers can affect technology choice by upstream firms.

It is fair to say that the analysis of horizontal mergers in bilaterally oligopolistic industries has been largely ignored in the literature. The effects of mergers on negotiated input prices have been previously studied in Horn and Wolinsky (1988a), von Ungern-Sternberg (1996), and Dobson and Waterson (1997). The differences between these articles and our contribution are manifold. Most important, they do not cover the bilaterally oligopolistic case.⁹ Furthermore, all these articles consider inefficient bargaining over constant unit prices and assume interdependent demand.¹⁰ With interdependent demand, mergers also reduce competition on the final product market. This blurs the analysis of a merger's impact on bargaining power. Finally, none of these articles has addressed the link between market structure and suppliers' technology choice.

Our analysis of technology choice is related to the holdup literature (see Grossman and Hart, 1986, and Hart and Moore, 1990). Whereas this literature analyzes how the integration of investing parties affects their incentives, we study the impact of the integration of outsiders, i.e., of downstream firms, on a firm's technology choice. Moreover, we are able to combine in one application three issues that are important to industrial organization. We investigate how incentives to invest in cost reduction are determined by (i) the nature of costs, (ii) the degree of competition between investing upstream firms, and (iii) the prevailing up- and downstream market

⁷ See Gilbert and Sunshine (1995) for an overview. In the United States, the earliest directive that relevant antitrust markets be defined around research and development activities can be found in the National Cooperative Research Act of 1984.

⁸ The current innovative market approach under Section 7 of the Clayton Act and Section 5 of the Federal Trade Commission Act was first applied in 1993, when the U.S. Department of Justice opposed the merger of the Allison Transmission Division of General Motors and ZF Friedrichshafen. Since the release of the 1995 Intellectual Property Guidelines, the FTC has levelled complaints against several additional mergers on the grounds that innovation markets would be harmed.

⁹ In particular, only Horn and Wolinsky (1988a) consider the case where there may be more than one supplier. However, they assume that each downstream firm is locked-in with a particular upstream firm. The case of locked-in firms is also studied in Inderst and Wey (2000a), where the major benefit of a downstream merger is to break this lock-in.

¹⁰ In fact, incentives for retailer mergers depend crucially on this combination of inefficient bargaining with interdependent demand. For instance, in Dobson and Waterson (1997), a monopolistic supplier who grants a discount to one particular retailer suffers from a decrease in his supply to other retailers, who buy at higher unit prices. Appealing to this negative externality in his negotiations with individual retailers, the supplier can extract more rents.

structure. By studying the interdependencies between market structure and investment incentives, our article is also related to Kranton and Minehart (2000). They analyze the stability of buyer-seller networks as an alternative to vertical integration. Buyer-seller networks are the outcome of suppliers' investments into productive capacity and of buyers' investments into establishing costly links with sellers.

The article is organized as follows. Section 2 introduces the economy. In Section 3 we propose and motivate the bargaining concept. Section 4 determines the equilibrium market structure when suppliers' production technologies are exogenously fixed. In Section 5 we introduce technology choice by suppliers. In Section 6 we discuss modifications to some assumptions. Section 7 concludes with possible extensions. Proofs are found in Appendix A.

2. The economy

■ We consider an intermediary goods market in which $N = 2$ producers, denoted by $s \in S^0 = \{A, B\}$, sell their products to $M = 2$ retailers, denoted by $r \in R^0 = \{a, b\}$. We assume that each supplier controls production of one differentiated good, where the total cost function is denoted by $K_s(\cdot)$. Each retailer owns a single outlet. Demand at different outlets is independent. Note that this assumption applies particularly to those cases where retailers are located in different regions or even countries. This assumption rules out standard monopolization effects of mergers and allows us to isolate the impact of market structure on bargaining power. We denote the indirect demand function for good s at retailer r by $p_{sr}(x_{sr}, x_{s'r})$, where $s' \neq s$ denotes the alternative supplier. A distinguishing feature of supply contracts in intermediary goods markets, as opposed to final goods markets, is that they are often negotiated. Consistent with this, supply contracts will be the result of bargaining. We denote the quantity of good s supplied to retailer r by x_{sr} .

So far we have treated each supplier and each retailer separately. In the following, we distinguish between four market structures, where suppliers or retailers can be integrated. We denote a market structure by $\omega = (n, m)$, where n stands for the number of independent suppliers and m stands for the number of independent retailers, with $n, m \in \{1, 2\}$. As demand at the two outlets is independent, mergers do not affect supplied quantities if suppliers' technologies are fixed. However, market structure will determine the parties' bargaining power and, thereby, the distribution of rents.

3. Bargaining concept

■ **Specification of the bargaining concept.** Negotiations are conducted between all independent suppliers and retailers. We employ the same bargaining concept for all market structures. In the next subsection we describe a particular bargaining procedure. As discussed in detail below, this procedure gives rise to the Shapley value. We choose to start out with the Shapley value as our solution concept to multilateral bargaining, while postponing the description of the underlying procedure.

We denote total industry profits for given supplies by

$$W(\{x_{sr}\}_{sr \in S^0 \times R^0}) = \sum_{r \in R^0} [p_{Ar}(x_{Ar}, x_{Br})x_{Ar} + p_{Br}(x_{Br}, x_{Ar})x_{Br}] - \sum_{s \in S^0} K_s(x_{sa} + x_{sb}).$$

Denoting the set of all firms by $\Omega = \{A, B, a, b\}$, we define W_Ω as the maximum industry profits. Suppose now that supplier $s = A$ leaves the market, which gives us the subset $\Omega \setminus \{A\}$. Calculating the maximum industry profits subject to the constraint that $x_{Aa} = x_{Ab} = 0$, we denote the respective value by $W_{\Omega \setminus \{A\}}$. We can proceed like this for any subset $\Omega' \subseteq \Omega$ and derive the resulting maximum industry profits $W_{\Omega'}$. Naturally, the industry profit is zero if a subset of firms does not include a retailer or a supplier. For the calculation of efficient supplies under the different scenarios, we impose the following assumption.

Assumption 1. $W(\cdot)$ is strictly quasi-concave and continuous.

Assumption 1 holds, in particular, for the case of linear demand and cost functions, on which we focus in Section 5. To calculate the Shapley value, we have to identify the set of independently negotiating parties, denoted by Ψ . For instance, for $\omega = (2, 1)$ we obtain $\Psi = \{A, B, ab\}$, where ab denotes the merged retailer. According to the Shapley value, the payoff of a member $\psi \in \Psi$ is given by

$$\sum_{\tilde{\Psi} \in \Psi; \psi \in \tilde{\Psi}} \frac{(|\tilde{\Psi}| - 1)! (|\Psi| - |\tilde{\Psi}|)!}{|\Psi|!} [W_{\tilde{\Psi}} - W_{\tilde{\Psi} \setminus \{\psi\}}], \quad (1)$$

where $|\tilde{\Psi}|$ and $|\Psi|$ denote the number of elements in these sets. One often refers to $W_{(\cdot)}$ as the characteristic function. The Shapley value reflects the incremental contribution of ψ to various subsets $\tilde{\Psi} \subseteq \Psi$. While this solution concept can be justified on axiomatic grounds, we argue in the next section that it is also the outcome of a rather natural description of simultaneous bargaining in a bilaterally oligopolistic industry.

□ **Bargaining procedure.** We propose the following requirements for negotiations:

- (i) *Simultaneous bilateral bargaining.* We assume simultaneous bilateral negotiations between the representatives of each independent retailer and supplier. For instance, under $\omega = (1, 2)$ the merged supplier employs two sales representatives (agents). One of his agents negotiates with retailer a , while the other agent visits retailer b .
- (ii) *Efficient bargaining and (net) surplus sharing.* In all bilateral negotiations agents choose the respective supplies so as to maximize the joint surplus of the two parties. When determining supplies, the two parties form rational expectations about the outcomes of all other simultaneous negotiations. Moreover, transfers between the two parties are specified so as to split the net surplus equally.
- (iii) *Contingent contracts.* In each negotiation the two sides conclude contracts for all possible contingencies. A contingency describes the set of successful bilateral negotiations in the industry. For instance, under $\omega = (1, 2)$ the agents of the single supplier and retailer a negotiate over two contracts, specifying transfers and supplies for the two cases where simultaneous negotiations with retailer b either are successful or have broken down. For each of these agreements the requirements of (ii), i.e., efficient bargaining and equal sharing of net surplus, apply.

The requirements (i)–(iii) can be easily formalized (see Appendix B). They give rise to an iterative procedure, starting from the simplest contingencies, where all other negotiations break down, up to the contingency where all negotiations are successful. Without further assumptions, however, the respective supplies chosen for the various contingencies may not maximize industry profits. For instance, if goods are complements, the failure to supply one good at some retailer may make it unprofitable also to supply the other good. This coordination failure could be ruled out by imposing some refinement, e.g., in the form of coalition-proofness (see, e.g., Bernheim and Whinston, 1986). Alternatively, we can impose restrictions on industry profits $W_{(\cdot)}$ to ensure that “corner solutions” are never optimal.

Assumption 2 (exclusion of corner solutions). Consider some contingency, i.e., a set of feasible supplier-retailer links L .¹¹ Maximizing industry profits $W_{(\cdot)}$ under the constraint that $x_{sr} = 0$ holds for all $(sr) \notin L$ must imply $x_{sr} > 0$ for all $(sr) \in L$.¹² Moreover, given these choices x_{sr} for all $(sr) \in L$, industry profits could be strictly increased by choosing some value $x_{sr} > 0$ for any additional supplier-retailer link $(sr) \notin L$.

Below we discuss in detail the case with linear demand and costs where these conditions are made explicit. Given Assumptions 1 and 2, it is now easily checked that equilibrium supplies are uniquely determined for all contingencies and that they maximize total industry profits.

¹¹ Formally, L is an element of the power set of $S^0 \times R^0$.

¹² Observe that all x_{sr} , with $s = A, B$ and $r = a, b$, are uniquely determined due to Assumption 1.

Denote now the payoff of supplier A by U_A and that of retailer a by U_a . If bargaining between these two parties breaks down, denote the respective payoffs under the new contingency by \tilde{U}_A and \tilde{U}_a . As agents split the net surplus equally in each bilateral negotiation, we obtain

$$U_A - U_a = \tilde{U}_A - \tilde{U}_a. \quad (2)$$

Condition (2) is called “balancedness,” which under our requirements must hold for all bilateral negotiations and for all contingencies. We are now in the position to argue that our requirements (i)–(iii) indeed generate the Shapley value. This follows in two steps. First, under Assumptions 1 and 2, total payoffs generated for any contingency maximize industry profits, i.e., we obtain the characteristic function $W_{(\cdot)}$. Second, under our requirements the distribution of payoffs is generated by the “balancedness condition” for all players and contingencies. By results in Jackson and Wolinsky (1996), which extend those in Myerson (1977), this implies that individual payoffs are determined by the Shapley value.¹³ Summing up, it is the joint assumption of (simultaneous) efficient negotiations and contingent contracting that generates the Shapley value.¹⁴

4. Horizontal mergers

■ **Equilibrium payoffs.** We now calculate equilibrium payoffs under different market structures. While the calculation of payoffs is immediate from the Shapley value, we want to use this opportunity to illustrate the bargaining procedure proposed in Section 3. For this purpose we consider the case $\omega = (1, 2)$, where only suppliers merge. Denote the payoff of retailer r by U_r and that of the single supplier by U_{AB} . Applying the Shapley value yields

$$\begin{aligned} U_{AB} &= \frac{1}{3} \left[W_{\Omega} + \frac{1}{2} W_{\Omega \setminus \{a\}} + \frac{1}{2} W_{\Omega \setminus \{b\}} \right], \\ U_a &= \frac{1}{3} \left[W_{\Omega} - W_{\Omega \setminus \{a\}} + \frac{1}{2} W_{\Omega \setminus \{b\}} \right], \\ U_b &= \frac{1}{3} \left[W_{\Omega} - W_{\Omega \setminus \{b\}} + \frac{1}{2} W_{\Omega \setminus \{a\}} \right]. \end{aligned} \quad (3)$$

The supplier signs with each of the two retailers $r = a, b$ the following contracts. One contract specifies supplies and transfers for the case where bargaining with the other retailer is also successful. A second contract is implemented if no contract is signed with the other retailer. If, for instance, bargaining with retailer b breaks down, the contract with retailer a allows the supplier to realize the payoff $(1/2)W_{\Omega \setminus \{b\}}$, i.e., half of the maximum feasible industry profits. Likewise, the contract with retailer b specifies that either side realizes $(1/2)W_{\Omega \setminus \{a\}}$ if there is no agreement with retailer a . Based on these results, we can next determine contracts for the contingency where all negotiations are successful. If S_r denotes the net surplus realized with retailer r , each retailer obtains $U_r = (1/2)S_r$, while the supplier realizes $U_{AB} = (1/2)W_{\Omega \setminus \{r\}} + (1/2)S_r$. As $U_a + U_b + U_{AB} = W_{\Omega}$ holds, it is straightforward to solve for the payoffs stated in (3) for the case where $\omega = (1, 2)$.

As industry profits are invariant to the choice of market structure and as it is sufficient for what follows to determine the joint payoff of either market side, we only state suppliers’ joint payoff under the different market structures. A complete statement of payoffs for the individual parties is confined to Appendix A.

¹³ Precisely, we can apply Theorem 4 in Jackson and Wolinsky (1996) after noting that our condition of noninterdependent demand is equivalent to their requirement that the value function (i.e., $W_{(\cdot)}$) is “component additive.” Incidentally, the “balancedness condition” is also used in Stole and Zwiebel (1996a, 1996b) when showing that their bargaining procedure between a single firm and many workers obtains the Shapley value. In contrast to our bargaining procedure, their main assumption is that wage contracts are nonbinding.

¹⁴ Below in Section 6 we comment on our bargaining procedure, where we also describe a noncooperative game that supports our solution as an equilibrium outcome.

Proposition 1. Under the different market structures we obtain for suppliers' payoff:

- (i) Bilateral monopoly, $\omega = (1, 1)$: $(1/2)W_\Omega$,
- (ii) Supplier merger, $\omega = (1, 2)$: $(1/3)[W_\Omega + (1/2)W_{\Omega \setminus \{a\}} + (1/2)W_{\Omega \setminus \{b\}}]$,
- (iii) Retailer merger, $\omega = (2, 1)$: $(1/3)[2W_\Omega - (1/2)W_{\Omega \setminus \{A\}} - (1/2)W_{\Omega \setminus \{B\}}]$,
- (iv) Fragmentation, $\omega = (2, 2)$: $(1/2)W_\Omega + (1/6)[W_{\Omega \setminus \{a\}} + W_{\Omega \setminus \{b\}} - W_{\Omega \setminus \{A\}} - W_{\Omega \setminus \{B\}}]$.

□ **Equilibrium market structure.** To determine the equilibrium market structure, we first compare the joint payoff of retailers and suppliers in the various cases. Simple calculations give rise to the following lemma.

Lemma 1.

- (i) Regardless of whether retailers have merged or not, suppliers' joint payoff increases after a merger if

$$W_{\Omega \setminus \{A\}} + W_{\Omega \setminus \{B\}} > W_\Omega, \tag{4}$$

whereas it decreases if the inequality is reversed.

- (ii) Regardless of whether suppliers have merged or not, retailers' joint payoff increases after a merger if

$$W_{\Omega \setminus \{a\}} + W_{\Omega \setminus \{b\}} > W_\Omega, \tag{5}$$

whereas it decreases if the inequality is reversed.

In equilibrium the joint payoff of either side of the market will not increase if this side chooses a different market structure (while, of course, the structure on the other side remains unchanged).¹⁵ The following corollary follows directly from Lemma 1.

Corollary 1. The equilibrium market structure satisfies the following:

- (i) Suppliers merge if $W_{\Omega \setminus \{A\}} + W_{\Omega \setminus \{B\}} > W_\Omega$ and they stay separated if $W_{\Omega \setminus \{A\}} + W_{\Omega \setminus \{B\}} < W_\Omega$.
- (ii) Retailers merge if $W_{\Omega \setminus \{a\}} + W_{\Omega \setminus \{b\}} > W_\Omega$ and they stay separated if $W_{\Omega \setminus \{a\}} + W_{\Omega \setminus \{b\}} < W_\Omega$.

Before providing some intuition for these results, we briefly investigate when conditions (4) and (5) should hold. We use the following definitions. We say that the cost function $K_s(\cdot)$ exhibits strictly increasing (decreasing) unit costs if $K_s(x)/x$ is strictly increasing (decreasing) on $x > 0$. Two goods are said to be strict substitutes if $x''_{s'r} > x'_{s'r}$ and $p_{sr}(x_{sr}, x'_{s'r}) > 0$ imply $p_{sr}(x_{sr}, x''_{s'r}) > p_{sr}(x_{sr}, x'_{s'r})$ for any choices $s, s' \in S^0$, $s \neq s'$, and $r \in R^0$. If $x''_{s'r} > x'_{s'r}$ and $p_{sr}(x_{sr}, x''_{s'r}) > 0$ imply $p_{sr}(x_{sr}, x''_{s'r}) < p_{sr}(x_{sr}, x'_{s'r})$ for any choices $s, s' \in S^0$, $s \neq s'$, and $r \in R^0$, we say that goods are strict complements.

Proposition 2. If both suppliers have strictly increasing (decreasing) unit costs, retailers merge (stay separated). If products are strict substitutes (complements) at the two outlets, suppliers merge (stay separated).

Using the bargaining procedure proposed in Section 3, we now provide additional intuition for our results. Consider first the retailers' incentives to merge. As supplies are not affected by market structure and total rents are therefore left unchanged, a merger can only shift rents between retailers and suppliers. If retailer a bargains with a supplier, they consider the additional costs incurred by the delivery to a . If retailers have merged, the two sides negotiate over the total supply of the respective good. Hence, negotiating separately with two retailers allows a supplier to roll over more of his additional or "marginal" costs. If unit costs are increasing, the supplier will thus enjoy more of the "inframarginal" rents. If retailers merge, they gain access to a larger share of these rents. The same principle prevails in the case of a supplier merger. For instance, if goods are complements, the positive cross-price effect implies that the net or additional surplus created

¹⁵ For a precise formulation of these conditions, see, e.g., Selten (1973).

by each good is increased. Hence, in the case of complements, suppliers prefer to negotiate “at the margin.”¹⁶

Broadly speaking, a merger shifts bargaining away from the margin. If the created net surplus is smaller at the margin, which is the case with increasing unit costs or substitutes, the respective market side prefers to become integrated. Although the exploration of this principle in the framework of a (bilaterally) oligopolistic market is to our knowledge new, the general principle has already been detected by Horn and Wolinsky (1988b) and Jun (1989). Both articles analyze bargaining between one firm and two workers (or groups of workers). Each worker can supply one unit of labor. If their respective inputs are complements, workers can extract more of the surplus by bargaining independently.

Observe that our results qualify the concept of “buyer power.” We identify reasonable circumstances under which retailers would be worse off if they merged. This is more likely if the industry exhibits high fixed costs and strong economies of scale. On the other side, if tight capacity implies that unit costs are increasing, retailers should gain from a merger.

Clearly, Proposition 2 does not exhaust all possible cases. For instance, unit costs may be nonmonotonic. Moreover, one of the two suppliers may enjoy decreasing unit costs while the other supplier has increasing unit costs. Under these circumstances we can still make precise predictions on the equilibrium market structure by referring to conditions (4) and (5) in Lemma 1.

5. Horizontal mergers and technology choice

■ In this section we assume that one supplier can choose between two production technologies. We consider two technologies $i = \alpha, \beta$, where technology α exhibits relatively low inframarginal (or fixed production) costs and relatively high marginal costs. For the other technology β this relation is reversed. By adopting technology β , the supplier gains a higher degree of volume flexibility in the sense that high output levels are relatively cheaper to produce.¹⁷ Instead of a change in production costs, we could also imagine that the supplier can choose between different distribution strategies. Using a highly flexible (computerized) logistical system may make it cheaper to ship additional quantities, but again this may come at the price of higher operating expenses.

Our model isolates the following two effects of market structure on technology choice, where the first effect is obtained by separating retailers and the second by separating suppliers.

- (i) *Rent-sharing effect.* By separating retailers, bargaining is shifted toward marginal production levels. Consequently, suppliers have to bear a larger share of their inframarginal costs and a smaller share of their marginal costs. Thus they have a greater incentive to trade off lower inframarginal costs with higher marginal costs.
- (ii) *Competition effect.* If suppliers are separated and goods are substitutes, a decrease of marginal costs reduces the rival firm’s supply. This negative externality is not internalized if suppliers are separated, which increases the incentives to reduce marginal costs at the expense of higher inframarginal costs.

In what follows, we consider a three-stage game. In the first stage, suppliers and retailers choose whether to merge. In the second stage, the supplier controlling production of product $s = A$ decides which technology to choose. In the third stage, supply contracts are negotiated. In

¹⁶ Although these results have been derived only for the duopolistic case, they can be extended as follows. For instance, under increasing (decreasing) unit costs at all suppliers, it can be shown that the payoff of a monopsonistic retailer is higher (lower) than the total payoff of all retailers in a fragmented industry. In this case the derivation of an equilibrium market structure poses the new issue of “coalition stability,” which is beyond the scope of this article.

¹⁷ The analysis of volume flexibility in the context of technology choice was pioneered by Stigler (1939) and Marshak and Nelson (1962). The subsequent literature has focused mainly on the interaction with demand uncertainty (see, e.g., Vives, 1986; Eaton and Schmitt, 1994). A practical example is given in United Nations (1986, p. 115), which attributes the cost differential to “the cost of computers and material handling [which] are usually higher under flexible manufacturing.”

the next subsection we analyze the second stage of the game, i.e., optimal technology choice for a given market structure. Then we will turn to the first stage and derive the equilibrium market structure.

□ **Technology choice.** Throughout this subsection we restrict consideration to the case where technologies and demand are both linear. We invoke both specifications in turn before proceeding to the analysis.

Technologies. We consider the following problem of technology choice. Goods can be produced with two technologies indexed by $i \in I = \{\alpha, \beta\}$. Initially, both goods are produced with the same technology $i = \alpha$. However, supplier $s = A$ can switch costlessly to technology β . We denote the respective cost functions under the two regimes by $K^i(x) = F^i + k^i x$ for $x > 0$. The cost component F^i is only incurred for a positive supply level, while costs are zero if no production takes place. Consequently, these (fixed) “operating costs” are not sunk before bargaining starts, but are part of the bilateral negotiation between suppliers and retailers. Below we briefly discuss the case where adjusting marginal or operating costs involves sunk costs, which are no longer part of subsequent negotiations.

We assume that technology β has lower (constant) marginal but higher operating costs; i.e., it holds that $0 \leq k^\beta < k^\alpha < 1$ and $0 \leq F^\alpha < F^\beta$. It is convenient to denote $\Delta_F = F^\beta - F^\alpha > 0$ and $\Delta_k = k^\alpha - k^\beta > 0$. Observe that the difference $K^\beta(x) - K^\alpha(x)$ is strictly decreasing in x and strictly positive at $x = 0$. For simplicity of exposition we set $k^\beta = 0$ and $F^\alpha = 0$, so that $\Delta_k = k^\alpha$ and $\Delta_F = F^\beta$.

Demand. The utility of a representative consumer purchasing at outlet r the quantities x_{sr} of supplier s at prices p_{sr} is given by

$$x_{Ar} + x_{Br} - \frac{1}{2} [x_{Ar}^2 + x_{Br}^2 + 2cx_{Ar}x_{Br}] - x_{Ar}p_{Ar} - x_{Br}p_{Br}.$$

As is well known, this gives rise to a system of linear demand functions. The inverse demand function for x_{sr} is given by $p_{sr} = 1 - x_{sr} - cx_{s'r}$, with $s' \neq s$. We restrict attention to the case of substitutes where $0 < c < 1$. Moreover, to ensure that Assumption 2 holds, we require

$$c < \bar{c} \equiv \min \left\{ 1 - \Delta_k, \frac{1 - 2\sqrt{\Delta_F}}{1 - \Delta_k} \right\}. \quad (6)$$

The derivation of this condition is contained in Appendix A.

Analysis. For a given market structure ω and fixed values of c and Δ_k , technology $i = \beta$ is chosen only if the increase in operating costs Δ_F remains sufficiently small. Precisely, for any market structure we can determine a threshold Δ_F^ω such that $i = \beta$ is strictly preferred if and only if $\Delta_F < \Delta_F^\omega$. Consider the case where both sides have merged. Suppliers obtain just half of total industry profits. Comparing the respective payoffs under the two technology regimes, we obtain for the threshold $\Delta_F^{1,1}$ the expression

$$\Delta_F^{1,1} = 2\Gamma,$$

where $\Gamma \equiv (1/4)[\Delta_k/(1 - c^2)][2(1 - c)(1 - \Delta_k) + \Delta_k]$. Proceeding as in this case, we obtain the threshold values Δ_F^ω for all market structures. By comparing these thresholds we can determine which market structure is more likely to lead to an adoption of technology α or β .

Proposition 3. The thresholds Δ_F^ω for technology choice satisfy the ordering¹⁸

$$\Delta_F^{1,2} < \Delta_F^{2,2} < \Delta_F^{1,1} < \Delta_F^{2,1}.$$

¹⁸ For the sake of brevity, we ignore the (nongeneric) case of indifference.

Proposition 3 confirms the rent-sharing and competition effects stipulated above. The supplier controlling the production at A cares more about marginal cost savings if either retailers merge or suppliers stay separated. More formally, by Proposition 3 we obtain for $m = 1, 2$ that $\Delta_F^{m,2} - \Delta_F^{m,1} < 0$, which illustrates the rent-sharing effect, and for $n = 1, 2$ that $\Delta_F^{2,n} - \Delta_F^{1,n} > 0$, which illustrates the competition effect.¹⁹ As a consequence, the market structure $\omega = (2, 1)$ yields the strongest incentives to adopt technology β ; i.e., for a given reduction in marginal costs, Δ_k , this market structure allows the largest operating cost increase, Δ_F . On the other side of the spectrum, the market structure $\omega = (1, 2)$ implies the lowest incentives to choose technology β with lower marginal costs.²⁰ Regarding the two intermediate cases, the two effects work in opposite directions. It turns out that in our example the rent-sharing effect dominates. It is also instructive to see how the difference in the two thresholds $\Delta_F^{1,1}$ and $\Delta_F^{2,2}$ changes in the degree of substitutability. Precisely, we obtain

$$\frac{d[\Delta_F^{1,1} - \Delta_F^{2,2}]}{dc} = -\frac{\Delta_k [(1 - c)^2 - \Delta_k((1 - c)^2 + c)]}{2(1 - c^2)^2},$$

which is strictly negative if $\Delta_k < (1 - c)^2 / [(1 - c)^2 + c]$, which holds by (6). Hence, $\Delta_F^{1,1} - \Delta_F^{2,2}$ strictly decreases in c , which underlines once again the role of the competition effect.

Before proceeding with the analysis, we briefly discuss the related case where suppliers can invest to reduce costs. The choice of technology thus involves an upfront investment, which cannot be recuperated in subsequent negotiations. Focusing again on the linear case, incentives to reduce operating costs do depend only on the downstream market structure. If retailers merge, the supplier can roll over a larger share of operating costs and thus has lower incentives to reduce these costs. Incentives to reduce marginal costs depend only on the upstream market structure. After a merger, suppliers internalize the negative (demand) externality for the other input and have thus small incentives to reduce marginal costs.²¹ This dichotomy, i.e., that incentives to reduce marginal (“inframarginal”) costs are affected only by upstream (downstream) market structure, is driven by our assumption of constant marginal costs. Generally, our previous analysis suggests that downstream mergers and upstream separation imply more investment if this predominantly affects costs at relatively high output levels, while downstream separation and upstream mergers imply more investment if this predominantly affects costs at relatively low output levels.

□ **Efficiency benchmarks.** We now compare the equilibrium technology choice with two benchmarks of efficiency: industry profits and welfare. As suppliers receive just half of total industry profits in a bilaterally monopolistic industry, their choice maximizes industry profits. Alternative market structures may lead to strictly lower aggregate profits.

Corollary 2. The benchmark of industry profits.

- (i) If $\Delta_F \in (\Delta_F^{1,1}, \Delta_F^{2,1})$, then technology choice under $\omega = (2, 1)$ fails to maximize industry profits.
- (ii) If $\Delta_F \in (\Delta_F^{2,2}, \Delta_F^{1,1})$, then technology choice under $\omega = (2, 2)$ and $\omega = (1, 2)$ fails to maximize industry profits.
- (iii) If $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{2,2})$, then technology choice under $\omega = (1, 2)$ fails to maximize industry profits.

¹⁹ The impact of coalitional (or ownership) structure on various forms of cost-reducing investment goes back to Hart and Moore (1990). See also the more recent Stole and Zwiebel (1996a, 1996b), in which a single firm bargains with its workers. In this setting only the rent-sharing effect is obtained.

²⁰ Recall that we now consider only the case of substitutes. It is intuitive that with complements, i.e., for $c < 0$, market structure $\omega = (2, 1)$ generates the lowest incentives to choose technology β .

²¹ Let k_s denote the marginal costs of supplier s . Then, differentiating the payoff of the independent supplier A with respect to its marginal costs, we obtain $dU_A/dk_A = [2(1 - k_A) - 2c(1 - k_B)]/[4(1 - c^2)]$, while proceeding analogously for the merged supplier yields $dU_{AB}/dk_A = [(1 - k_A)(3 - c^2) - 2c(1 - k_B)]/[6(1 - c^2)]$. As $(1 - k_A)c > 1 - k_B$ holds, the incentives are lower after a merger.

- (iv) For all other cases, technology choice maximizes industry profits under all market structures.

We come next to a comparison of welfare, i.e., the sum of industry profits and consumer surplus. Consider a regulator who can prescribe market structure but neither directly the choice of technology nor individual outputs. As the supplied quantities are independent of the market structure for a given technology, the regulator is thus concerned only with the impact of market structure on technology choice. By substituting equilibrium quantities, we can determine welfare under the two technology regimes. Comparing welfare, we again obtain a unique threshold for the difference of operating costs Δ_F , which is now denoted by Δ_F^* . We obtain

$$\Delta_F^* = 3\Gamma.$$

Hence, the choice $i = \beta$ maximizes welfare if and only if $\Delta_F \leq \Delta_F^*$. To determine whether a given market structure maximizes welfare, it thus remains to compare Δ_F^* with the respective thresholds Δ_F^ω .

Proposition 4. For the welfare-maximizing technology choice, the threshold Δ_F^* satisfies

$$\Delta_F^* > \Delta_F^{2,1}.$$

Observe first that the welfare-maximizing threshold Δ_F^* should surely exceed the threshold derived for a bilateral monopoly $\Delta_F^{1,1}$. This follows because we know that technology choice in a bilateral monopoly maximizes industry profits, but it ignores consumer surplus. As equilibrium supply is always inefficiently low, the regulator has a stronger preference for the technology with smaller marginal costs and thus a higher equilibrium supply. This argument suggests quite generally that the regulator should have a stronger preference for the technology with lower marginal costs than suppliers have under all market structures $\omega \in \{(1, 2), (2, 2), (1, 1)\}$. On the other hand, observe that according to Proposition 4, the regulator's threshold also exceeds $\Delta_F^{2,1}$. We conjecture that this result is less robust and depends on our particular choice of technologies.

Proposition 4 implies the following result.

Corollary 3. The benchmark of welfare.

- (i) If $\Delta_F \in (\Delta_F^{2,1}, \Delta_F^*)$, then technology choice fails to maximize welfare under all market structures.
- (ii) If $\Delta_F \in (\Delta_F^{1,1}, \Delta_F^{2,1})$, then technology choice under $\omega = (1, 2)$, $\omega = (2, 2)$, and $\omega = (1, 1)$ fails to maximize welfare.
- (iii) If $\Delta_F \in (\Delta_F^{2,2}, \Delta_F^{1,1})$, then technology choice under $\omega = (1, 2)$ and $\omega = (2, 2)$ fails to maximize welfare.
- (iv) If $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{2,2})$, then technology choice under $\omega = (1, 2)$ fails to maximize welfare.
- (v) For all other cases, technology choice maximizes welfare under all market structures.

In the linear case, the supplier's technology choice is most likely to be in line with the regulator's preferences if the upstream market is fragmented and the downstream market concentrated. As noted above, we conjecture that particularly the ordering $\Delta_F^* > \Delta_F^{1,1}$ is quite robust. Hence, if the realization of Δ_F is either stochastic or nonobservable, then a regulator would be advised not to choose a market structure where retailers are separated. Moreover, in the linear case he should prefer additionally that suppliers stay separated.

□ **Equilibrium market structure with technology choice.** Given the benchmarks in Corollaries 2 and 3, the natural question now is which market structure would arise endogenously. Because goods are substitutes and unit costs are nonincreasing in our linear example, the first conjecture would be that suppliers merge while retailers stay separated. This conjecture is,

however, wrong for retailers, as they now take into account the impact of downstream market structure on suppliers' technology choice.

Consider first the choice of upstream market structure. As goods are substitutes, we know that a merger allows suppliers to extract more of total industry profits. As the decision to implement α or β is made optimally by the respective supplier, it is straightforward that regardless of the downstream market structure, suppliers will merge. In contrast, as retailers cannot directly control the choice of technology, they must take this into consideration when deciding whether to merge. If Δ_F is below $\Delta_F^{1,2}$, suppliers will always choose technology β regardless of the downstream market structure. As this implies strictly decreasing unit costs at plant A , retailers are better off when staying separated. Similarly, suppliers' technology choice is also unaffected by downstream market structure if Δ_F exceeds $\Delta_F^{1,1}$. As both goods are now produced with technology α , which has zero operating costs, retailers are indifferent toward a merger.²² Hence, for relatively low or high values of Δ_F , the picture has not changed compared to our previous analysis without subsequent technology choice. In contrast, for $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$, we now find that retailers merge, even though the resulting choice of technology β implies strictly decreasing unit costs.

Proposition 5. The equilibrium market structure with subsequent technology choice is $\omega = (1, 2)$ for all $\Delta_F < \Delta_F^{1,2}$ and $\omega = (1, 1)$ for all $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$. For $\Delta_F > \Delta_F^{1,1}$, either $\omega = (1, 2)$ or $\omega = (1, 1)$ may emerge.

Retailers prefer to merge for $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$, as this tilts the suppliers' choice of technology toward β . Observe that for this interval, β maximizes industry profits. While a merger reduces the retailers' share of the total surplus as their bargaining position deteriorates, this is more than compensated by the resulting increase in total profits, which can be distributed.

□ **Discussion of technology choice.** In the case where retailers merge to influence suppliers' technology choice, we know from Corollary 3 that this also leads to an increase in welfare. The resulting switch to the technology with lower marginal costs increases output and consumer rents. Hence, in this case all parties—i.e., suppliers, retailers, and consumers—gain from a higher concentration in the downstream market. Our analysis, therefore, suggests a new buyer-power based efficiency defense for downstream mergers. By shifting the bargaining problem with suppliers away from the margin, downstream mergers may improve the appropriability of rents from marginal cost reductions and thus lead to lower consumer prices.

Although our analysis is limited to the linear case, we believe that the point we make is more general. As we know from Section 4, a merger shifts the bargaining problem more toward inframarginal production quantities. As a consequence, suppliers' incentives for cost reduction at the margin increase, implying an increase in total output and thus a rise in consumer rents.²³ (Admittedly, the effect of retailer concentration on consumer surplus might have to be qualified if retailers did not serve independent markets.) Moreover, our observation that retailer concentration may imply more efficient production runs counter to a widely held view. For the case of retailer mergers in the grocery industry, Dobson, Waterson, and Chu (1998) and FTC (2001) state that a monopsony reduces productive efficiency by erasing suppliers' rents.²⁴ However, our analysis suggests that this view has to be qualified in two respects. First, retailer concentration has different effects on suppliers' benefits from various forms of cost reduction, i.e., those affecting more inframarginal or more marginal costs. Second, from the consumers' perspective, the latter form of cost reduction may matter far more. And as we showed above, suppliers' incentives to reduce marginal costs may in fact increase if retailers are more concentrated.

²² This indifference could easily be resolved by assuming $F^\alpha > 0$. Although it does not affect the previous results as long as $\Delta F > 0$, this somewhat complicates all expressions.

²³ As already noted above, incentives increase only if the respective action affects relatively more cost increases at high output levels than cost increases at low output levels.

²⁴ More generally, see the discussion in Blair and Harrison (1993). A similar view is expressed in the health care market, which in many instances has become a bilateral oligopoly in the United States (see Gaynor and Haas-Wilson, 1999). Again, it is feared that buyer power may reduce quality provision by way of affecting the distribution of total rents (see Pitofsky, 1997).

We are aware only of one empirical study that tries to measure the impact of downstream concentration on upstream investments or technology choice. Farber (1981) finds that R&D effort, as measured by scientific and engineering personnel, can both increase or decrease with downstream market concentration. For further empirical studies, our results have the following two main implications. First, incentives depend greatly on the type of investment decision or technology choice, i.e., in which “form” rents are created. Second, as exemplified in Proposition 5, market structure and technology choice interact and must be treated as endogenous.

6. General discussion

■ **The bargaining procedure.** We will now comment briefly on the choice of our bargaining procedure as discussed in the second part of Section 3. It is straightforward to show that nothing would change qualitatively if we were to assume a different sharing rule of (net) surplus, which is not directly affected by market structure. If bargaining were to proceed sequentially instead of by simultaneous bilateral negotiations, the distribution of payoffs would depend crucially on the (artificially?) chosen sequence. To see this, suppose that one side has merged. Suppose first that players can write complex contracts, which may, for instance, specify a penalty if one of the players subsequently negotiates with a third player. In such a setting it is typically the case that the two players who start bargaining can extract extremely high rents from the third party (see, e.g., Aghion and Bolton, 1987). On the other side, if the contractual set is rather constrained and may only permit a fixed cash payment, the outcome can be markedly different. To see this, suppose that two suppliers with strictly complementary goods bargain with a single retailer. Once the retailer has obtained the first good, the incremental surplus of obtaining the second good can be extremely high. As this allows the second supplier to extract a high payment, the supplier selling first receives far less.

Our results on equilibrium market structure and technology choice depend on the fact that bargaining between two parties proceeds *overproportionally* on the respective “margin,” i.e., over the net surplus, while the definition of this “margin” depends on the firms’ size, i.e., whether they are merged or stay separate. We conjecture that any bargaining concept for oligopolistic industries with these features would reproduce our results. As established in Inderst and Wey (2000b), this holds, in particular, for the case of simultaneous Nash bargaining over simple (noncontingent) supply contracts.

The bargaining procedure as described by the requirements (i)–(iii) falls short of a fully specified noncooperative game. To fill this gap, consider any bilateral negotiation. We specify that the supplier’s agent is chosen to make an offer. If the retailer’s agent rejects, there is another and last round of bargaining in which either side is chosen with equal probability to make a final offer. Additionally, with some (arbitrarily) small probability ε the two sides fail to start negotiations due to some exogenous event. This specification generates incentives to contract on all contingencies. It is easily checked that an equilibrium of this game supports the equilibrium outcome of our bargaining procedure.²⁵

□ **Interdependent demand.** We have so far assumed that the demand at the two retailers is independent. Suppose that both market sides are fragmented and that the retailers’ markets overlap. Under our bargaining procedure, contracts between supplier s and retailer r can only condition on the set of successful bilateral negotiations in the economy. With this specification, contracts fail to maximize industry surplus, as opportunistic behavior in the bilateral negotiations leads to higher output levels (see McAfee and Schwartz, 1994). In this case, a downstream merger would have the immediate benefit of monopolizing the final market. If we allow instead for more complex contracts that can condition on the whole set of supplied quantities in the industry, we

²⁵ Equilibrium payoffs are, however, not uniquely determined. We can generate equilibria where, say, A and a specify a penalty paid to a if there is agreement in the pair (A, b) , which allows A to extract a higher price from b . Choosing an open time horizon for negotiations poses the problem of specifying whether the whole industry is “stalled” if there is delay in a particular relation (see Inderst, 2000). See also Björnerstedt and Stennek (2001), who develop a noncooperative model of decentralized bilateral bargaining.

can show that there exists an equilibrium where industry profits are maximized regardless of the market structure. Intuitively, as each supplier serves all retailers in equilibrium, it is feasible to internalize all externalities (over goods and retailers) by bilateral contracts.²⁶

We conjecture that our results survive qualitatively under a suitable choice of equilibrium for varying market structures. In addition, with interdependent demand at the two retailers, we would obtain new incentives for a downstream merger. The logic applying to a merger of suppliers in case of substitutes now applies likewise to downstream merger incentives.

7. Conclusion

■ This article makes three related contributions. First, we propose a rather natural form of negotiations and contracting in bilateral oligopolistic industries, which gives rise to the Shapley value. Second, we explore the motivations for up- and downstream horizontal mergers if the only effect of market structure is to determine the distribution of industry profits. Third, we explore the interaction of market structure with technology choice. As market structure determines how marginal and inframarginal rents are shared, we find that (i) market structure affects technology choice and (ii) firms may choose a particular organizational form to influence the technology choice of other firms in the value chain. The link between market structure and technology choice also generates scope for welfare-enhancing merger policy.

The framework suggested in this article can easily be extended beyond the considered case of a bilateral duopoly. One interesting path would then be to analyze when “interior” market structures, which lie between full integration and full fragmentation, would arise. We conjecture that this might be the case with S-shaped cost functions. Loosely speaking, if downstream concentration becomes sufficiently high, such that the supplier-retailer bargaining problem reaches inframarginal production levels at which unit costs start to decrease, further concentration should become unprofitable.

Throughout the article we have been silent on the possibility of vertical mergers. Extending both the analysis of market structure and that of technology choice to this case seems to be a fruitful avenue for further research. For instance, one might ask whether, starting from a fragmented market structure, either retailers or another supplier has more to gain from merging with a particular “target” supplier to strengthen their bargaining position. Alternatively, one could ask which market structure maximizes suppliers’ incentives to decrease marginal or inframarginal costs and whether this market structure could arise endogenously.

A further extension would be to put exogenous restrictions on the industry’s supply patterns. For instance, we may suppose that some firms cannot procure from certain suppliers because they have not previously invested in the necessary infrastructure. It may be interesting to analyze how industry surplus is shared under such restrictions. Moreover, imposing these restrictions may allow us to explore new incentives for (horizontal) mergers.²⁷

Finally, this article has confined itself to studying the impact of market structure on technology choice at a single supplier. By exploring further the idea of how market structure at one level may affect investment and strategic (nonprice) choices at other levels of the value chain, the following questions naturally arise: How does downstream market structure affect the product choice of suppliers, e.g., their degree of substitutability or complementarity? How are incentives for (not fully contractible) demand-enhancing activities, e.g., advertising by retailers or product innovation by suppliers, determined by the integration of suppliers or retailers respectively?

²⁶ These questions are addressed in the research areas of contracting with externalities and contracting with common principals and common agents.

²⁷ Similar questions are addressed in the network literature (see Jackson and Wolinsky, 1996; Kranton and Minehart, 2000).

Appendix A

■ Proofs of Propositions 1–5 and the derivation of condition (6) follow.

Proof of Proposition 1. The proof consists of the application of the Shapley value for the different market structures.

- (i) $\omega = (1, 1)$: The two parties share the surplus W_Ω equally.
- (ii) $\omega = (1, 2)$: Retailer r realizes $(1/3)[W_\Omega - W_{\Omega \setminus \{r\}} + (1/2)W_{\Omega \setminus \{r'\}}]$, where $r' \neq r$, while the integrated supplier realizes $(1/3)[W_\Omega + (1/2)W_{\Omega \setminus \{r\}} + (1/2)W_{\Omega \setminus \{r'\}}]$.
- (iii) $\omega = (2, 1)$: Supplier s realizes $(1/3)[W_\Omega - W_{\Omega \setminus \{s\}} + (1/2)W_{\Omega \setminus \{s'\}}]$, where $s' \neq s$, while the integrated retailer realizes $(1/3)[W_\Omega + (1/2)W_{\Omega \setminus \{s\}} + (1/2)W_{\Omega \setminus \{s'\}}]$.
- (iv) $\omega = (2, 2)$: Supplier s realizes

$$\frac{1}{4}W_\Omega + \frac{1}{12} [W_{\Omega \setminus \{s', r'\}} + W_{\Omega \setminus \{s', r\}} - W_{\Omega \setminus \{s, r'\}} - W_{\Omega \setminus \{s, r\}}] + \frac{1}{12} [W_{\Omega \setminus \{r'\}} + W_{\Omega \setminus \{r\}} + W_{\Omega \setminus \{s'\}} - W_{\Omega \setminus \{s\}}],$$

where $s' \neq s$, while retailer r realizes

$$\begin{aligned} & \frac{1}{4}W_\Omega + \frac{1}{12} [W_{\Omega \setminus \{s', r'\}} + W_{\Omega \setminus \{s', r\}} - W_{\Omega \setminus \{s', r\}} - W_{\Omega \setminus \{s, r\}}] \\ & + \frac{1}{12} [W_{\Omega \setminus \{s'\}} + W_{\Omega \setminus \{s\}} + W_{\Omega \setminus \{r'\}} - 3W_{\Omega \setminus \{r\}}], \end{aligned}$$

where $r' \neq r$. *Q.E.D.*

Proof of Proposition 2. Consider first the case of a retailer merger. For all $\Omega' \in \{\Omega, \Omega \setminus \{a\}, \Omega \setminus \{b\}\}$, denote by $x_{sr}^{\Omega'}$ the (by Assumption 1 unique) quantities supplied to realize maximum industry profits $W_{\Omega'}$. We show next that (5) holds if unit costs at both suppliers are strictly increasing. Note that the sum of payoffs $W_{\Omega \setminus \{a\}} + W_{\Omega \setminus \{b\}}$ does not increase if we replace the optimal quantities $x_{sb}^{\Omega \setminus \{a\}}$ and $x_{sa}^{\Omega \setminus \{b\}}$ by the respective quantities x_{sr}^{Ω} , which are optimal if all firms participate. As a consequence, (5) holds if

$$\sum_{s \in S^0} K_s(x_{sa}^{\Omega} + x_{sb}^{\Omega}) > \sum_{s \in S^0} K_s(x_{sa}^{\Omega}) + \sum_{s \in S^0} K_s(x_{sb}^{\Omega}),$$

which follows if $K_s(y+z) > K_s(y) + K_s(z)$ holds for all $y, z > 0$ and $s \in S^0$. This holds as unit costs are by assumption strictly decreasing.²⁸ The case of decreasing unit costs is analogous.

Consider next the case of a supplier merger with substitutes. Denote again by $x_{sr}^{\Omega'} > 0$ the optimal quantities for the sets $\Omega' \in \{\Omega, \Omega \setminus \{A\}, \Omega \setminus \{B\}\}$. Note first that prices at the chosen quantities $x_{sr}^{\Omega'}$ are strictly positive by Assumptions 1 and 2, i.e., that $p_{sr}(x_{sr}^{\Omega'}, x_{sr}^{\Omega'}) > 0$ holds with $r' \neq r$. From our definition, this implies that the respective prices at s will strictly decrease if $x_{sr}^{\Omega'}$ is increased. We must now show that (4) holds, which is the case if the inequality still holds after replacing $x_{Br}^{\Omega \setminus \{A\}}$ and $x_{Ar}^{\Omega \setminus \{B\}}$ by the respective quantities x_{sr}^{Ω} . This leads to the requirement

$$\sum_{r \in R^0} [p_{Ar}(x_{Ar}^{\Omega}, 0)x_{Ar}^{\Omega} + p_{Br}(0, x_{Ar}^{\Omega})x_{Br}^{\Omega}] > \sum_{r \in R^0} [p_{Ar}(x_{Ar}^{\Omega}, x_{Br}^{\Omega})x_{Ar}^{\Omega} + p_{Br}(x_{Br}^{\Omega}, x_{Ar}^{\Omega})x_{Br}^{\Omega}],$$

which holds by the definition of substitutes. The argument for complements is again analogous, which completes the proof. *Q.E.D.*

Derivation of condition (6). We show below that Assumption 2 holds for the linear case with substitutes if

$$1 - k_s > c(1 - k_{s'}) + 2\sqrt{F_s} \tag{A1}$$

is satisfied for $s' \neq s$. Substituting the specifications for k_s and F_s for the technology regimes α, β , we obtain the two requirements

$$\begin{aligned} c &< 1 - \Delta_k, \\ c &< \frac{1 - 2\sqrt{\Delta_F}}{1 - \Delta_k}, \end{aligned}$$

²⁸ Denoting unit costs at s by $\kappa_s(x) = K_s(x)/x$ for $x > 0$, $K_s(y+z) > K_s(y) + K_s(z)$ holds if $\kappa_s(y+z) > [y\kappa_s(y) + z\kappa_s(z)]/(y+z)$, where the left-hand side does not exceed $\max\{\kappa_s(y), \kappa_s(z)\}$, which by assumption is smaller than $\kappa_s(y+z)$.

which give rise to (6). To derive (A1) from Assumption 2, note first that our linear case exhibits nonincreasing unit costs at both suppliers. Hence, with substitutes the additional surplus of an additional retailer-supplier link $\bar{s}\bar{r}$ is smallest if the initial link structure is $L = \{(s, a), (s, b)\}$; i.e., if only supplies of the other good s were previously feasible. To maximize industry profits, x_{sa} and x_{sb} are both equal to $(1 - k_s)/2 > 0$. Given these supplies, the optimal (additional) supply of $x_{\bar{s}\bar{r}}$ maximizes

$$(1 - x_{\bar{s}} - c \frac{1 - k_s}{2} - k_{\bar{s}})x_{\bar{s}} - F_{\bar{s}} - cx_{\bar{s}} \frac{1 - k_s}{2}. \tag{A2}$$

Maximizing (A2) yields a positive value for $x_{\bar{s}\bar{r}}$, whenever $1 - c - k_{\bar{s}} + ck_s > 0$, while the maximum additional surplus (A2) is positive if $1 - k_{\bar{s}} > c(1 - k_s) + 2\sqrt{F_{\bar{s}}}$. *Q.E.D.*

Proof of Proposition 3. We first derive the threshold values Δ_F^ω under all market structures. For a given technology $i \in \{\alpha, \beta\}$, the payoff U_i^ω of the supplier controlling production of good A under a particular market structure ω is derived from the Shapley value formula, which in the general case yields

$$\begin{aligned} U_i^{1,1} &= \frac{1}{2} W_\Omega^i, \\ U_i^{1,2} &= \frac{1}{3} (W_\Omega^i + W_{\Omega \setminus \{r\}}^i), \\ U_i^{2,1} &= \frac{1}{3} (W_\Omega^i - W_{\Omega \setminus \{A\}}^i + \frac{1}{2} W_{\Omega \setminus \{B\}}^i), \\ U_i^{2,2} &= \frac{1}{12} (3W_\Omega^i + 2W_{\Omega \setminus \{B,r\}}^i - 2W_{\Omega \setminus \{A,r\}}^i + 2W_{\Omega \setminus \{r\}}^i + W_{\Omega \setminus \{B\}}^i - 3W_{\Omega \setminus \{A\}}^i), \end{aligned}$$

where $W_{\Omega'}^i$ is the industry profit for a coalition $\Omega' \subseteq \Omega$, when technology i is chosen. For the linear case, we derive the following values for $W_{\Omega'}^i$:

$$\begin{aligned} W_\Omega^i &= \frac{1}{2} \frac{(1 - k^\alpha)^2 + (1 - k^i)^2 - 2c(1 - k^\alpha)(1 - k^i)}{1 - c^2} - F^i - F^\alpha, \\ W_{\Omega \setminus \{r\}}^i &= \frac{1}{4} \frac{(1 - k^\alpha)^2 + (1 - k^i)^2 - 2c(1 - k^\alpha)(1 - k^i)}{1 - c^2} - F^i - F^\alpha, \\ W_{\Omega \setminus \{A\}}^i &= \frac{(1 - k^\alpha)^2}{2} - F^\alpha, \\ W_{\Omega \setminus \{B\}}^i &= \frac{(1 - k^i)^2}{2} - F^i, \\ W_{\Omega \setminus \{B,r\}}^i &= \frac{(1 - k^i)^2}{4} - F^i, \\ W_{\Omega \setminus \{A,r\}}^i &= \frac{(1 - k^\alpha)^2}{4} - F^\alpha. \end{aligned}$$

The thresholds Δ_F^ω are now calculated by setting $U_\beta^\omega = U_\alpha^\omega$, and we obtain

$$\begin{aligned} \Delta_F^{1,1} &= 2\Gamma, \\ \Delta_F^{1,2} &= \frac{3}{2}\Gamma, \\ \Delta_F^{2,2} &= \frac{3}{2}\Gamma + \frac{1}{8}\Theta, \\ \Delta_F^{2,1} &= 2\Gamma + \frac{1}{6}\Theta, \end{aligned}$$

with $\Gamma \equiv (1/4)[\Delta_k/(1 - c^2)][2(1 - c)(1 - \Delta_k) + \Delta_k]$ and $\Theta \equiv [c\Delta_k/(1 - c^2)][2(1 - c)(1 - \Delta_k) - c\Delta_k]$. Comparing the threshold values yields the ordering stated in the proposition. *Q.E.D.*

Proof of Proposition 4. Let V^i denote welfare if technology $i \in I$ is chosen. Welfare is given by

$$V^i = \sum_{r \in R^0} u(x_{A,r}^i, x_{B,r}^i) - K_A^i(x_{A,r}^i + x_{A,r'}^i) - K_B^\alpha(x_{B,r}^\alpha + x_{B,r'}^\alpha),$$

with $i \in I$, where $x_{s,r}^i$ indicates the respective supply of good s at retailer r if technology i is chosen, and $K_s^i(\cdot)$ stands for the total costs of supplier s under technology i . Recall that these quantities are chosen so as to maximize industry

profits. We obtain

$$V^\alpha = \frac{3(1-k^\alpha)^2}{2(1+c)} - 2F^\alpha,$$

$$V^\beta = \frac{3}{4} \left(\frac{2(1-k^\alpha - \Delta_k)(1-k^\alpha)}{(1+c)} + \frac{(\Delta_k)^2}{(1-c^2)} \right) - 2F^\alpha + \Delta_F.$$

Comparison of V^α and V^β yields the threshold value $\Delta_F^* = 3\Gamma$ for a welfare-improving adoption of technology $i = \beta$. Comparison with $\Delta_F^{2,1}$ shows that $\Delta_F^* - \Delta_F^{2,1} > 0$ holds if

$$\Delta_k < \tilde{\Delta}_k \equiv \frac{2(3-5c+2c^2)}{3-10c+2c^2}.$$

As $\Delta_k < 1-c$ holds by (6), while it holds that $\tilde{\Delta}_k > 1-c$, it follows that $\Delta_F^* > \Delta_F^{2,1}$. *Q.E.D.*

Proof of Proposition 5. As argued in the main text, it is immediate that suppliers merge. It thus remains to consider the choice between $\omega = (1, 1)$ and $\omega = (1, 2)$. For $\Delta_F < \Delta_F^{1,2}$ and $\Delta_F > \Delta_F^{1,2}$, it was already argued in the main text that the assertions follow from the analysis of Section 4. Consider thus the remaining interval where $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$. In this case, Proposition 3 implies that technology α is chosen under $\omega = (1, 2)$ and technology β is the optimal technology choice under $\omega = (1, 1)$. Hence, retailers' joint payoff under market structure $\omega = (1, 1)$ and technology $i = \beta$ becomes

$$\frac{1}{4} \frac{(1-k^\alpha)^2 + (1-k^\beta)^2 - 2c(1-k^\alpha)(1-k^\beta)}{1-c^2} - \frac{1}{2}(F^\alpha + F^\beta), \quad (\text{A3})$$

while they realize

$$\frac{1}{3} \frac{(1-k^\alpha)^2 + (1-k^\alpha)^2 - 2c(1-k^\alpha)(1-k^\alpha)}{1-c^2} - \frac{1}{12} \frac{(1-k^\alpha)^2 + (1-k^\alpha)^2 - 2c(1-k^\alpha)(1-k^\alpha)}{1-c^2} \quad (\text{A4})$$

under market structure $\omega = (1, 2)$ when technology $i = \alpha$ is chosen. The assertion for $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$ holds whenever (A3) > (A4), which transforms to the requirement

$$\Delta_F > \tilde{\Delta}_F \equiv \frac{\Delta_k [2(1-c) - \Delta_k(1-2c)]}{2(1-c^2)}.$$

Using $\Delta_k < 1-c$ from (6), it follows that $\tilde{\Delta}_F$ is strictly decreasing in Δ_k . It thus remains to show that $\Delta_F > \tilde{\Delta}_F$ holds at the lower boundary of the considered interval, where

$$\Delta_F = \Delta_F^{1,2} = \frac{3}{2} \left(\frac{1}{4} \frac{\Delta_k}{1-c^2} (2(1-c)(1-\Delta_k) + \Delta_k) \right).$$

At this point, $\Delta_F > \tilde{\Delta}_F$ transforms to the requirement $c < (2 - \Delta_k)/[2(1 - \Delta_k)]$. Because $(2 - \Delta_k)/[2(1 - \Delta_k)] > 1$, this holds by (6) and $\Delta_k > 0$, which completes the proof. *Q.E.D.*

Appendix B

■ In this Appendix we formalize the bargaining procedure described in the second part of Section 3. For this purpose we need some additional notation. Denote the set of independent suppliers by Σ and that of retailers by Π . For instance, if suppliers are separated, we obtain $\Sigma = \{A, B\}$. All parties to the negotiations are summarized in the set $\Psi = \Sigma \cup \Pi$. The set of feasible contingencies is denoted by $P_{\Sigma, \Pi}$, which is equal to the power set of $\Sigma \times \Pi$. For instance, if merged suppliers bargain with nonintegrated retailers, $P_{\Sigma, \Pi}$ contains the three contingencies $\{(AB, a)\}$, $\{(AB, b)\}$, and $\{(AB, a), (AB, b)\}$, where the last contingency consists of the two "links" $p = (AB, a)$ and $p = (AB, b)$. For each contingency $\tilde{P} \in P_{\Sigma, \Pi}$ we need to specify transfers and supplied quantities for all involved parties. Given some $p \in \tilde{P}$ with $p = (\sigma, \pi)$, where $\sigma \in \Sigma$ and $\pi \in \Pi$, agreed transfers from π to σ are denoted by $t_p^{\tilde{P}}$. Regarding quantities, note that π and σ may negotiate over the supply of more than one good to more than one outlet if at least one of the two parties has merged. To reduce the amount of notation, we write $s \in \sigma$ ($r \in \pi$) if the possibly merged supplier σ (retailer π) controls outlet $s \in S^0$ ($r \in R^0$). Hence, π and σ determine all quantities $x_{sr}^{\tilde{P}}$ where $s \in \sigma$ and $r \in \pi$. Finally, we denote the payoff of some $\psi \in \Psi$ under contingency $\tilde{P} \in P_{\Sigma, \Pi}$ by $U_\psi^{\tilde{P}}$.

We are now in a position to formalize our equilibrium requirements (i)–(iii). The derivation of equilibrium contracts

and payoffs for some market structure ω with independent firms Σ and Π proceeds iteratively on the set of possible contingencies $P_{\Sigma, \Pi}$. We denote the respective equilibrium contracts and payoffs by $x_{sr}^{\tilde{P},*}$, $t_p^{\tilde{P},*}$, and $U_\psi^{\tilde{P},*}$, and we set the expressions equal to zero for all contingencies \tilde{P} that do not contain the respective links or parties, i.e., $t_p^{\tilde{P},*} = 0$ if $p \notin \tilde{P}$, $x_{sr}^{\tilde{P},*} = 0$ if there is no $(\sigma, \pi) \in \tilde{P}$ satisfying $s \in \sigma$ and $r \in \pi$, and $U_\psi^{\tilde{P},*} = 0$ if there is no $(\sigma, \pi) \in \tilde{P}$ satisfying $\sigma = \psi$ or $\pi = \psi$. For all contingencies $\tilde{P} \in P_{\Sigma, \Pi}$, the following conditions must hold.

Optimality. For all $p \in \tilde{P}$, the quantities $x_{sr}^{\tilde{P},*}$, with $p = (\sigma, \pi)$, $s \in \sigma$, and $r \in \pi$, solve the problem

$$\max_{x_{sr} \text{ with } s \in \sigma, r \in \pi} \left\{ \sum_{r \in \pi} [P_{Ar}(x_{Ar}, x_{Br})x_{Ar} + P_{Br}(x_{Br}, x_{Ar})x_{Br}] - \sum_{s \in \sigma} K_s(x_{sa} + x_{sb}) \right\},$$

where $x_{s'r'} = x_{s'r'}^{\tilde{P},*}$ in case $s' \notin \sigma$ or $r' \notin \pi$.

Net surplus sharing. For all $p \in \tilde{P}$, transfers $t_p^{\tilde{P},*}$ are chosen to achieve an equal sharing of the net surplus between the two parties σ and π , where $p = (\sigma, \pi)$, i.e., it holds that

$$U_\sigma^{\tilde{P}} - U_\pi^{\tilde{P} \setminus \{(\sigma, \pi)\}} = U_\sigma^{\tilde{P}} - U_\pi^{\tilde{P} \setminus \{(\sigma, \pi)\}}.$$

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