Bargaining, Mergers, and Technology Choice in Bilaterally Oligopolistic Industries[*]

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Abstract

This paper discusses the interaction of upstream and downstream market structure and technology choice in a bilaterally oligopolistic industry. The distribution of industry profits is determined by bilateral bargaining over contingent contracts, which is shown to generate the Shapley value.

Our analysis proceeds in three steps. First, analyzing the implication of market structure for the distribution of industry profits, we find that downstream mergers are more likely (less likely) if upstream firms have increasing (decreasing) unit costs, while upstream mergers are more likely (less likely) if supplies are substitutes (complements). Second, exploring how market structure affects upstream technology choice, we find that an upstream (downstream) merger reduces (increases) the focus on marginal cost reduction. Third, we show that downstream firms may strategically choose a particular market structure to affect upstream technology choice.

One of the key applications of our setting is to cross-country retailer mergers, which –as we show– may increase welfare by affecting suppliers' choice of technology.

1 Introduction

Since the emergence of large retail chains in the 1970s, buying power has become a key feature in the relationship between manufacturers and retailers.[1] While economic analysis has traditionally viewed retailers as lacking influence on wholesale markets, recent consolidation in the retailing 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 explicitly enters merger control as an efficiency defence via the 1992 Horizontal Merger Guidelines, with the revisions to Section 4 on efficiencies in 1997.[5] The buyer power defence has also been made explicit in the 1998 Competition Act of the U.K. The buyer power defence asserts that lower input prices due to higher purchasing power are passed (partially) through to consumers. As discussed 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, take-overs, or

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[1] For example, Dell (1996, p. 50) 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 per cent of stores now account for over half of all grocery sales. In the U.S. the supermarket industry is in the midst of an unprecedented merger wave. Recent examples include Safeway and Dominick's, Kroger and Fred Meyer, and Ahold and Giant Food. For an overview of recent concentration changes in the retailing sector see also Dobson and Waterson (1999) and OECD (1999).

[2] The bilaterally oligopolistic market structure in the EU food retailing sector is described in Dobson et al. (2000). According to their typology, only three EU markets are categorized as "unconcentrated", while four markets are dominated by a single retailer and five markets are either duopolies or triopolies. 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/Toys "R" Us* case it was ascertained that it would be very difficult for manufacturers to replace the 30 percent 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, e.g., in 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 (see Pitofsky 1998 for an assessment from the FTC's perspective).

alliances between retail chains.[6] According to an often expressed (but hitherto unmodeled) 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 et. al. (2000, p. 12) 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 foregone completely."

This paper presents a model of input price determination in a bilateral oligopolistic industry, which allows to address the following two questions motivated by the above account. First, what are the strategic incentives for horizontal mergers if pricing behavior on the final goods market is not affected? Second, what are (if any) the welfare implications of horizontal mergers in a bilaterally oligopolistic industry? One contribution of this paper 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, marginal costs reduction 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 non-linear 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 requirements 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. Amongst other things, we find 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 (non-contractible) technology choice by suppliers. The structure of both the upstream and the downstream markets affect suppliers' trade-off between inframarginal cost savings and cost savings "on the

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

margin". By studying the case of linear demand and cost functions, we can make this trade-off 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 where a regulator would like to implement a different market structure than that arising in equilibrium.

Our paper 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 (non-contractible) choice of their suppliers. This contrasts with more standard merger analysis where firms merge to either monopolize the final good market (e.g., Salant et. al. 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. Though this question has a long history, it has recently gained much importance in antitrust policy.[7] So far this approach only considers concentration and investment at the same market "level". In contrast, our paper 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 papers and our contribution are manyfold. Most importantly, they do not cover the bilaterally oligopolistic case.[8] Furthermore, all of these papers consider inefficient bargaining over constant unit prices, which together with the assumption of interde-

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[7]See Gilbert and Sunshine (1995) for an overview. In the U.S. 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. 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 DOJ 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 leveled complaints against several additional mergers on the grounds that innovation markets would be harmed.

[8]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.

pendent demand creates incentives for retailer mergers.[9] With interdependent demand mergers also reduce competition on the final product market, which blurs the analysis of a merger's impact on bargaining power. Finally, none of these papers has addressed the link between market structure and suppliers' technology choice.

Our analysis of a (non-contractible) technology choice is related to the hold-up literature (see Grossman and Hart 1986 and Hart and Moore 1990). Whereas this literature analyzes how the integration of investing parties affects their incentives, it is the integration of outsiders, i.e., of downstream firms, which impacts on the technology choice of upstream firms in our paper. 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 structure.

The paper is organized as follows. Section 2 introduces the economy. In Section 3 we propose and motivate the bargaining concept. Section 4 determines 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.

2 The Economy

We consider an intermediary goods market in which $N = 2$ producers, which are denoted by $s \in S^0 = \{A, B\}$, sell their products to $M = 2$ retailers, which are 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}.

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[9]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. This negative externality allows the supplier to extract more rents.

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

3.1 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 Section 3.2 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

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

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 $\Omega \backslash \{A\}$. Calculating the maximum industry profits subject to the constraint that $x_{Aa} = x_{Ab} = 0$, we denote the respective value by $W_{\Omega \backslash \{A\}}$. 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 A.1. $W_{(\cdot)}$ *is strictly quasi-concave and continuous.*

Assumption (A.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, which is 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

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

where $\left|\tilde{\Psi}\right|$ and $|\Psi|$ denote the numbers 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.

3.2 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 are either 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 to supply also the other good. This co-ordination 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 $W_{(.)}$ which ensure that "corner solutions" are never optimal.

Assumption A.2. *Exclusion of corner solutions*

Consider some contingency, i.e., a set of feasible supplier-retailer links L.[10] Maximizing industry profits $W_{(.)}$ under the constraint that $x_{sr} = 0$ holds for all $(sr) \notin L$ must imply $x_{sr} > 0$ for all $(sr) \in L$.[11] 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 suppler-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 (A.1) and (A.2), it is now easily checked that equilibrium supplies are uniquely determined for all contingencies and that they maximize total industry profits.

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

$$U_A - U_a = \tilde{U}_A - \tilde{U}_a. \tag{2}$$

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 (A.1)-(A.2) total payoffs generated for any contingency maximize industry profits, i.e., we obtain the characteristic function $W_{(.)}$. 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.[12] Summing up, it is the joint assumption of (simultaneous) efficient negotiations and contingent contracting that generates the Shapley value.[13]

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

[11]Observe that x_{sr} are uniquely determined due to Assumption (A.1).

[12]Precisely, we can apply Theorem 4 in Jackson and Wolinsky (1996) after noting that our condition of non-interdependent demand is equivalent to their requirement that the "value function" (i.e., $W_{(.)}$) is "component additive". Incidentally, balancedness is also used in Stole and Zwiebel (1996a/b) 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 non-binding.

[13]Below in Section 6.1 we comment on our bargaining procedure, where we also describe a non-cooperative game that supports our solution as an equilibrium outcome.

4 Horizontal Integration

4.1 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 3.2. 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

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

The supplier signs with 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 $\frac{1}{2}W_{\Omega\setminus\{b\}}$, i.e., half of the maximum feasible industry profits. Likewise the contract with retailer b specifies that either side realizes $\frac{1}{2}W_{\Omega\setminus\{a\}}$ 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 $U_r = \frac{1}{2}S_r$, while the supplier realizes $U_{AB} = \frac{1}{2}W_{\Omega\setminus\{r\}} + \frac{1}{2}S_r$. 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 the Appendix.

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

(i) Bilateral monopoly, $\omega = (1,1)$: $\frac{1}{2}W_\Omega$,

(ii) Supplier merger, $\omega = (1,2)$: $\frac{1}{3}\left[W_\Omega + \frac{1}{2}W_{\Omega\setminus\{a\}} + \frac{1}{2}W_{\Omega\setminus\{b\}}\right]$,

(iii) Retailer merger, $\omega = (2,1)$: $\frac{1}{3}\left[2W_\Omega - \frac{1}{2}W_{\Omega\setminus\{A\}} - \frac{1}{2}W_{\Omega\setminus\{B\}}\right]$,

(iv) Fragmentation, $\omega = (2,2)$: $\frac{1}{2}W_\Omega + \frac{1}{6}\left[W_{\Omega\setminus\{a\}} + W_{\Omega\setminus\{b\}} - W_{\Omega\setminus\{A\}} - W_{\Omega\setminus\{B\}}\right]$.

Proof. See Appendix.

4.2   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

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

while it decreases if the inequality is reversed.

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

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

while 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).[14] The following corollary follows directly from Lemma 1.

Corollary 1. *The equilibrium market structure satisfies:*

(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).*

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

Proof. See Appendix.

Using the bargaining procedure proposed in Section 3.2, we now provide additional intuition for our results. Consider first the incentives of retailers 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 "infra-marginal" 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 by each good is increased. Hence, in case of complements, suppliers prefer to negotiate "at the margin".[15]

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. While the exploration of this principle in the framework of a (bilaterally) oligopolistic market is to our knowledge new, the general principle has been already detected by Horn and Wolinsky (1988b) and Jun (1989). Both papers 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 fast, retailers should gain from a merger.

Clearly, Proposition 2 does not exhaust all possible cases. For instance, unit costs may be non-monotonic. 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 the conditions (4) and (5) in Lemma 1.

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[15] While these results have only been derived 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 paper.

5 Horizontal Integration 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.[16] 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 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.

1. *Rent-Sharing Effect:* By separating retailers, bargaining is shifted towards marginal production levels. Consequently, suppliers have to bear a larger share of their inframarginal costs and a smaller share of their marginal costs. They have thus more incentives to trade-off lower inframarginal costs with higher marginal costs.

2. *Competition Effect:* If suppliers are separated and goods are substitutes, a decrease of marginal costs reduces the supply of the rival firm. 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, and in the third stage supply contracts are negotiated. The following section analyzes the second stage of the game, i.e., optimal technology choice for a given market structure. In Section 5.3 we will turn to the first stage and derive the equilibrium market structure.

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

5.1 Technology Choice

Throughout this section 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 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

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

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

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

The derivation of this condition is contained in the Appendix.

Analysis

For a given market structure ω and fixed values of c and Δ_k technology $i = \beta$ is only chosen 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 $\Gamma \equiv \frac{1}{4}\frac{\Delta_k}{1-c^2}[2(1-c)(1-\Delta_k) + \Delta_k]$. 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 adoption of technology α or β.

Proposition 3. *The thresholds Δ_F^ω for technology choice satisfy the ordering*[17]

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

Proof. See Appendix.

Proposition 3 confirms the above stipulated rent-sharing and competition effects. 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 $\Delta_F^{m,2} - \Delta_F^{m,1} < 0$ and for $n = 1, 2$ that $\Delta_F^{2,n} - \Delta_F^{1,n} > 0$, which illustrates the competition effect.[18] 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.[19] 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 threshold $\Delta_F^{1,1}$ and $\Delta_F^{2,2}$ changes in the degree of substitutability. We obtain that $\Delta_F^{1,1} - \Delta_F^{2,2}$ strictly decreases in c, which underlines once again the role of the competition effect.[20]

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 up-front

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[17]For the sake of brevity, we ignore the (non-generic) case of indifference.

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

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

[20]Precisely, we obtain $\frac{d[\Delta_F^{1,1} - \Delta_F^{2,2}]}{dc} = -\frac{\Delta_k[(1-c)^2 - \Delta_k((1-c)^2 + c)]}{2(1-c^2)^2}$. Note that the numerator is strictly positive if $\Delta_k < \frac{(1-c)^2}{(1-c)^2 + c}$, which holds by (6).

investment, which cannot be recuperated in subsequent negotiations. Focusing again on the linear case, incentives to reduce operating costs do only depend on the downstream market structure. If retailers merge, the supplier can roll over a larger share of operating costs and has therefore lower incentives to reduce these costs. Incentives to reduce marginal costs only depend 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 only affected 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 higher investment if this affects predominately costs at high output levels, while downstream separation and upstream mergers spur investment that helps to reduce costs at relatively low levels of output.

5.2 Efficiency Benchmarks

We compare next 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 $\Delta_F \in \left(\Delta_F^{1,1}, \Delta_F^{2,1} \right)$, technology choice under $\omega = (2,1)$ fails to maximize industry profits.

(ii) If $\Delta_F \in \left(\Delta_F^{2,2}, \Delta_F^{1,1} \right)$, technology choice under $\omega = (2,2)$ and $\omega = (1,2)$ fail to maximize industry profits.

(iii) If $\Delta_F \in \left(\Delta_F^{1,2}, \Delta_F^{2,2} \right)$, technology choice under $\omega = (1,2)$ fails to maximize industry profits.

(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 that of individual outputs. As the supplied quantities are independent of the market structure for a given technology, the regulator is thus

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[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 $\frac{dU_A}{dk_A} = \frac{1}{1-c^2} \frac{1}{4} [2(1 - k_A) - 2c(1 - k_B)]$, while proceeding analogously for the merged supplier yields $\frac{dU_{AB}}{dk_A} = \frac{1}{1-c^2} \frac{1}{4} [2(1 - k_A) \frac{3-c^2}{3} - \frac{4}{3} c(1 - k_B)]$. As $(1 - k_A)c > 1 - k_B$ holds, the incentives are lower after a merger.

only concerned 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 obtain again 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*

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

Proof. See Appendix.

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 as we know that technology choice in a bilateral monopoly maximizes industry profits, but 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 $\Delta_F \in \left(\Delta_F^{2,1}, \Delta_F^*\right)$, technology choice fails to maximize welfare under all market structures.

(ii) If $\Delta_F \in \left(\Delta_F^{1,1}, \Delta_F^{2,1}\right)$, technology choice under $\omega = (1,2)$, $\omega = (2,2)$, and $\omega = (1,1)$ fails to maximize welfare.

(iii) If $\Delta_F \in \left(\Delta_F^{2,2}, \Delta_F^{1,1}\right)$, technology choice under $\omega = (1,2)$ and $\omega = (2,2)$ fails to maximize welfare.

(iv) If $\Delta_F \in \left(\Delta_F^{1,2}, \Delta_F^{2,2}\right)$, 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 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 non-observable, 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.

5.3 Equilibrium Market Structure with Technology Choice

Given the benchmarks in Corollaries (2) and (3), the natural question is now which market structure would arise endogenously. As goods are substitutes and unit costs are non-increasing in our linear example, the first conjecture would be that suppliers merge while retailers stay separated. This conjecture is, however, wrong for retailers who now take into consideration 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. Given the resulting strictly decreasing unit costs at plant A, retailers are better off by 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 towards 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.*

Proof. See Appendix.

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[22]This indifference could be easily resolved by assuming $F^\alpha > 0$. While not affecting the previous results as long as $\Delta F > 0$, this somewhat complicates all expressions.

Retailers prefer to merge for $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$ as this tilts the suppliers' choice of technology towards β. Observe that for this interval β maximizes industry profits. While integration 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.

5.4 Discussion of Technology Choice

In the case where retailers merge to influence suppliers' technology choice, we know from Corollary 3 that this leads also 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 defence 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.

While 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 towards 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 may 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 et. al. (2000) 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 affects differently suppliers' benefits from various forms of cost-reduction, i.e., those affecting more infra-marginal or more marginal costs. Second, from 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.

We are only aware of one empirical study that tries to measure the impact of down-

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[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, p. 36-43). A similar view is expressed in the health care market, which in many instances has become a bilateral oligopoly in the U.S. (see Gaynor and Haas-Wilson 1998). Again it is feared that buyer power may reduce quality provision by way of affecting the distribution of total rents (see Pitofsky 1997).

stream 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 much 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

6.1 The Bargaining Procedure

We briefly comment on the choice of our bargaining procedure as discussed in Section 3.2. 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 the 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 size of the firms, 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 (non-contingent) supply contracts.

The bargaining procedure as described by the requirements (i)-(iii) falls short of a fully specified non-cooperative 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 where 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]

6.2   Interdependent Demand

We have so far assumed that 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 (dis-)agreements in the economy. With this specification contracts fail to maximize industry surplus as opportunistic behavior in the bilateral negotiations leads to higher output (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 supplies in the industry, we can show that there exists an equilibrium where industry profit is 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 applies now likewise to downstream merger incentives.

7   Conclusion

This paper makes three related contributions. First, we propose a rather natural form of negotiations and contracting in bilateral oligopolistic industries, which gives rise to the

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[25]Equilibrium payoffs are, however, not uniquely determined. As players care only about expected payoffs, we can generate equilibria where, say, A and a specify some penalty paid to a if there is agreement in the pair (A, b). This allows the agent of A who negotiates with b to extract a higher price. Note also that choosing an open time horizon for negotiations poses the problem to specify whether the whole industry is "stalled" if there is delay in a particular relation; a problem which also arises in two-person multi-issue bargaining situations (see Inderst 2000). See also Björnerstedt and Stennek (2001) who develop a non-cooperative model of decentralized bilateral bargaining.

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

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 that (ii) firms may choose a particular organizational form in order to influence the technology choice of other firms in the value chain. The link between market structure and technology choice generates also scope for welfare enhancing merger policy.

The framework suggested in this paper can be easily extended beyond the considered case of a bilateral duopoly. One interesting question would then be to ask 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 paper we have also 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 have 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 supply patterns in the industry. For instance, we may suppose that some firms cannot procure from certain suppliers as 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 to explore new incentives for (horizontal) mergers.[27]

Finally, this paper has confined itself to study the impact of market structure on technology choice at a single supplier. Exploring further the idea how market structure at one level may affect investment and strategic (non-price) choices at other levels of the value chain, the following questions arise naturally. 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

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

activities, e.g., advertising by retailers or product innovation by suppliers, determined by the integration of suppliers or retailers respectively?

Appendix A: Proofs

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 $\frac{1}{3}[W_\Omega - W_{\Omega\setminus\{r\}} + \frac{1}{2}W_{\Omega\setminus\{r'\}}]$, where $r' \neq r$, while the integrated supplier realizes $\frac{1}{3}[W_\Omega + \frac{1}{2}W_{\Omega\setminus\{r\}} + \frac{1}{2}W_{\Omega\setminus\{r'\}}]$.

(iii) $\omega = (2,1)$: Supplier s realizes $\frac{1}{3}[W_\Omega - W_{\Omega\setminus\{s\}} + \frac{1}{2}W_{\Omega\setminus\{s'\}}]$, where $s' \neq s$, while the integrated retailer realizes $\frac{1}{3}[W_\Omega + \frac{1}{2}W_{\Omega\setminus\{s\}} + \frac{1}{2}W_{\Omega\setminus\{s'\}}]$.

(iv) $\omega = (2,2)$: Supplier s realizes

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

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

$$
\frac{1}{4}W_\Omega + \frac{1}{12}\left[W_{\Omega\setminus\{s',r'\}} + W_{\Omega\setminus\{s',r'\}} - W_{\Omega\setminus\{s',r\}} - W_{\Omega\setminus\{s,r\}}\right]
$$
$$
+\frac{1}{12}\left[W_{\Omega\setminus\{s'\}} + W_{\Omega\setminus\{s\}} + W_{\Omega\setminus\{r'\}} - 3W_{\Omega\setminus\{r\}}\right],
$$

where $r' \neq r$.

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 (A.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 $\Omega' \in \{\Omega, \Omega \backslash \{A\}, \Omega \backslash \{B\}\}$. Note first that prices at the chosen quantities $x_{sr}^{\Omega'}$ are strictly positive from (A.1)-(A.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 $x_{Br}^{\Omega \backslash \{A\}}$ and $x_{Ar}^{\Omega \backslash \{B\}}$ by the respective quantities x_{sr}^{Ω}. This leads to the requirement

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

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

Derivation of Condition (6).

We show below that (A.2) holds for the linear case with substitutes if

$$1 - k_s > c(1 - k_{s'}) + 2\sqrt{F_s} \tag{7}$$

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

$$c < 1 - \Delta_k,$$
$$c < \frac{1 - 2\sqrt{\Delta_F}}{1 - \Delta_k},$$

which give rise to (6). To derive (7) from (A.2), note first that our linear case exhibits non-increasing unit costs at both suppliers. Hence, with substitutes the additional surplus of an additional retailer-supplier link $\widetilde{sr}$ is smallest if the initial link structure is $L = \{(s, a), (s, b)\}$; i.e., if previously only supplies of the other good s were 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 $x_{\widetilde{sr}}$ maximizes

$$(1 - x_{\widetilde{s}} - c\frac{1 - k_s}{2} - k_{\widetilde{s}})x_{\widetilde{s}} - F_{\widetilde{s}} - cx_{\widetilde{s}}\frac{1 - k_s}{2}. \tag{8}$$

---

[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 $\kappa_s(y + z) > \frac{y\kappa_s(y) + z\kappa_s(z)}{y + z}$, where the left-hand side does not exceed $\max\{\kappa_s(y), \kappa_s(z)\}$, which by assumption is smaller than $\kappa_s(y + z)$.

Maximizing (8) yields a positive value for $x_{\widetilde{sr}}$, whenever $1 - c - k_{\widetilde{s}} + ck_s > 0$, while the maximum additional surplus (8) is positive if $1 - k_{\widetilde{s}} > c(1 - k_s) + 2\sqrt{F_{\widetilde{s}}}$.

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 structures, ω, is derived form the Shapley value formula, which yields in the general case

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

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 $W_{\Omega'}^i$:

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

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 $\Gamma \equiv \frac{1}{4}\frac{\Delta_k}{1-c^2}[2(1-c)(1-\Delta_k) + \Delta_k]$ and $\Theta \equiv \frac{c\Delta_k}{1-c^2}[2(1-c)(1-\Delta_k) - c\Delta_k]$. Comparison of the threshold values yields the ordering stated in the proposition.

Proof of Proposition 4.

Let V^i denote welfare if technology $i \in I$ is chosen. Welfare is given by $V^i = \sum_{r \in R^0} u(x^i_{A,r}, x^i_{B,r}) - K^i_A(x^i_{A,r} + x^i_{A,r'}) - K^\alpha_B(x^\alpha_{B,r} + x^\alpha_{B,r'})$, with $i \in I$, where $x^i_{s,r}$ indicates the respective supply of good s at retailer r if technology i is chosen, and $K^i_s(\cdot)$ 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

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

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 $\Delta^{2,1}_F$ shows that $\Delta^*_F - \Delta^{2,1}_F > 0$ holds if

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

As $\Delta_k < 1 - c$ holds by (6), while it holds that $\widetilde{\Delta}_k > 1 - c$, it follows that $\Delta^*_F > \Delta^{2,1}_F$.

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 $\Delta_F < \Delta^{1,2}_F$ and $\Delta_F > \Delta^{1,2}_F$ it was already argued in the main text that the assertions follow from the analysis of Section 4. Consider thus the remaining interval where $\Delta_F \in (\Delta^{1,2}_F, \Delta^{1,1}_F)$. 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

$$
\frac{1}{4}\frac{(1-k^\alpha)^2 + (1-k^\beta)^2 - 2c(1-k^\alpha)(1-k^\beta)}{1 - c^2} - \frac{1}{2}(F^\alpha + F^\beta), \tag{9}
$$

while they realize

$$
\begin{aligned}
&\frac{1}{3}\frac{(1-k^\alpha)^2 + (1-k^\alpha)^2 - 2c(1-k^\alpha)(1-k^\alpha)}{1 - c^2} \\
&\quad - \frac{1}{12}\frac{(1-k^\alpha)^2 + (1-k^\alpha)^2 - 2c(1-k^\alpha)(1-k^\alpha)}{1 - c^2}
\end{aligned} \tag{10}
$$

under market structure $\omega = (1,2)$ when technology $i = \alpha$ is chosen. The assertion for $\Delta_F \in (\Delta^{1,2}_F, \Delta^{1,1}_F)$ holds whenever (9)>(10), which transforms to the requirement

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

Using $\Delta_k < 1 - c$ from (6), it follows that $\widetilde{\Delta}_F$ is strictly decreasing in Δ_k. It thus remains to show that $\Delta_F > \widetilde{\Delta}_F$ holds at the lower boundary of the considered interval, where $\Delta_F = \Delta_F^{1,2} = \frac{3}{2}(\frac{1}{4}\frac{\Delta_k}{1-c^2}(2(1-c)(1-\Delta_k) + \Delta_k))$. At this point $\Delta_F > \widetilde{\Delta}_F$ transforms to the requirement $c < \frac{2-\Delta_k}{2(1-\Delta_k)}$. As $\frac{2-\Delta_k}{2(1-\Delta_k)} > 1$, this holds by (6) and $\Delta_k > 0$, which completes the proof.

Appendix B: Formalization of the Bargaining Procedure

To formalize the bargaining procedure described in Section 3.2 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 non-integrated 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 the 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 set the expressions equal to zero for all contingencies $\tilde{P}$ which 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.

(1) 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

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

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

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

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

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