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ABSTRACT

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

This Paper provides a conceptual framework of multilateral bargaining in a bilaterally oligopolistic industry to analyse the motivations for horizontal mergers, technology choice, and their welfare implications. We first analyse the implication of market structure for the distribution of industry profits. We find that retailer mergers are more likely (less likely) if suppliers have increasing (decreasing) unit costs, while supplier mergers are more likely (less likely) if goods are substitutes (complements). In a second step we explore how market structure affects suppliers' technology choice, which reflects a trade-off between infra-marginal and marginal production costs. We find that suppliers focus more on marginal cost reduction if (i) retailers are integrated and (ii) suppliers are non-integrated. In a final step we consider the whole picture where both market structure and (subsequent) technology choice are endogenous. Analysing the equilibrium market structure, we find cases where retailers become integrated to induce suppliers to choose a more efficient technology, even though integration weakens their bargaining position. In this case the merger benefits all parties, i.e. suppliers, retailers, and even consumers. We also show that the equilibrium market structure does often not maximize welfare.

JEL Classification: D40, L10 and L40
Keywords: antitrust, bargaining, buyer power, mergers and technology choice

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1 Introduction

Supply contracts in markets for intermediate goods are often negotiated. An important example are contracts between producers and retailers. Moreover, it is rather exceptional that either the upstream market side or the downstream market side is fully integrated. Instead, a given producer typically supplies many independent retailers, while a given retailer sells products of many different suppliers. Despite its prevalence, bilaterally oligopolistic markets with negotiated supply contracts have been largely ignored in the literature.[1]

This paper develops a model of multilateral bargaining in a bilaterally oligopolistic setting. In equilibrium each retailer sells all brands, while each producer supplies to all retailers. We subsequently use this model to study two related questions. First, we investigate the incentives for horizontal mergers. Second, we analyze how market structure affects technology choice by suppliers.

Precisely, our set-up is as follows. For the main part we assume that demand at both retailers is independent. This allows us to abstract from monopolization effects on the final market when investigating the incentives for horizontal mergers. Our bargaining concept contains two major ingredients. First, we assume that bargaining is efficient as the two sides can write non-linear supply contracts. This seems reasonable for the case where retailers procure their supply via bilateral negotiations and not via a market interface. Second, we assume that bargaining between all parties proceeds simultaneously, which deprives any party of a first-mover advantage. Applying this framework, we proceed in three steps. We first analyze equilibrium market structure when mergers only affect the distribution of industry profits. In a second step we introduce (non-contractible) technology choice by suppliers and investigate how this is affected by the market structure. Finally, we complete the picture and analyze the case where both market structure and technology choices are endogenous.

Focusing on the impact of market structure on the distribution of rents, we derive exact conditions when suppliers or retailers prefer to become integrated. One implication will be that retailers prefer to merge if the production technologies exhibit strictly increasing unit costs. If suppliers have strictly decreasing unit costs, retailers prefer to stay non-integrated. By affecting the distribution of industry profits, market structure

[1] The standard way to model imperfectly competitive input markets is to consider a two-stage market game in which upstream firms compete as Stackelberg leaders via wholesale prices (see, e.g., Waterson (1980), Salinger (1988), and Kühn and Vives (1999)). In a similar fashion, the literature on vertical agreements typically assumes that suppliers, that are few in numbers, have sufficient market power to impose contractual obligations on powerless retailers (see, e.g., recent work by Rasmusen et al. (1991) and Bernheim and Whinston (1998)).

also provides incentives for suppliers to choose a particular technology. More specifically, market structure affects the trade-off between inframarginal cost savings and cost savings "on the margin". By studying the case of linear demand and cost functions, we can make this trade-off fully explicit. We find that the incentives to adopt a technology with higher marginal costs are reduced if either suppliers become non-integrated or if retailers become integrated. In contrast to the previous case where market structure only affected the distribution of industry profits, the size of industry profits and welfare depends now on the market structure. We find that retailers may now choose more often to become integrated as this induces suppliers to choose a more efficient production technology. Incidentally, implementing the efficient technology also benefits consumers, implying that in this case increased downstream concentration should not be contested by any party. As argued in more detail below, our finding runs counter to the often pronounced view that downstream (retailer) concentration reduces upstream efficiency. However, we also find that a regulator who takes consumer rents into consideration would often prefer a different market structure than that arising endogenously.

Before reviewing some of the related literature, we want to illustrate for the case of retailer mergers why the issues discussed in this paper are of more than just academic interest. Since the emergence of large retail chains in the 1970s, buying power has become a key feature in the relationship between manufacturers and retailers.[2] While economic analysis has traditionally viewed retailers as lacking in power 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.[3] 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)).[4]

[2] 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. Similar trends can be observed in other European countries. 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).

[3] 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 (see Dobson et al. (2000, table 4.2, p. 24)). 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)).

[4] Market power at the local outlet market has been identified as the main source of buyer power (see, e.g., OECD (1999)). For instance, in the recent *United States/Toys "R" Us* case it was ascertained

Buyer power has also become an important issue in competition policy.[5] Most notable, 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.[6,7] 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 alliances between retail chains, which do not affect local downstream market structure.[8] 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." One contribution of this paper is to qualify this view by

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that it would be very difficult for manufacturers to replace the 30 percent of their sales accounted for by *Toys "R" Us* (see FTC (1996, 1997)).

[5] The growing concern about buying power in the legal debate in the United States and the European Union is documented in Steptoe (1993), Ehlermann and Laudati (1997), Dobson et al. (1998), Vogel (1998), Balto (1999), Dobson and Waterson (1999), OECD (1999), and Schwartz (1999).

[6] While efficiency claims in general have not been dispositive in any enforcement action belonging to the retail sector, 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 Balto (1999) and Pitofsky (1998) for assessments of that case from the FTC's perspetive). However, the court found that the claims were not sufficient to offset the anticompetitive effects in those local markets, where the two firms competed directly.

[7] The buyer power defence has also been made explicit in the 1998 Competition Act of the U.K. and in the 1996 Business Acquisition Guidelines of the Commerce Commission of New Zealand. In the EU merger enforcement buyer power was considered in the case *Enso/Stora* (Case No IV/M.1225). The merger reduced the number of suppliers of liquid packaging board to three. As the market was also heavily concentrated on the demand side, the Commission concluded that these circumstances produced a situation of mutual dependence between buyers and sellers, which the merger was unlikely to disturb (see European Commission (1998)).

[8] 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). According to Cotterill (2000) mergers between supermarket chains in the Unted States give rise to the same problem.

studying the role of retailer concentration for the technology choice of suppliers. Our analysis suggests that the above stated presumption has to be qualified depending on whether marginal or inframarginal cost reductions are considered. We show that under negotiated contracts retailer integration shifts the bargaining problem from marginal to inframarginal production quantities. This implies that suppliers have to bear relatively more of their marginal costs, while inframarginal costs are shared to a larger extent with the integrated retailer. Consequently, marginal costs reduction becomes more attractive for suppliers when facing an integrated retailer. As consumers benefit from the resulting lower price and higher quantity, we can show that welfare is unambiguously increased.

In our framework the induced technology choice made by *other parties* in the value chain can both motivate (retailer) mergers and determine their welfare impact. This contrasts with more standard merger analysis where firms merge to either monopolize the final good market (e.g., Salant et al. (1983) and Deneckere and Davidson (1985)) or to realize synergies within the merged firm (e.g., Williamson (1968), Perry and Porter (1985) and Farrell and Shapiro (1990)).

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.[9] Furthermore, all of these papers consider non-efficient bargaining where contracts can only specify a constant unit price. Indeed, the derived benefits from a horizontal (downstream) merger rely on the combination of this contractual incompleteness with the assumption that retailers' demand is interdependent.[10] Note also that with interdependent demand horizontal mergers have the main benefit of monopolizing 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 the interaction between market structure and technology choice is related to three different strands of the literature which analyze incentives for cost reduction and innovation. The first strand analyses how firms' incentives to reduce their costs vary with the form of competition (e.g., Bertrand or Cournot), their market share, or the presence of spill-overs (see Bester and Petrakis (1993), Flaherty (1980), Qiu (1997), and

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

[10] 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 from non-integrated retailers.

Spence (1984), respectively). The second strand, which is more closely related to our contribution, considers investment incentives under the problem of hold-up, where asset ownership can partially compensate for contractual incompleteness (see Grossman and Hart (1986), Hart and Moore (1990)). In light of this literature one of our contributions is to combine in one application three important issues. We investigate how incentives to invest in cost reduction are determined by (i) the nature of costs, (ii) the degree of competition between investing suppliers, and (iii) the prevailing up- and downstream market structure.

Finally, our result on how market structure affects technology choice fits well into the perspective of "innovative markets", which emphasizes the impact on innovative activities. Though this question has a long history,[11] it has recently gained much importance in antitrust policy.[12] While typically this approach only considers concentration and investment at the same market "level", our paper suggests a broader view. Downstream mergers may affect investment and technology choice at upstream firms.

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, so that mergers only affect the distribution of industry profits. In Section 5 we introduce technology choice by suppliers. Section 6 analyzes the equilibrium market structure under technology choice. In Section 7 we discuss modifications to some assumptions. Section 8 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 commands over the 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

[11] See Gilbert and Sunshine (1995) for an overview.

[12] 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.

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 $p_{sr}(x_{sr}, x_{s'r})$, with $r \in R^0$, 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 $s \in S^0$ supplied to retailer $r \in R^0$ 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

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, which seems rather natural to us. In particular, it is characterized by simultaneous efficient contracting. As discussed in detail below, this procedure gives rise to the Shapley value. For this reason 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 $\Omega \setminus \{A\}$. 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 $\tilde{\Omega} \subseteq \Omega$ and derive the resulting maximum industry profits $W_{\tilde{\Omega}}$. 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 various scenarios, we impose the following assumption, which helps us below to identify our bargaining procedure with the Shapley value.

Assumption A.1. $W(\cdot)$ *is strictly quasi-concave. It is also continuous on* R^+ *and equal to zero if all supplies are set to zero.*[13]

To calculate the Shapley value, we have to specify a particular market structure 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 integrated retailer. According to the Shapley value, the payoff of a member $\psi \in \Psi$ is given by[14]

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

It 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 now a particular bargaining procedure which, under additional assumptions, gives rise to the Shapley value. Our proposed bargaining procedure contains the following ingredients:

(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 integrated 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 the respective 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.[15]

[13] This condition holds in particular for the case of linear demand and cost functions, on which we focus in Section 5.

[14] $\left|\tilde{\Psi}\right|$ and $|\Psi|$ denote the numbers of elements in these sets. Observe also that $W_{(\cdot)}$ represents the characteristic function.

[15] The assumption that surplus is split equally is not essential for our qualitative results.

(iii) Contingent contracts: In each negotiation the two sides conclude contracts for all possible contingencies, where a contingency describes the set of successful bilateral negotiations in the industry. For instance, under $\omega = (1, 2)$ the agents of the integrated supplier and retailer a negotiate over two contracts, specifying transfers and supplies for the two cases where simultaneous negotiations with retailer b are either successfully concluded or have broken down. For each of these agreements the requirements of (ii), i.e., efficient bargaining and 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.[16]

We analyze now under which conditions this procedure has a unique equilibrium outcome which gives rise to the same equilibrium profits as those calculated under the Shapley value. Observe that this requires both that equilibrium supplies are chosen efficiently (to maximize industry profits) and that industry rents are distributed according to the Shapley value formula (1). As is easily seen, (A.1) is not sufficient to ensure that equilibrium supplies are uniquely determined. For instance, this may be the case if goods are complements and failure to supply good A at $r = a$ may make it also efficient not to supply good B at this retailer. Decreasing unit costs provide another example. One way to rule out this multiplicity, which is due to the assumption of simultaneous bargaining and the resulting problem of co-ordination failure between different agents, would be to impose some refinement, e.g., in the form of coalition-proofness.[17] An alternative route is to invoke additional assumptions on the demand and cost functions which ensure that this problem does not arise.

The following conditions are sufficient to establish uniqueness of equilibrium supplies under the proposed bargaining procedure. Suppose that only a subset of the four possible supplier-retailer "links" sr is active; i.e., that only these supplies can be positive. If we choose the respective supplies x_{sr} to maximize industry profits, we require that all supplies must be positive. Moreover, if we now consider an *additional* supplier-retailer link $\tilde{s}\tilde{r}$ with supplies $x_{\tilde{s}\tilde{r}}$, then maximizing industry profits while keeping the original supplies fixed shall imply $x_{\tilde{s}\tilde{r}} > 0$. (Of course, the latter condition is only applicable if we start from a strict subset of all possible supplies.)

These requirements are now re-stated more formally in the following assumption.[18]

[16] We discuss in Section 7 how changes in these requirements would affect our results.

[17] This has been used in a slighlty related setting by Bernheim and Whinston (1986).

[18] Note that (A.2) requires in particular that fixed costs are sufficiently low. Below we discuss in detail the linear case where these conditions are made explicit.

Assumption A.2. *Exclusion of corner solutions:*

(i) Consider a non-empty set of supplier-retailer links L.[19] *Maximizing $W(\cdot)$, where $x_{sr} = 0$ for all $(sr) \notin L$, must imply $x_{sr} > 0$ for all $(sr) \in L$. Denote the optimal choices by $x_{sr}(L)$, which is unique by Assumption (A.1).*

(ii) Consider some L and $(\tilde{s}\tilde{r}) \notin L$. Then maximizing $W(\cdot)$, where $x_{sr} = x_{sr}(L)$ for $(sr) \in L$ and $x_{sr} = 0$ for $(sr) \notin L \cup \{(\tilde{s}\tilde{r})\}$, must imply $x_{\tilde{s}\tilde{r}} > 0$.

Given Assumptions (A.1) and (A.2), it is now easily checked that equilibrium supplies are uniquely determined and strictly positive for all bilateral negotiations and all contingencies. Moreover, all equilibrium supplies are strictly positive.

Given the determination of supplies, we turn next to the question of how profits are distributed. Consider the case with bilateral non-integration. Denote the payoff of supplier A for the contingency that all negotiations are successful 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 $\tilde{U}_a$. Recall now that players split the net surplus in each bilateral negotiation. Clearly, this implies

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

The implication (2) is called the condition of "balancedness" or "balanced -contribution" condition, which under our requirements must hold for all bilateral negotiations and all contingencies.[20] By results in Jackson and Wolinsky (1996), which extend those in Myerson (1977), this condition indeed implies that equilibrium payoffs are determined by the Shapley value.[21,22] This implication extends clearly to the cases where one or both sides of the market are integrated.

Admittedly, our specification of the bargaining procedure falls short of the full description of a 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, then there is another and last round of bargaining where either side is chosen with equal probability to make a final offer. Additionally, we assume that with some (arbitrarily) small probability ε the two sides fail to start negotiations due to some exogenous event. It is easily checked that an equilibrium of this game supports the equilibrium outcome of our

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

[20] This shall not be confused with the "balancedness" condition in the theory of the core.

[21] Precisely, we can apply their Theorem 4 after noting that our condition of non-interdependent demand is equivalent to their requirement that the "value function" (i.e., $W_{(\cdot)}$) is "component additive".

[22] The balancedness condition is also used in Stole and Zwiebel (1996a/b) when showing that their bargaining procedure between a single firm and n workers obtains the Shapley value. In contrast to our bargaining procedure, their main assumption is that simple wage contracts are non-binding.

bargaining procedure.[23,24]

4 Horizontal Integration

4.1 Equilibrium Payoffs

We now calculate equilibrium payoffs under the 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 are integrated.

Illustration of the bargaining procedure for the case $\omega = (1, 2)$

We denote the payoff of retailer r under market structure $\omega = (1, 2)$ by $U_r^{1,2}$ and that of the integrated suppliers by $U_{AB}^{1,2}$. Applying the Shapley value yields

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

We show now how we obtain (3) from our bargaining procedure as presented in Section 3.2. The integrated supplier signs with the two retailers $r = a, b$ the following contracts. One contract specifies supplies and transfers for the case when bargaining with the other retailer is also successful. A second contract is implemented if no contract is signed with the other retailer. Moreover, for each contingency supplies are chosen efficiently and the net surplus is split equally. Suppose now bargaining between the integrated supplier and retailer b breaks down. For this contingency the contract with retailer a allows the supplier to realize the payoff $\frac{1}{2}W_{\Omega\backslash\{b\}}$, i.e., half of the maximum industry profits which

[23] The issue of uniqueness is more contrived for two reasons. First, without additional frictions before the second round, players are indifferent between striking a deal in the first round and waiting until either side is chosen to make a final offer. This ambiguity could be easily restored by assuming breakdown after the first round with probability $\varepsilon' \to 0$. Second, simultaneous bargaining with multiple parties gives rise to the following possibility of rent-extraction. Consider bargaining between A and a. Their contracts may now specify a substantial (additional) transfer to A if there is agreement in the pair (B, a), while the opposite happens if there is agreement in (A, b). This construction allows the two parties to extract substantial rents in their simultaneous negotiations with B and b, respectively. In Section 7 we have more to say on this issue.

[24] Though a game with an open time horizon (as in Binmore et al. (1986)) would seem more attractive, this 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)).

are feasible without retailer b. Likewise the contract with retailer b specifies that either side realizes $\frac{1}{2}W_{\Omega\backslash\{a\}}$ if there is no agreement with retailer a. Based on these results we can now determine contracts for the contingency where all negotiations are successful. Denote for this purpose the respective total transfer from retailer r to the integrated supplier by t_r, which is paid for the supply of x_{Ar}, x_{Br}. When bargaining with $r = a$, the *net surplus*, S_a, is given by

$$\begin{aligned} S_a &= x_{Aa}p_{Aa}(x_{Aa,}x_{Ba}) + x_{Ba}p_{Ba}(x_{Ba}, x_{Aa}) \\ &\quad - K_A(x_{Aa} + x_{Ab}) - K_B(x_{Ba} + x_{Bb}) + K_A(x_{Ab}) + K_B(x_{Bb}). \end{aligned}$$

As the net surplus is again split equally, retailer a must realize $U_a^{1,2} = \frac{1}{2}S_a$, while the supplier realizes $U_{AB}^{1,2} = \frac{1}{2}W_{\Omega\backslash\{a\}} + \frac{1}{2}S_a$. We can proceed likewise for negotiations with retailer b, where $U_b^{1,2} = \frac{1}{2}S_b$ and $U_{AB}^{1,2} = \frac{1}{2}W_{\Omega\backslash\{b\}} + \frac{1}{2}S_b$. As $U_a^{1,2} + U_b^{1,2} + U_{AB}^{1,2} = W_\Omega$, it is straightforward to obtain from these requirements the payoffs stated in (3).

Equilibrium payoffs

To determine equilibrium market structures in what follows, it is sufficient to calculate the joint payoffs of suppliers and retailers. Moreover, as total industry profits are invariant to the choice of market structure, it is sufficient to state in each case the joint payoffs of suppliers. A complete statement of payoffs for the individual parties is confined to the Appendix.

Proposition 1. *Under the different market structures we obtain for the aggregate payoffs of suppliers:*

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

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

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

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

Proof. See Appendix.

4.2 Equilibrium Market Structure

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

Lemma 1.

(i) Regardless of whether retailers are integrated or not, suppliers' joint payoffs are higher under integration if

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

while their joint payoffs are lower under integration if the inequality is reversed.

(ii) Regardless of whether suppliers are integrated or not, retailers' joint payoffs are higher under integration if

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

while their joint payoffs are lower under integration if the inequality is reversed.

We say that a market structure is an equilibrium market structure if the joint profits of participants on either side of the market do not increase if they change their respective market structure (while, of course, the structure on the other side remains unchanged).[25] The following corollary follows therefore directly from Lemma 1.

Corollary 1. *We can make the following predictions for the equilibrium market structure:*

i) Suppliers are integrated if $W_{\Omega\setminus\{A\}} + W_{\Omega\setminus\{B\}} > W_\Omega$ *and they stay non-integrated if* $W_{\Omega\setminus\{A\}} + W_{\Omega\setminus\{B\}} < W_\Omega$.

ii) Retailers are integrated if $W_{\Omega\setminus\{a\}} + W_{\Omega\setminus\{b\}} > W_\Omega$ *and they stay non-integrated 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. Consider first the retailers' incentives to merge. 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 $x > 0$. It can be shown that (5) must hold if both cost functions exhibit strictly increasing unit costs, while the converse holds if both cost functions exhibit strictly decreasing unit costs. Consider next suppliers. We say that the two goods are 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 $r \in R^0$. In this case we can show that (4) holds, implying that suppliers become integrated. 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. In this case suppliers prefer to stay non-integrated.

Proposition 2. *If both suppliers have strictly increasing (decreasing) unit costs, retailers are integrated (non-integrated) in equilibrium. If products are strict substitutes (complements) at the two outlets, suppliers are integrated (non-integrated) in equilibrium.*

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 integrate. As supplies

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

are not affected by market structure and total rents are therefore left unchanged, integration can only shift rents between retailers and suppliers. If a non-integrated retailer a bargains with a supplier, they consider the additional costs incurred by the delivery to a. The same logic applies to negotiations with $r = b$. In contrast, if retailers are integrated, the two sides negotiate about the total supply of the respective good. Loosely speaking, negotiating separately with two non-integrated 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 become integrated in this case, they gain access to a larger share of these rents. The same principle prevails in the case of supplier integration. 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".[26]

Broadly speaking, integration 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 much of the surplus by bargaining independently.[27]

Observe that our results qualify the concept of "buyer power". Indeed, we identify reasonable circumstances under which retailers would be worse off if they were integrated. 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, the benefits from integration should be rather high for retailers.

We consider it worthwhile to briefly elaborate more on the role of capacity constraints. Suppose that the economy can be in one of two states, where total demand is either high or low. In the high-demand state capacity constraints of suppliers are rather binding,

[26] 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 dis-integrated retailers. However, 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.

[27] The effects have also been exploited by Bolton and Scharfstein (1996), where the individual agreements of debtholders have a complementary role. Stole and Zwiebel (1999a/b) consider bargaining between one firm and many workers, while Segal (2000) allows coalitions to specify alternative contractual arrangements. For earlier work see the references in Legros (1987).

implying that each retailer becomes more or less dispensable. In fact, even if total supply would be sold at only one retailer, this might only slightly depress prices and revenues. In particular, it may hold that $\overline{W}_{\Omega\backslash\{a\}} + \overline{W}_{\Omega\backslash\{b\}} > \overline{W}_{\Omega}$, where the upper bar denotes the high-demand state. We know that in this case retailers would prefer to become integrated. Consider next the case with low demand and thus more than sufficient capacity. If producing involves, however, some fixed costs, this could imply overall decreasing unit costs and thus $\underline{W}_{\Omega\backslash\{a\}} + \underline{W}_{\Omega\backslash\{b\}} < \underline{W}_{\Omega}$, where the lower bar denotes the low-demand state. Retailers would then be better off to stay non-integrated. If market structure exhibits a sufficient degree of inertia, which seems to be a realistic assumption, retailers' choice now depends on their outlook on future demand.

Clearly, Proposition 2 does not exhaust all possible cases. For instance, unit costs may be decreasing and increasing at different output levels. 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.

5 Horizontal Integration and Technology Choice

In the preceding analysis market structure does not affect equilibrium supplies. In that sense the industry's performance is invariant to market structure. Particularly, total welfare and consumer surplus are not affected by market structure, implying no role for merger control. In this and the following section we let suppliers choose technologies and study the interaction with market structure. Among other things, this will imply the possibility of welfare enhancing merger policy.

In this section we assume that one supplier can choose between two production technologies which differ with respect to inframarginal and marginal cost levels.[28] More precisely, 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.[29] Instead of a change in production costs, we could also imagine that

[28] As the two suppliers produce differentiated products, assuming that only one supplier has the choice to switch to a production technology is not unrealistic.

[29] 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, 1989), Eaton and Schmitt (1994), and Boyer and Moreaux (1997)). 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

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, so that suppliers have to bear a larger share of their inframarginal costs and a smaller share of their marginal costs compared to the case of retailer integration. As a result, suppliers have more incentives to trade-off lower inframarginal costs with higher marginal costs if retailers stay non-integrated.

2. *Competition Effect:* If suppliers become non-integrated and goods are substitutes, a marginal cost reduction leads to a decreasing output level of the rival supplier. This negative externality from a marginal cost reduction is not internalized if suppliers are not integrated. Hence, disintegrating suppliers 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 can become integrated. In the second stage, the supplier commanding over production of brand $s = A$ decides which technology to choose, and in the third stage supply contracts are negotiated.[30] The following section analyzes the second stage of the game, i.e., optimal technology choice for a given market structure. In Section 6 we will turn to the first stage and derive the equilibrium market structure.

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 $K^i(x) = F^i + k^i x$

higher (under flexible manufacturing)."

[30] We thus assume that market structure exhibits sufficient inertia so that it cannot be changed (again) right after the technology has been chosen.

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" costs are not sunk before bargaining starts, but are part of the bilateral negotiation between suppliers and retailers. To make this clear, we refer to them as (fixed) "operating costs". 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 our analysis, it suffices to concentrate on the case $k^\beta = 0$ and $F^\alpha = 0$, so that $\Delta_F = F^\beta$ and $\Delta_k = k^\alpha$.

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

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

As is well-known, this gives rise to a system of linear demand functions, where 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 (A.2) holds, we require that

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

The derivation of this condition is contained in the Appendix.

We can now proceed with the analysis. It is intuitive that 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 $\Delta_F < \Delta_F^\omega$. To make our procedure well-understood, consider the case where both sides are integrated such that the aggregate payoff of suppliers is 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 $\Gamma \equiv \frac{1}{4}\frac{\Delta_k}{1-c^2}\left[2(1-c)(1-\Delta_k) + \Delta_k\right]$. Proceeding as in this case for all market structures, we obtain the following result.

Lemma 2. *In the linear case, technology $i = \beta$, which has lower marginal and higher operating costs compared to technology $i = \alpha$, is chosen as long as the difference in operating costs Δ_F is not larger than Δ_F^{ω}, where*[31]

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

with $\Theta \equiv \frac{c\Delta_k}{1-c^2}\left[2(1-c)(1-\Delta_k) - c\Delta_k\right]$.

Proof. See Appendix.

Using Lemma 2, we can determine which market structure is more likely to lead to either technology α or β.[32]

Proposition 3. *In the linear case, thresholds Δ_F^{ω} for the technology choice satisfy the following ordering:*

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

Proof. See Appendix.

Proposition 3 confirms the stipulated rent-sharing and competition effects. The supplier controlling the production at A cares more about marginal cost-savings if either retailers become integrated or suppliers stay non-integrated. 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.[33] 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 $\omega = (1, 1)$ implies the lowest incentives to choose technology β.[34] Regarding the two intermediate cases, the two effects work in opposite directions. It

[31] For the sake of brevity we do not specify what happens in case of indifference. This is without consequences for the further analysis as we will simply omit these parameters.

[32] To compare $\Delta_F^{1,1}$ with $\Delta_F^{2,2}$ note that $\Theta > 0$ follows from condition (6).

[33] The impact of coalitional (or ownership) structure on various forms of cost-reducing investment goes back 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.

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

turns out that in our example the rent-sharing effect dominates. However, it is 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.[35]

Before proceeding with the analysis, we briefly discuss the related case where suppliers can invest to reduce costs. Hence, it this case the choice of technology involves an up-front investment which cannot be (partially) recuperated in subsequent negotiations. Incentives to reduce marginal or infra-marginal costs are now affected differently by the market structure. Focusing again on the linear case, incentives to reduce operating costs do only depend on the downstream market structure. If retailers are integrated, we know that the supplier can roll-over a larger portion of operating costs, which reduces his incentives. In contrast, incentives to reduce marginal costs only depend on the upstream market structure. It is easy to establish that integration of suppliers decreases the benefits from reducing marginal costs.[36,37] If suppliers are not integrated, supplier A does not internalize the (negative) demand spill-over for good $s = B$ after a reduction in marginal costs.

5.2 Efficiency Benchmarks

We compare next the respective technology choices with two benchmarks of efficiency: industry profits and welfare. First, we consider industry profits. It is immediate that technology choice under a bilateral monopoly, $\omega = (1, 1)$, maximizes aggregate profits. Proposition 3 allows to obtain the parameter regions for which alternative market structures lead to a less efficient choice.

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

[36] Let k_s denote the marginal costs of supplier s. Then, differentiating the payoff of the non-integrated 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 integrated 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 for the non-integrated supplier to reduce his marginal costs are higher.

[37] 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 integration and upstream non-integration imply higher investment if this affects predominately costs at high output levels, while downstream non-integration and upstream integration spur investment that helps to reduce costs at relatively low levels of output. Interestingly, in the latter case the resulting cost reduction may not increase industry profits if cost-levels at equilibrium output are not affected. In this case the investment is solely made to enhance suppliers' outside option in the subsequent negotiations.

Corollary 2. *In the linear case the following results hold regarding industry profits:*
(i) If $\Delta_F \in \left(\Delta_F^{1,1}, \Delta_F^{2,1}\right)$, $\omega = (2,1)$ *implements the less efficient technology.*
(ii) If $\Delta_F \in \left(\Delta_F^{2,2}, \Delta_F^{1,1}\right)$, $\omega = (2,2)$ *and* $\omega = (1,2)$ *implement the less efficient technology.*
(iii) If $\Delta_F \in \left(\Delta_F^{1,2}, \Delta_F^{2,2}\right)$, $\omega = (1,2)$ *implements the less efficient technology.*
(iv) For all other cases all market structures implement the efficient technology.

We come next to a comparison of social welfare (the sum of industry profits and consumer surplus). Precisely, we have now in mind the picture of 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, the regulator is thus only concerned with the impact of market structure on technology choice. By substituting equilibrium quantities, we can determine social welfare under the two technology regimes. We denote social welfare when technology $i \in I$ is used by SW^i. Comparison of SW^α and SW^β yields 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 derived in Proposition 4.

Proposition 4. *In the linear case the welfare threshold* Δ_F^* *satisfies*

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

Proof. See Appendix.

This result is intuitive given that retailers set prices to maximize industry profits. As a consequence, equilibrium supply is always inefficiently low. To counteract this marginalization effect, the regulator has a stronger preference for the technology with smaller marginal costs and thus a higher equilibrium supply. Note that this argument suggests quite generally that the regulator should have a stronger preference for the technology with lower marginal costs than suppliers under all market structures $\omega \in \{(1,2),(2,2),(1,1)\}$. In contrast, the ordering of Δ_F^* and $\Delta_F^{2,1}$ seems to depend on the choice of linear demand and cost functions.

Proposition 4 implies the following result.

Corollary 3. *In the linear case the following results hold regarding total welfare:*
(i) If $\Delta_F \in \left(\Delta_F^{2,1}, \Delta_F^*\right)$, *all market structures implement the less efficient technology.*

(ii) If $\Delta_F \in \left(\Delta_F^{1,1}, \Delta_F^{2,1}\right)$, $\omega = (1,2)$, $\omega = (2,2)$, *and* $\omega = (1,1)$ *implement the less efficient technology.*

(iii) If $\Delta_F \in \left(\Delta_F^{2,2}, \Delta_F^{1,1}\right)$, $\omega = (1,2)$ *and* $\omega = (2,2)$ *implement the less efficient technology.*

(iv) If $\Delta_F \in \left(\Delta_F^{1,2}, \Delta_F^{2,2}\right)$,$\omega = (1,2)$ *implements the less efficient technology.*

(v) For all other cases all market structures implement the efficient technology.

As a consequence of Proposition 4 and Corollary 3, a regulator is more likely to prefer the market structure $\omega = (2,1)$, i.e., to integrate retailers, but to keep suppliers disintegrated.

Given the benchmarks in Corollaries 2-3, the natural question is now which market structure would arise endogenously. As goods are substitutes and unit costs are non-increasing, the first conjecture would be that suppliers merge while retailers stay disintegrated. This conjecture is, however, wrong for retailers who now take into consideration the impact of their organizational form on suppliers' technology choice.

6 Equilibrium Market Structure with Technology Choice

Consider first the choice of upstream market structure. As goods are substitutes, we know that integration 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 become integrated. In contrast, as retailers cannot directly control the choice of technology, they must take this into consideration when choosing whether to become integrated. 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 non-integrated. 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 integration.[38] Hence, for relatively low or high values of Δ_F the picture has not changed compared to our previous analysis. In contrast, for $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$ we find that retailers become integrated, even though the resulting choice of technology β implies strictly decreasing unit costs.

[38] 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.

Proposition 5. *In the linear case the equilibrium market structure under 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.

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.

In the case where retailers integrate strategically to influence suppliers' technology choice, we know from Corollary 3 that this leads also to an increase in total welfare. The resulting switch to the technology with lower marginal costs boosts 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 improve the appropriability of rents from marginal cost reductions and thus lead to lower consumer prices. While the regulator would thus support integration of retailers, it also follows from Corollary 3 that he would want suppliers to stay non-integrated so as to ensure that technology β is implemented for a larger spectrum of Δ_F.

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, integration 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 consumer rents. While the effects of retailer concentration on consumer surplus may have to be qualified depending on possible monopolization effects at the outlet markets, their positive effects on manufacturers' investment and technology choices would still persist. 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. (1998) and FTC (2001)[39] state that a monopsony reduces productive efficiency by erasing suppliers' rents.[40] 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

[39] More generally, see the discussion in Blair and Harrison (1993, p. 36-43).

[40] A similar view is expressed in the health care market, which in many instances has become a bilateral oligopoly in the US (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)).

more infra-marginal or marginal costs. Second, from consumers' perspective the latter form of cost-reduction may matter far more, while suppliers' incentives to keep down marginal costs may in fact increase if retailers are concentrated.

We are only aware of one empirical study which 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 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 both ways and must both be treated as endogenous.

7 Discussion

7.1 The Bargaining Procedure

We now 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, the distribution of payoffs would depend crucially on the (artificially?) chosen sequence. To see this, suppose that one side is integrated, implying the presence of exactly three independent parties. Suppose also that players can write rather complicated 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, for instance, Aghion and Bolton (1987), Marx and Shaffer (1999), and Bernheim and Whinston (1998)). 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. This has been formally explored by Cai (2000).

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., on being integrated or not. 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.

7.2 Interdependent Demand at the Retail Outlets

We have so far assumed that demand at the two retailers is independent. If this is no longer the case, the choice of the contractual set discussed above rises another issue. Consider the case of bilateral non-integration. 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 under interdependent demand due to opportunistic behavior in the bilateral negotiations (see McAfee and Schwartz (1994)). Precisely, the cross-price effects over the two retailers are not taken into consideration. In this case downstream integration would have the immediate benefit of monopolizing the final market. Instead, if we allow for complex arrangements where bilateral contracts can condition on the whole set of contracts in the economy, there exists an equilibrium where the final market is fully monopolized. Intuitively, as each supplier serves all retailers in equilibrium, it is feasible to internalize all externalities (over goods and retailers) by bilateral contracts.[41] 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 downstream integration. Indeed, the logic obtained for suppliers in case of substitutes could now be directly applied to downstream merger incentives.

8 Conclusion

This paper makes three related contributions. First, we propose a rather natural form of negotiations and contracting in bilateral oligopolistic industries, which happens to give 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 that (ii) firms may choose a particular organizational form in order to influence the technology choice of other firms

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

in the value chain. The link between market structure and technology choice provides also a basis for regulatory interference even though market structure has no direct impact on consumer welfare.

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 so large 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 non-integrated 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 certain firms (retailers) 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.[42]

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

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

Appendix A: Proofs

Proof of Proposition 1

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

(i) $\omega = (1,1)$: If both sides are integrated, the two parties share the surplus W_Ω equally.

(ii) $\omega = (1,2)$: If only suppliers are integrated, 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) $\omega = (2,1)$: If only retailers are integrated, 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) $\omega = (2,2)$: If both sides are non-integrated, 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 retailer integration. 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 surely 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.[43] As a consequence, (5) holds surely 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.[44] For the case of decreasing

[43] Given (A.1)-(A.2) this change results even in a strict decrease of payoffs.

[44] 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 $\kappa_s(y+z)$.

unit costs, we have to show that $W_{\Omega\backslash\{a\}} + W_{\Omega\backslash\{b\}} < W_{\Omega}$. The argument is analogous by replacing x_{sa}^{Ω} with $x_{sa}^{\Omega\backslash\{b\}}$ and x_{sb}^{Ω} with $x_{sb}^{\Omega\backslash\{a\}}$.

Consider next the case of supplier integration 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 again surely 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 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

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

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 $\widetilde{s}\widetilde{r}$ 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 $x_{\widetilde{s}\widetilde{r}}$ maximizes

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

Maximizing (8) yields a positive value for $x_{\widetilde{s}\widetilde{r}}$, 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 Lemma 1

For a given technology $i \in \{\alpha, \beta\}$ the payoff, U_i^ω of the supplier commanding over 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 obtained by setting $U_\beta^\omega = U_\alpha^\omega$.

Proof of Proposition 4

Social welfare is given by $SW^i = \sum_{r\in R^0} u(x_{A,r}^i, x_{B,r}^i) - K_A^i(x_{A,r}^i + x_{A,r'}^i) - K_B^\alpha(x_{B,r}^\alpha + x_{B,r'}^\alpha)$, 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

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

Comparison of SW^α and SW^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

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

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

Proof of Proposition 5

As argued in the main text, it is immediate that suppliers must be integrated. 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

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

while they realize

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

under market structure $\omega = (1,2)$ when technology $i = \alpha$ is chosen. The assertion for $\Delta_F \in (\Delta_F^{1,2}, \Delta_F^{1,1})$ 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 non-integrated, 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 integrated 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 is integrated. To reduce the amount of notation, we write $s \in \sigma$ $(r \in \pi)$ if the possibly integrated supplier σ (retailer π) commands over 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

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

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

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

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