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Market Structure, Bargaining, and Technology Choice

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ABSTRACT

Market Structure, Bargaining, and Technology Choice*

Roman Inderst and Christian Wey

The first part of this paper analyzes the impact of *horizontal* mergers of suppliers or retailers on their respective bargaining power. In contrast to previous approaches, we suppose that parties resolve the bargaining problem *efficiently*. Moreover, by ensuring that demand is independent at all retailers we exclude monopolization effects. We find that downstream mergers are more likely (less likely) if suppliers have increasing (decreasing) unit costs, while upstream mergers are more likely (less likely) if goods are substitutes (complements). In both cases a merger enables the involved parties to gain access to inframarginal rents.

In the second part of the paper we explore how the role of bargaining power affects technology choice under different market structures. We isolate two effects. First, if retailers are non-integrated, suppliers focus disproportionately more on inframarginal cost reduction. Second, this bias is mitigated if goods are substitutes and suppliers are non-integrated as competition exerts a disciplining force.

Keywords: Merger, Bargaining Power, Technology Choice

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ZUSAMMENFASSUNG

Horizontale Unternehmenszusammenschlüsse, Verhandlungen und die Wahl der Produktionstechnologie

Der erste Teil des Aufsatzes zeigt, wie sich *horizontale* Zusammenschlüsse zwischen Produzenten und Einzelhändlern auf die Verhandlungsmacht der Vertragsparteien auswirken. Im Gegensatz zu vorhergehenden Ansätzen nehmen wir an, daß die Parteien ihre Verhandlungsprobleme *effizient* lösen. Des weiteren unterstellen wir, daß die Einzelhändler Märkte bedienen, die unabhängig voneinander sind, wodurch Monopolisierungsvorteile ausgeschlossen werden. Unsere Ergebnisse zeigen, daß Einzelhändler einen Zusammenschluß favorisieren, wenn die Stückkosten der Produzenten mit zunehmender Ausbringungsmenge ansteigen. Umgekehrt sind die gemeinsamen Gewinne unabhängiger Einzelhändler höher als bei einem Zusammenschluß, wenn die Stückkosten der Produzenten fallend verlaufen. Die Produzenten können ihre gemeinsamen Gewinne durch eine Fusion steigern, wenn ihre Erzeugnisse substituierbar sind. Stehen die Güter der Produzenten in einem komplementären Verhältnis zueinander, so ist ein Zusammenschluß nicht vorteilhaft. Diese Ergebnisse sind unabhängig von der Struktur der anderen Marktseite. Allgemein gilt sowohl für die Produzenten als auch für die Einzelhändler, daß ein Zusammenschluß den Zugriff auf inframarginale Renten der anderen Marktseite ermöglicht.

Im zweiten Teil der Arbeit untersuchen wir, wie die Berücksichtigung von Verhandlungsmacht die Technologiewahl eines Produzenten bei unterschiedlichen Marktstrukturen beeinflußt. Wir können zwei Effekte isolieren. (1) Produzenten haben einen Anreiz Kosteneinsparungen bei inframarginalen Ausbringungsmengen zu Lasten von höheren Gesamtkosten zu tauschen, wenn die Einzelhändler nicht zusammengeschlossen sind. (2) Diese Verzerrung hin zu einer ineffizienten Technologiewahl wird abgemildert, wenn die Güter substituierbar sind und die Produzenten unabhängig agieren, weil Konkurrenz eine disziplinierende Funktion ausübt.

Schlagwörter: Fusionen, Verhandlungsmacht, Wahl der Produktionstechnologie

1 Introduction

This paper analyzes horizontal mergers between suppliers and retailers under a bargaining perspective. We first explore the impact of up- and downstream integration on the distribution of surplus. In particular, this leads to a theory of market structure based on bargaining power. In a second step, we can exploit these results to investigate how market structure affects suppliers' technology choice.

In our model each retailer controls a single outlet, while suppliers offer differentiated products. Suppliers and retailers engage in efficient bargaining to determine the supplied quantity and the respective transfer. We restrict attention to the case where demand is independent at the different outlets. This allows us to focus on the bargaining effects of mergers, while excluding those cases where parties merge solely to monopolize the final product market. The first part of the paper analyzes the incentives of suppliers and retailers to integrate. We show that retailers become integrated (non-integrated) if suppliers' production functions exhibit increasing (decreasing) unit costs. Intuitively, if retailers stay non-integrated, they bargain separately with each supplier over an increase in production "at the margin". As a consequence, the additional surplus from reaching an agreement becomes smaller (larger), if unit costs are increasing (decreasing). Hence, if unit costs are increasing, the respective joint transfer exceeds that realized by an integrated retailer. By an analogous reasoning, an upstream merger increases (decreases) the suppliers' share of surplus if goods are substitutes (complements).

In a second step, we assume that one supplier can choose its technology before bargaining with retailers. We analyze the supplier's technology choice under different market structures. If an integrated supplier faces non-integrated buyers, the supplier bears disproportionately more of his inframarginal costs than of his costs at the margin. Clearly, this will bias the supplier's technology choice towards a technology which ensures higher profits at inframarginal output levels. We show that either integration of retailers or disintegration of the (previously) monopolistic supplier may mitigate this problem.

Our paper contributes to the industrial organization literature on horizontal mergers. Broadly speaking, this literature has discussed the following three major motivations for horizontal mergers. First, firms may merge to monopolize the final good market and thus raise prices and increase producers' profits.[1] Second, a merger may set free synergies leading to efficiency gains.[2] Finally, if firms sell or procure in imperfectly competitive

[1]The analysis of the conditions under which it is profitable for competing firms to merge can be traced back to Stigler (1950). A formal analysis is provided by Salant, Switzer, and Reynolds (1983) for the case where firms compete in quantities and by Deneckere and Davidson (1985) for competition in prices. See also more recently Kamien and Zang (1990) and Gaudet and Salant (1991, 1992).

[2]Efficiency gains may be realized (i) by achieving an optimal allocation of the production levels

factor markets, integration may affect their bargaining position. Our paper contributes to the third line of research, which, at least in our view, has so far received comparatively small attention.

The previous theoretical contributions on mergers and bargaining power by Horn and Wolinsky (1988a), von Ungern-Sternberg (1996), and Dobson and Waterson (1997) differ from our approach in the following three important aspects. First, as retailers compete in these papers, downstream integration has the benefit of monopolizing the final product market, which blurs the analysis of a merger's impact on bargaining power. Second, all of these papers consider non-efficient bargaining where suppliers and retailers can only bargain over contracts specifying a constant unit price. To see how this assumption drives the results in these papers, consider Dobson and Waterson (1997) where retailers face a monopolistic supplier. If the supplier grants a discount to one particular retailer, this decreases his supply to the other retailers who buy at higher unit prices. This effect vanishes under efficient bargaining because all these papers assume linear production costs, what excludes any benefits from a downstream merger apart from the aforementioned monopolization of the final market.[3] Finally, only Horn and Wolinsky (1988a) consider the possibility of an upstream merger. However, they restrict attention to the case where each retailer is locked-in to a particular supplier.[4] In contrast, multiple sourcing will always occur in our setting as goods are imperfect substitutes. Indeed, this will drive our results as it shifts bargaining between each individual supplier and retailer "to the margin".

From a theoretical perspective our analysis of the incentives to merge is most closely related to Horn and Wolinsky (1988b). They develop an alternating-offer bargaining model for the case in which two groups of workers face a single employer.[5] Under the assumption that employment levels are fixed, they show that workers tend to form a

across different plants (also called rationalization), (ii) through realization of economies of scale and/or scope, and (iii) by enhancing technological progress. Since the seminal paper by Williamson (1968), the trade-off between monopolization and efficiency effects of mergers has been studied quite exhaustively (see, e.g., Perry and Porter (1985) and Farrell and Shapiro (1990)).

[3] As Dobson and Waterson (1997) assume that a merger reduces the number of product variants (or outlets in our terminology), there would still be a countervailing effect. A different approach for analyzing the effects of buyers' size on input market prices, and hence, buyers' profits has been explored by Snyder (1996). He develops an infinitely repeated game with competing suppliers in which the ability of suppliers to sustain collusion is limited in the presence of large buyers.

[4] Of course, the picture of locked-in suppliers is more appropriate if the supplied input represents labor, which is the particular case on which Horn and Wolinsky (1988a) focus. See also Inderst and Wey (2000) for an analysis of bargaining power with locked-in suppliers.

[5] See also Jun (1989) for a union formation model in which two groups of workers bargain with the firm over wages. Moreover, Stole and Zwiebel (1998) consider the incentives of firms (with locked-in labor) to merge in a similar setting.

single union when the two types of workers are substitutes. In this case the sum of the additional contributions of the two labor groups is smaller than their total value. On the other side, if the two types of workers are complements, they will be better off if they organize in separate unions because the sum of their marginal contributions is larger than their total value. Our model extends this basic idea in two important directions. First, we consider both downstream and upstream mergers, and second, we explore the role which the shape of the manufacturers' production function plays in determining retailers' incentives to merge.[6] Moreover, we develop a model of multilateral bargaining between many upstream and downstream firms.

Our model is also related to the work by Stole and Zwiebel (1996a/b). Though they apply a different bargaining approach to appropriately map employment-at-will between workers and a firm, their results are also driven by the fact that bargaining in pairs between the single indispensable player (the firm) and each worker proceeds at the "margin" of the value function.[7]

Finally, to our knowledge, our analysis of the impact of market structure on technology choice is novel to the literature. In particular, we show how bargaining considerations may induce firms to adopt an inefficient production technique which trades off lower cost savings at inframarginal production levels with higher production costs at the margin. This finding is reminiscent to the argument in Stole and Zwiebel (1996a/b) that subsequent bargaining with workers may lead a firm to choose an inefficient production technology.[8] In our terminology, they consider the situation of a single retailer facing more than one supplier. In contrast, our analysis deals with the technology choice of suppliers in a multilateral relationship. In addition, our focus is not on this effect per se, but on how it changes with the market structure; i.e., with up- and downstream integration by suppliers and retailers.

With respect to technology choice, we finally want to emphasize that we do not consider a standard hold-up problem where a supplier invests to reduce production costs.[9] Indeed, in our framework the choice of the technology does not involve any

[6] By contrast, Horn and Wolinsky (1988a), von Ungern-Sternberg (1996) and Dobson and Waterson (1997) only consider the case in which suppliers incur zero fixed costs and have constant-marginal-cost production technologies.

[7] The approach of Stole and Zwiebel has been recently applied to *vertical* integration by de Fontenay and Gans (1999). Related is also Gertner (1994) who studies bargaining between two sellers with complementary goods and a single buyer.

[8] See Skillman and Ryder (1993) for an early account of this effect.

[9] The incentives of producers to invest in cost reductions have been analyzed by Bester and Petrakis (1993) in a standard Cournot and Bertrand setting. A recent overview of the hold-up literature can be found in Felli and Roberts (2000). Their work also contributes to the rather novel strand of the literature which investigates how hold-up is affected by competition (see Bolton and Whinston (1993) for

up-front costs.

The rest of this paper is organized as follows. Section 2 analyzes the role of bargaining power and derives the equilibrium market structure. In Section 3 we exploit these results to investigate technology choice under various market structures. Section 4 concludes.

2 Bargaining Power and Market Structure

In this section we investigate the impact of market structure on the distribution of surplus between suppliers and retailers. In Section 2.1 we describe the analyzed economy. Section 2.2 introduces our bargaining concept in the context of a fully dispersed (or bilaterally non-integrated) market. In Section 2.3 we apply the solution concept to various market structures and derive the equilibrium market structure. As indicated in the introduction, we will extend our analysis in Section 3 to analyze how market structure influences suppliers' technology choice.

2.1 The Economy

We consider an intermediary goods market in which N producers, indexed by $n \in N = \{1, ..., N\}$, sell their products to M retailers, indexed by $m \in M = \{1, ..., M\}$, for subsequent distribution to final consumers. We assume that each retailer is a local monopolist in the final goods market and that each supplier commands over one differentiated product x when all suppliers are non-integrated. Without loss of generality, we focus on the case where $N = 2$ and $M = 2$. 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 are the result of bargaining in our model.

We denote the quantity of good $n \in N$ supplied at outlet $m \in M$ by $x_{n,m}$. Demand at the different outlets is supposed to be independent. This assumption is made to rule out standard monopolization effects of mergers in order to focus on the impact of market structure on bargaining power. We next invoke several additional assumptions on the demand functions. While these assumptions are not essential to achieve our effects, they allow us to heavily economize on notation. First, we make standard assumptions which ensure that we can use the first-order approach to derive equilibrium quantities

a seminal work in this direction). Competition by, say, buyers for sellers may induce efficient investment by sellers as it makes - in the language of Makowski and Ostroy (1995) - the buyers' outside option binding and thus allows sellers to fully appropriate the value of their investment. We want to emphasize that this effect is different to the disciplining role of competition among suppliers which we identify in Section 3 of this paper. On the role of bargaining coalitions (e.g., in the form of mergers) in hold-up problems see also Segal and Whinston (2000a) and Heavner (1999).

below. Second, we assume that demand at the M outlets is symmetric, and that demand at each is symmetric across goods. Hence, a single function $p(x, x')$ denotes the price prevailing for some good $n \in N$ at an outlet $m \in M$ if the supplied quantities are given by $x = x_{n,m}$ and $x' = x_{n',m}$, for $n' \neq n$. We denote first derivatives by the respective subscripts $p_1(x, x') \equiv \partial p(x, x')/\partial x$ and $p_2(x, x') \equiv \partial p(x, x')/\partial x'$.

We make the standard assumptions that $p_1 < 0$ (over the relevant range; i.e., where prices are strictly positive), while the direct effect shall exceed the indirect effect as $|p_1| > |p_2|$. Note that this assumption excludes the case where goods are perfect substitutes. The considered goods may be either substitutes or complements.

Each supplier incurs production costs $K_n(x)$. While the suppliers' cost functions may differ, we assume that they both exhibit either (weakly) increasing or decreasing unit costs for all output levels.[10] For simplicity, we assume that the retail technology converts each unit of the manufacturers' products into one unit of the final good at a zero marginal cost.

So far we have treated each supplier separately. In the following, we will distinguish four market structures where suppliers or retailers can be integrated.[11] We denote a market structure by $\omega = (s, r)$, where s stands for the number of suppliers and r stands for the number of retailers, with $s, r \in \{1, 2\}$. As demand at the two outlets is independent, we will show that mergers have no impact on supplied quantities. While market structure, therefore, has no impact on welfare, it will determine the parties' bargaining power and, thereby, the distribution of rents.

2.2 Bargaining if Both Sides are Non-Integrated

We start by considering the case where both suppliers and retailers are non-integrated; i.e., $\omega = (2, 2)$. In this framework we introduce our concept of a bargaining equilibrium. We then proceed to derive equilibrium quantities and transfers. In Section 2.3 we extend the solution concept to the remaining three market structures where at least one side is integrated.

We consider a bilateral bargaining game in which each supplier negotiates with each retailer simultaneously and separately. Each bilateral bargain between supplier n and retailer m determines a contract $(x_{n,m}, v_{n,m})$, where $x_{n,m} \geq 0$ is the delivery of product n

[10] This symmetry assumption may be justified as both producers belong to the same industry.

[11] For the purpose of this paper it is sufficient to consider only the possibility of horizontal mergers. Moreover, in our context, it can be shown that it is sufficient to allow only for integration and non-integration; i.e., to exclude more general forms of (contractual) arrangements as discussed in Segal (1999).

to retailer m and $v_{n,m}$ is retailer m's payment to supplier n.[12] We denote the respective equilibrium choice by $x^*_{n,m}$. We now invoke two essential assumptions regarding the bargaining process. First, in all simultaneous negotiations between supplier $n \in N$ and retailer $m \in M$, both parties believe that all other bilateral agreements settle at the equilibrium quantities. Second, the two parties engage in efficient bargaining, so that the chosen quantity, $x^*_{n,m}$, maximizes the incremental surplus of that agreement, and the agreed transfer, $v^*_{n,m}$, splits the incremental surplus equally. Summing up, our equilibrium concept combines efficient bargaining in a single bilateral relation with a simultaneous Nash equilibrium approach over all relations.[13]

By efficient bargaining, the quantity $x_{n,m}$ is now chosen to maximize the incremental joint surplus

$$x_{n,m}p(x_{n,m}, x^*_{n',m}) + x^*_{n',m}p(x^*_{n',m}, x_{n,m}) - K_n(x_{n,m} + x^*_{n,m'}), \tag{1}$$

where $x^*_{n',m}$ denotes the (equilibrium) quantity of the other good n' supplied at the same outlet m, while $x^*_{n,m'}$ denotes the (equilibrium) quantity of the same good n supplied at the other outlet m'.

Suppose now that all supplied quantities are positive in equilibrium. Below we will show that this is implied by excluding perfect substitutes and by making an additional assumption which ensures that it is indeed efficient to produce both goods. In this case the first-order approach applies, so that the equilibrium quantity $x^*_{n,m}$ solves the first-order condition

$$x^*_{n,m}p_1(x^*_{n,m}, x^*_{n',m}) + p(x^*_{n,m}, x^*_{n',m}) + x^*_{n',m}p_2(x^*_{n',m}, x^*_{n,m}) - K'_n(x^*_{n,m} + x^*_{n,m'}) = 0, \tag{2}$$

for all $n \in N$ and $m \in M$, where $K'_n(\cdot) \equiv \partial K_n(\cdot)/\partial x_{n,m}$. We posit that the incremental joint surplus is strictly quasi-concave and bounded, so that the solution to (2) is unique.

As demand is symmetric, we immediately obtain that $x^*_{n,m} = x^*_{n,m'}$ for $n \in N$. It is thus convenient to abbreviate in what follows $x^*_{n,1} = x^*_{n,2} = x^*_n$. Observe finally that the conditions for x^*_n imply that the equilibrium quantities uniquely maximize the industry

[12] In the models of Horn and Wolinsky (1988a), von Ungern-Sternberg (1996), and Dobson and Waterson (1997) the input supplier and the retailer bargain about a constant price per unit. As a consequence, utility is not perfectly transferable between the parties and leads to inefficiencies because of double-marginalization. Note also that our specification of the supply contract in intermediate goods markets includes general forms of non-linear pricing schemes.

[13] While our approach adopts the axiomatic Nash-solution, we may also think of this outcome as the limit of a perfect Bayesian equilibrium of an alternating-offers bargaining game à la Rubinstein (1982) in which the probability that negotiations break down goes to zero (see also Binmore et al. (1986)). Players are supposed to hold "passive" beliefs regarding the outcome in all other negotiations (see on this point also McAfee and Schwartz (1994) and, more recently, Segal and Whinston (2000b)).

profits[14]

$$2 \sum_{n \in N, n' \neq n} x_n^* p(x_n^*, x_{n'}^*) - \sum_{n \in N} K_n(2x_n^*). \tag{3}$$

We turn next to the derivation of transfers, for which we apply our assumption that the respective two parties split the surplus equally. We calculate first the additional surplus realized if bargaining between n and m is successful. In this case, the retailer's sales yield $x_n^* p(x_n^*, x_{n'}^*) + x_{n'}^* p(x_{n'}^*, x_n^*)$, while the producer's costs equal $K_n(2x_n^*)$. Suppose now bargaining between n and m breaks down. Since in this case all other contracts remain in force and are not renegotiated by assumption, the supplier's costs reduce to $K_n(x_n^*)$, while sales revenue at m are now equal to $x_{n'}^* p(x_{n'}^*, 0)$.[15] Summing up, the additional surplus realized from an agreement between supplier n and outlet m is given by

$$x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^* \left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*) \right] - \left[K_n(2x_n^*) - K_n(x_n^*) \right].$$

Observe that this expression contains three elements: (i) The additional revenue from offering the good n at the outlet, which is equal to $x_n^* p(x_n^*, x_{n'}^*)$, (ii) the impact on the price of good $n' \neq n$ offered at the same outlet, which is equal to $-x_{n'}^* \left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*) \right]$, and (iii) the additional costs $K_n(2x_n^*) - K_n(x_n^*)$ incurred by supplier n.

As the surplus is split equally by assumption, the unique equilibrium transfer from any outlet m to supplier n, which is denoted by $v_n^*(\omega)$, becomes

$$v_n^*(2,2) = \frac{1}{2} \left[x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^* \left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*) \right] \right] + \frac{1}{2} \left[K_n(2x_n^*) - K_n(x_n^*) \right]. \tag{4}$$

As a last step, we calculate the equilibrium payoffs of retailers, $R_n^*(\omega)$, and suppliers, $S_m^*(\omega)$, for $\omega = (2,2)$. If retailers and producers remain non-integrated, each (symmetric) retailer realizes the payoff $R_m^*(2,2)$ which is given by

$$R_m^*(2,2) = \frac{1}{2} \sum_{n \in N, n' \neq n} \left[x_n^* p(x_n^*, x_{n'}^*) + x_{n'}^* \left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*) \right] \right] - \frac{1}{2} \sum_{n \in N} \left[K_n(2x_n^*) - K_n(x_n^*) \right],$$

[14] Below we will show that this property implies that the choice of output levels is independent of the market structure.

[15] We feel that it is reasonable to exclude renegotiations with all remaining retailers and suppliers (and the follow-up renegotiations between all market participants based on these changes) if the duration of these contracts is not too extensive. Moreover, this assumption is similarly invoked in Horn and Wolinsky (1988a). While Horn and Wolinsky (1988b) develop an extensive form game, they assume that the size of each group of workers is fixed.

while supplier n realizes

$$S_n^*(2,2) = x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^* \left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*)\right] - K_n(x_n^*). \tag{5}$$

We postpone an interpretation of transfers and payoffs until Section 2.3 where we allow for mergers among retailers and suppliers.

We can now summarize results for the fully dispersed case, $\omega = (2,2)$. Recall that we have so far assumed that all $x_{n,m}^*$, for $n \in N$ and $m \in M$, are positive. In the following lemma we prove that this is implied by ruling out perfect substitutability of both products. Moreover, we derive conditions which ensure that both goods are indeed supplied; i.e., that there exists no producer n with $x_{n,1}^* = x_{n,2}^* = 0$. Intuitively, such corner solutions may only occur if one production technology is sufficiently more efficient or if, in case of symmetry, cost functions are sufficiently concave, e.g., due to the presence of high fixed costs. Moreover, this is surely less likely if goods are poor substitutes.

Lemma 1. *If both sides are non-integrated, $\omega = (2,2)$, there exists a unique equilibrium. Equilibrium quantities are chosen to maximize (3), while transfers and payoffs are derived by (4)-(5).*

Proof. See Appendix.

2.3 Bargaining under Market Structures with Integration

We now discuss market structures where at least one side becomes integrated. We can immediately extend our concept of a bargaining equilibrium to these cases. For instance, if suppliers are integrated, the single merged supplier bargains with each retailer m over the supply levels of both goods $x_{n,m}^*$, for $n \in N$, and the respective transfers $v_{n,m}^*$, for $n \in N$. The quantities $x_{n,m'}^*$, with $n \in N$, supplied to the other retailer $m' \neq m$ are taken as given by both parties. Again, we assume efficient bargaining and that the surplus is split equally.

We start by deriving equilibrium quantities which are shown to be identical regardless of the market structure. Take again the case where only suppliers are integrated. When bargaining with retailer m, the quantities $x_{n,m}^*$ and $x_{n',m}^*$ are chosen to maximize the joint surplus

$$\sum_{n \in N, n' \neq n} \left[x_{n,m} p(x_{n,m}, x_{n',m}) + x_{n',m} p(x_{n',m}, x_{n,m})\right] - \sum_{n \in N} K_n(x_{n,m} + x_{n,m'}^*),$$

where the supplied quantities for the other retailer $m' \neq m$ is again taken to be fixed. By inspection, the respective equilibrium quantities are identical to those derived under full dispersion; i.e., they maximize the aggregate surplus (3). The same procedure can now be applied to the remaining cases where only retailers are integrated and where both sides are integrated. We have thus derived the following result.[16]

Lemma 2. *Equilibrium supply levels* $x^*_{n,m}$*, with* $n \in N$ *and* $m \in M$*, are independent of the market structure,* ω*, with* $\omega = (s, r)$*, for* $s, r \in \{1, 2\}$*.*

By Lemma 2 market structure does not affect welfare. At any interior optimum, marginal revenues from sales of product n are equal to the marginal cost of producing the product. This result hinges crucially on our assumption that demand at the different outlets is independent. Otherwise, integration would result in a welfare loss due to monopolization. As discussed above, we abstract from the well-documented monopolization effect of mergers in order to focus on the impact on bargaining power. Moreover, in Section 3 we analyze technology choice which will imply that market structure has indeed welfare implications.

In complete analogy to the non-integrated case analyzed in Section 2.2, we proceed next to the determination of transfers under the various market structures. Consider the case $\omega = (1, 2)$, where only suppliers are integrated. If the merged supplier bargains with any of the two symmetric outlets, the additional surplus equals

$$\sum_{n \in N, n' \neq n} x^*_n p(x^*_n, x^*_{n'}) - 2 \sum_{n \in N} \left[K_n(2x^*_n) - K_n(x^*_n)\right].$$

As the supplier is integrated, we can sum-up the two transfers received for the supply of goods $n \in N$. The aggregate transfer received from any of the two outlets $m \in M$ is given by

$$\sum_{n \in N} v^*_n(1, 2) = \frac{1}{2} \left[\sum_{n \in N, n' \neq n} x^*_n p(x^*_n, x^*_{n'}) + \sum_{n \in N} \left[K_n(2x^*_n) - K_n(x^*_n)\right] \right]. \tag{6}$$

Finally, we obtain for each retailer $m \in M$ the payoff

$$R^*_m(1, 2) = \frac{1}{2} \left[\sum_{n \in N, n' \neq n} x^*_n p(x^*_n, x^*_{n'}) - \sum_{n \in N} \left[K_n(2x^*_n) - K_n(x^*_n)\right] \right],$$

while the integrated supplier realizes

$$S^*(1, 2) = \sum_{n \in N} S^*_n(1, 2) = \sum_{n \in N, n' \neq n} x^*_n p(x^*_n, x^*_{n'}) - \sum_{n \in N} K_n(x^*_n).$$

[16] To be precise, as in the proof of Lemma 1 we must again invoke conditions which ensure that there exists indeed a unique equilibrium where both goods are supplied. See also the proof of Proposition 3 where these conditions are made explicit for a linear example.

It is now instructive to compare the difference in transfers and payoffs before and after an upstream merger. If suppliers are integrated, we find by comparison of (4) with (6) that the difference of aggregate transfers under integration and non-integration equals

$$\sum_{n\in N, n'\neq n} x_n^* \left[p(x_{n'}^*, x_n^*) - p(x_{n'}^*, 0)\right].$$

If goods are substitutes, this difference is strictly positive, implying that the aggregate transfer and thus the payoff of suppliers strictly increases by an upstream merger.[17] The intuition for this result is the following. Observe that in the non-integrated case a retailer can "claim" in the negotiations with *both* suppliers that their respective product comes *in addition* to the supply made by the other producer. The resulting negative impact on the price of the other good is thus shared by both sides. Observe that this argument is valid if either demand is inelastic or if an outlet is only procured from a single producer, which, however, never arises in equilibrium as goods are by assumption at least marginally differentiated. In essence, bargaining between n and m in the non-integrated case is thus only over the "marginal" surplus obtained from adding the respective product. In contrast, integration gives suppliers a hold on inframarginal rents.[18] If goods are complements, transfers decrease after a merger. Indeed, by $p(x_{n'}^*, x_n^*) - p(x_{n'}^*, 0) < 0$, the previous argument for substitutes is completely reversed.

Consider next the market structure $\omega = (2,1)$, where suppliers are non-integrated and face a single integrated retailer. If the merged retailer bargains with supplier n, the bargaining surplus is given by

$$2\left[x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^*\left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*)\right]\right] - K_n(2x_n^*).$$

Using again the notation developed in the previous section, the aggregate transfer payed by the integrated retailer to supplier $n \in N$ equals

$$2v_n^*(2,1) = x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^*\left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*)\right] + \frac{1}{2}K_n(2x_n^*), \tag{7}$$

which yields for the integrated retailer the aggregate payoff

$$R^*(2,1) = \sum_{n\in N, n'\neq n} \left[x_n^* p(x_n^*, x_{n'}^*) + x_{n'}^*\left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*)\right]\right] - \frac{1}{2}\sum_{n\in N} K_n(2x_n^*).$$

The supplier n realizes the payoff

$$S_n^*(2,1) = x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^*\left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*)\right] - \frac{1}{2}K_n(2x_n^*).$$

[17] Note that comparison of aggregate suppliers' payoffs is equivalent to the comparison of aggregate transfers because aggregate costs are independent of the market structure.

[18] In a strict sense of the words this only holds if there is a continuum of retailers.

In analogy to the case of upstream integration, we compare again transfers and payoffs before and after downstream integration. By comparison of (7) with (4) aggregate transfers made by both retailers are lower *after* a downstream merger if and only if

$$\sum_{n\in N} K_n(2x_n^*) > 2\sum_{n\in N} K_n(x_n^*). \tag{8}$$

Recall now our assumption that *both* technologies at $n \in N$ exhibit either increasing or decreasing unit costs. In case unit costs are strictly increasing, condition (8) holds, while decreasing unit costs imply the inverse relation. Loosely speaking, if retailers are non-integrated, a given supplier n can always argue that his supply quantity to some retailer m comes "on top" of the supply to the other retailer $m' \neq m$. In contrast, if retailers are merged, the single retailer bargains with a given supplier n over his entire production $2x_n^*$. When unit production costs are increasing this effect gives retailers clear incentives to merge.[19]

Finally, we consider the case of a bilateral monopoly, $\omega = (1,1)$, where both sides are integrated. We can immediately derive the aggregate transfer by

$$2\sum_{n\in N} v_n^*(1,1) = \sum_{n\in N, n'\neq n} x_n^* p(x_n^*, x_{n'}^*) + \frac{1}{2}\sum_{n\in N} K_n(2x_n^*),$$

which yields the aggregate payoffs for the retailer, $R^*(1,1)$, and the supplier, $S_n^*(1,1)$,

$$R^*(1,1) = S^*(1,1) = \sum_{n\in N, n'\neq n} x_n^* p(x_n^*, x_{n'}^*) - \frac{1}{2}\sum_{n\in N} K_n(2x_n^*).$$

Given that the other market side is monopolized, comparison of retailers' and suppliers' profits before and after a merger yields the same conditions as derived above. This means that the profitability of a horizontal merger is independent of the structure of the other market side. We will use this property when we derive the equilibrium market structure. At this point, let us now summarize our results. To save space, we confine ourselves to re-stating aggregate transfers in the following proposition.

Proposition 1. *Equilibrium quantities and transfers are uniquely determined under the four market structures, $\omega = (s,r)$, with $s, r \in \{1,2\}$. While quantities are independent of the choice of market structure, the sum of transfers from retailers to suppliers depends on the market structure as follows:*

(i) Non-integration, $\omega = (2,2)$:

$$2\sum_{n\in N} v_n^*(2,2) = \sum_{\substack{n\in N,\\ n'\neq n}} \left[x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^* \left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*)\right]\right] + \sum_{n\in N} \left[K_n(2x_n^*) - K_n(x_n^*)\right].$$

[19] We have more to say on the shape of cost functions when applying our results to the analysis of technology choice. In particular, we will become more explicit on the role of fixed costs.

(ii) Upstream merger, $\omega = (1,2)$:

$$2\sum_{n\in N} v_n^*(1,2) = \sum_{n\in N, n'\neq n} x_n^* p(x_n^*, x_{n'}^*) + \sum_{n\in N} \left[K_n(2x_n^*) - K_n(x_n^*)\right].$$

(iii) Downstream merger, $\omega = (2,1)$:

$$2\sum_{n\in N} v_n^*(2,1) = \sum_{n\in N, n'\neq n} \left[x_n^* p(x_n^*, x_{n'}^*) - x_{n'}^* \left[p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*)\right]\right] + \frac{1}{2}\sum_{n\in N} K_n(2x_n^*).$$

(iv) Bilateral monopoly, $\omega = (1,1)$:

$$2\sum_{n\in N} v_n^*(1,1) = \sum_{n\in N, n'\neq n} x_n^* p(x_n^*, x_{n'}^*) + \frac{1}{2}\sum_{n\in N} K_n(2x_n^*).$$

2.4 Equilibrium Market Structure

Proposition 1 allows us now to determine the equilibrium market structure. For the limited purpose of this paper we refrain from deriving a particular game form of how mergers are formed (see, e.g., Bloch (1995)). Instead, we impose the following two conditions. First, we only allow for horizontal mergers. Second, a market structure is an equilibrium if the joint profits of participants on either side of the market does not increase if they change their respective market structure (while, of course, the structure on the other side remains unchanged).[20] Proposition 1 and the explicit derivation of payoffs in Sections 2.2 and 2.3 yield the following predictions.

Proposition 2. *There always exists a unique equilibrium market structure $\omega^* = (s,r)$, for $s, r \in \{1,2\}$, with the following characteristics:*[21]

(i) If goods are substitutes and unit costs are decreasing, only suppliers merge and the equilibrium market structure is $\omega^* = (1,2)$.

(ii) If goods are substitutes and unit costs are increasing, both market sides become integrated and the equilibrium market structure is $\omega^* = (1,1)$.

(iii) If goods are complements and unit costs are decreasing, both market sides remain non-integrated and the equilibrium market structure is $\omega^* = (2,2)$.

(iv) If goods are complements and unit costs are increasing, only retailers merge and the equilibrium market structure is $\omega^* = (2,1)$.

Proof. Since equilibrium output levels are independent of the market structure by Lemma 2, aggregate production costs and aggregate revenues are the same for all

[20] For a precise formulation, see e.g., Selten (1973).

[21] Strictly speaking, a sufficient condition for uniqueness of the market structure is strict monotonicity of unit costs and that demand of the N goods (at each retailer) is not independent.

$\omega = (s, r)$, with $s, r \in \{1, 2\}$. Independently of whether retailers are integrated or not, suppliers (strictly) prefer to merge if and only if $2\sum_{n\in N} v_n^*(1, r) > 2\sum_{n\in N} v_n^*(2, r)$, for $r \in \{1, 2\}$, which holds if $\sum_{n\in N, n'\neq n} [x_{n'}^*(p(x_{n'}^*, 0) - p(x_{n'}^*, x_n^*))] < 0$; i.e., whenever both products are substitutes. Accordingly, retailers (strictly) prefer to merge if and only if $2\sum_{n\in N} v_n^*(s, 1) < 2\sum_{n\in N} v_n^*(s, 2)$, for $s \in \{1, 2\}$, which is fulfilled if $\sum_{n\in N} K_n(2x_n^*) > 2\sum_{n\in N} K_n(x_n^*)$; i.e., whenever both production technologies exhibit increasing unit costs. This gives the equilibrium market structures as stated in the proposition. **Q.E.D.**

3 Market Structure and Technology Choice

We now investigate how market structure affects suppliers' technology choice. In particular, we want to isolate the following two effects which will be subsequently illustrated in an example for the case in which demand is linear and suppliers' incur positive fixed costs and have constant-marginal cost production technologies. First, if suppliers face non-integrated retailers they are more prepared to trade off "inframarginal" cost savings with higher costs "at the margin". Second, the incentives for choosing a technology with lower "inframarginal" cost and higher costs "at the margin" is mitigated by competition between non-integrated suppliers.

Consider the following problem of technology choice. Suppose one supplier, say $n = 1$, can choose between two technologies indexed by $i \in I = \{A, B\}$. The supplier must make his choice before contracting with retailers. We denote the respective cost functions by $K_1^i(x)$. If technology i has been chosen by supplier 1, we denote the unique equilibrium quantities by $x_n^{*,i}$. Technologies A and B differ as follows. While technology B implies cost reductions at "inframarginal" production levels (i.e., at the lower end), technology A implies cost reductions "at the margin" (i.e., at the higher end). One particular constellation would be that the difference $\Delta K_1(x) = K_1^B(x) - K_1^A(x)$ is strictly increasing, with $\Delta K_1(x = 0) < 0$.

3.1 Determinants of Technology Choice

To provide a benchmark, suppose first that both sides of the market are integrated; i.e., $\omega = (1, 1)$. By Proposition 1, the integrated supplier chooses $i \in I$ to maximize

$$S^{*,i}(1,1) = \sum_{n\in N, n'\neq n} x_n^{*,i} p(x_n^{*,i}, x_{n'}^{*,i}) - \frac{1}{2}\left[K_1^i(2x_1^{*,i}) + K_2(2x_2^{*,i})\right], \tag{9}$$

which is exactly half the industry profit. Hence, the monopolistic supplier behaves like a fully integrated firm (horizontally and vertically). We next compare (9) with the objective function when retailers are non-integrated. In a second step, we will then also separate suppliers.

The Effect of Downstream Non-Integration

Suppose that suppliers remain merged, while retailers are now non-integrated. For $\omega = (1,2)$, the aggregate payoff of the monopolistic supplier when choosing technology $i \in I$ is given by

$$S^{*,i}(1,2) = \sum_{n \in N, n' \neq n} x_n^{*,i} p(x_n^{*,i}, x_{n'}^{*,i}) - K_1^i(x_1^{*,i}) - K_2(x_2^{*,i}). \tag{10}$$

It is instructive to suppose first that the equilibrium output levels do *not* change when switching technologies; i.e., $x_n^{*,A} = x_n^{*,B}$, with $n \in N$. For an illustration, assume that the supplier can choose between the two cost functions depicted in Figure 1.

Figure 1 goes here!

If retailers are non-integrated, the supplier receives from each individual retailer his cost share $\frac{1}{2}\left[K_1^i(2x_1^{*,i}) - K_1^i(x_1^{*,i})\right]$. This leaves the supplier with the residual costs $K_1^i(x_1^{*,i})$, which he has to bear alone. Thus, compared with the benchmark of bilateral integration, a switch to downstream non-integration implies that the (integrated) supplier now focuses disproportionately on inframarginal cost savings. Hence, in our terminology this makes the supplier more inclined to prefer technology B to technology A in case retailers are non-integrated. Clearly, this effect will still be important even if equilibrium quantities vary depending on the choice of technology.

The Effect of Upstream Non-Integration

We next compare (10) with the objective function of a non-integrated supplier. We will furthermore assume that goods are substitutes. We argue that the previously identified bias towards adoption of technology B if retailers are non-integrated can be mitigated by competition between non-integrated suppliers. By Proposition 1, supplier 1 chooses $i \in I$ to maximize

$$S_1^{*,i}(2,2) = x_1^{*,i} p(x_1^{*,i}, x_2^{*,i}) - x_2^{*,i}\left[p(x_2^{*,i}, 0) - p(x_2^{*,i}, x_1^{*,i})\right] - K_1^i(x_1^{*,i}). \tag{11}$$

If we compare (11) with (10), we observe two differences. First, the term $x_2^{*,i}[p(x_2^{*,i}, 0) - p(x_2^{*,i}, x_1^{*,i})]$ is absent under integration.[22] Ignoring this difference for a moment, the

[22] Indeed, recall from Section 2.3 that suppliers incentives to merge are determined by this term. While in this case suppliers should merge in equilibrium, we regard our analysis of all possible market structures as relevant. First, it serves to isolate an effect which should still prevail in more general settings. Second, an upstream merger might not be profitable due to transaction costs or it might be blocked by a restrictive antitrust policy if demand at the two outlets is not independent.

objective function of the integrated supplier contains also his share of the revenue realized with product $n = 2$. Recall now that we assumed that goods are substitutes, while technology A implies more cost savings "at the margin". It is therefore reasonable to assume that $x_1^{*,A} > x_1^{*,B}$ holds, which implies $x_2^{*,A} < x_2^{*,B}$. While the integrated supplier reaps some benefits of the shift in supply from good 1 to good 2, this is not captured by the non-integrated supplier. With a slight abuse of language, we may say that the integrated supplier internalizes the effects of the shift of demand, while this is not the case when suppliers are not integrated. Hence, inframarginal cost savings under technology B at the expense of higher costs "at the margin" becomes relatively less attractive for a non-integrated supplier.[23] Having said this, it still remains to sign the so far neglected term $x_2^{*,i}[p(x_2^{*,i}, 0) - p(x_2^{*,i}, x_1^{*,i})]$. Depending on the particular choice of the demand function, this expression may be higher or lower under either technology. This prevents us from obtaining clear-cut results at this level of generality.

To obtain further results and to explore how market structure affects technology choice, and hence, welfare, we now specialize to the case of linear demand and constant-marginal-costs production technologies with positive fixed costs.

3.2 Example

We consider the example of two differentiated products which are substitutes. Initially, both goods are produced with the same technology A, where $K_n^A(x) = F^A + k^A x$, for $n \in N$, with $F^A > 0$ and $k^A \leq 0$. Before bargaining starts, the supplier in control of $n = 1$ can switch costlessly to the technology B, where $K_1^B(x) = F^B + k^B x$. We posit that technology B has lower fixed but higher (constant) marginal costs; i.e., it holds that $0 \leq k^A < k^B < 1$ and $0 \leq F^B < F^A$. It is convenient to denote $\Delta_F = F^A - F^B$ and $\Delta_k = k^B - k^A$. Below we will derive restrictions on k^A, F^A, Δ_k, and Δ_F such that both products are supplied under both technology choices. Observe that the difference $K_1^B(x) - K_1^A(x)$ is strictly increasing in x and strictly negative at $x = 0$. The utility of a representative consumer purchasing at outlet $m \in M$ the quantities $x_{n,m}$ at prices $p_{n,m}$, with $n \in N$, is given by $u(x_{1,m}, x_{2,m}) - p_{1,m}x_{1,m} - p_{2,m}x_{2,m}$, where we assume that

$$u(x_{1,m}, x_{2,m}) = x_{1,m} + x_{2,m} - \frac{1}{2}\left(x_{1,m}^2 + x_{2,m}^2 + 2cx_{1,m}x_{2,m}\right).$$

As is well-known, this gives rise to a linear demand function, where c measures the degree of substitutability. Precisely, over the relevant range of quantities the inverse

[23] Of course, when goods are complements this effect works in the opposite direction. The integrated supplier internalizes the negative externality caused by the adoption of technology B, what would make him comparatively less inclined to trade off lower "inframarginal" costs with higher costs "at the margin".

demand function for the supply of $x_{n,m}$ is given by $p_{n,m} = 1 - x_{n,m} - cx_{n',m}$, with $n' \neq n$ and $0 \leq c < 1$.

We now proceed as follows. First, we follow Section 3.1 and analyze how market structure affects the equilibrium choice of technology. Observe that technology B trades off a decrease in fixed costs with higher (constant) marginal costs. By exploring the two effects isolated in Section 3.1, we show that integrating suppliers and separating retailers unambiguously shifts incentives towards choosing technology $i = B$. In a second step we consider whether the respective choice is efficient under two different benchmarks: industry profits and social welfare.

We start by deriving the equilibrium quantities $x_n^{*,i}$, which by Lemma 2 are independent of the market structure and maximize total industry profits. We obtain the first-order conditions

$$\begin{aligned} 1 - 2x_1^{*,i} - 2cx_2^{*,i} - k^i &= 0, \\ 1 - 2x_2^{*,i} - 2cx_2^{*,i} - k^A &= 0. \end{aligned}$$

Substitution yields the respective equilibrium quantities

$$x_1^{*,A} = x_2^{*,A} = \frac{1 - k^A}{2(1+c)}, \tag{12}$$

when product 1 is produced with technology A and

$$x_1^{*,B} = \frac{(1-c)(1-k^A) - \Delta_k}{2(1-c^2)},\ x_2^{*,B} = \frac{(1-c)(1-k^A) + c\Delta_k}{2(1-c^2)}, \tag{13}$$

when product 1 is produced with technology B. To derive the equilibrium payoffs of the suppliers, these expressions can now be ploughed back into the respective payoff equations derived in Sections 2.1 to 2.3. This allows us to determine how the equilibrium choice of technology depends on the underlying parameters. It is intuitive that for given market structure ω and fixed values of k^A, F^A, and (sufficiently small) Δ_k, technology B is only chosen if the decrease in fixed costs Δ_F is sufficiently large. Precisely, for any market structure ω, we can determine a threshold Δ_F^ω such that $i = B$ is chosen if and only if $\Delta_F \geq \Delta_F^\omega$. These thresholds can be used to compare how the trade-off between fixed and marginal costs is resolved under the different market structures.

To make our procedure well-understood, consider the case of $\omega = (1, 2)$. By Proposition 1, the payoffs of the upstream monopolist under technology $i \in I$ are given by

$$\begin{aligned} S^{*,A}(1,2) &= x_1^{*,A}p_1^{*,A} + x_2^{*,A}p_2^{*,A} - \left(F^A + kx_1^{*,A}\right) - \left(F^A + kx_2^{*,A}\right), \\ S^{*,B}(1,2) &= x_1^{*,B}p_1^{*,B} + x_2^{*,B}p_2^{*,B} - \left(F^A - \Delta_F + (k^A + \Delta_k)x_1^{*,B}\right) - \left(F^A + kx_2^{*,B}\right). \end{aligned}$$

Comparing these payoffs, we obtain the threshold

$$\Delta_F^{1,2} = \frac{\Delta_k}{4(1-c^2)}\left[2(1-c)(1-k^A) - \Delta_k\right].$$

We relegate the explicit statement of all other values Δ_F^{ω} to the appendix. Define next

$$\tilde{c} \equiv \frac{1-k^A-\Delta_k}{1-k^A}.$$

Clearly, by inspection of (12) and (13) the requirement $c < \tilde{c}$ is necessary to ensure that all supplied quantities are strictly positive. We thus restrict attention to these parameters.

Proposition 3. *In the example, the thresholds Δ_F^{ω} satisfy the following ordering:*

(i) $\Delta_F^{1,2} \leq \Delta_F^{2,2} < \Delta_F^{1,1} \leq \Delta_F^{2,1}$, if $c \in \left[0, \min\left\{\frac{1}{\sqrt{2}}, \tilde{c}\right\}\right)$, where $\Delta_F^{1,2} = \Delta_F^{2,2}$ and $\Delta_F^{1,1} = \Delta_F^{2,1}$ for $c = 0$, and

(ii) $\Delta_F^{1,2} < \Delta_F^{1,1} \leq \Delta_F^{2,2} < \Delta_F^{2,1}$, if $c \in \left[\frac{1}{\sqrt{2}}, \tilde{c}\right)$ and if $\tilde{c} > \frac{1}{\sqrt{2}}$ hold, where $\Delta_F^{2,2} = \Delta_F^{1,1}$ for $c = \frac{1}{\sqrt{2}}$.

Proof. See Appendix.

Proposition 3 confirms our arguments in Section 3.1. Clearly, market structure $\omega = (1,2)$ yields the strongest incentives to adopt technology B; i.e., to trade off a reduction in fixed costs with an increase in (constant) marginal costs. In particular, the respective threshold is strictly smaller than that under a bilateral monopoly $\Delta_F^{1,1}$. Recall now that, besides integrating retailers, we proposed in Section 3.1 another way how to reduce the incentives to adopt technology B if goods are substitutes: separation of suppliers. Indeed, by Proposition 3 we can see that $\Delta_F^{2,r} > \Delta_F^{1,r}$ holds regardless of the choice of $r \in \{1,2\}$. Finally, as a consequence of *both* effects, we obtain that $\omega = (2,1)$ yields the lowest incentives to adopt technology B.

It is also instructive to compare the two cases in Proposition 3. If c is sufficiently high, the ordering of $\Delta_F^{2,2}$ and $\Delta_F^{1,1}$ is changed. Intuitively, if goods become closer substitutes, the second (competition) effect isolated in Section 3.1 becomes more pronounced. As a consequence, a non-integrated supplier becomes less inclined to adopt technology B, so that the respective threshold of $\Delta_F^{2,2}$ may become larger than $\Delta_F^{1,1}$.

We compare next the respective technology choices with two benchmarks of efficiency. Consider first industry profits. By our previous arguments in Section 3.1 we know that the technology choice under a bilateral monopoly, $\omega = (1,1)$, maximizes aggregate profits. Inspection of Proposition 3 reveals that, compared to this benchmark, the incentives to adopt technology B are always higher for $\omega = (1,2)$ and lower for $\omega = (2,1)$. Regarding a comparison of $\omega = (1,1)$ with $\omega = (2,2)$, the results are generally ambiguous as the two isolated effects work now in opposite direction. These remarks give rise to the following corollary to Proposition 3.

Corollary 1. *In the example the following results hold regarding industry profits:*

(i) If $\Delta_F \in \left(\Delta_F^{1,2}, \Delta_F^{1,1}\right)$*, then industry profits are strictly higher under* $\omega = (1,1)$ *than under* $\omega = (1,2)$*.*

(ii) If $\Delta_F \in \left(\Delta_F^{1,1}, \Delta_F^{2,1}\right)$*, then industry profits are strictly higher under* $\omega = (1,1)$ *than under* $\omega = (2,1)$*.*

We come next to a comparison of welfare (the sum of industry profits and consumer surplus). Precisely, we have now in mind the picture of a social planer who can prescribe market structure but neither directly the choice of technology nor that of individual outputs. As the supplied quantities are by Lemma 2 independent of the market structure, the planer is thus only concerned with the impact of market structure on technology choice. By substituting equilibrium quantities from (12), we can determine welfare under the two technologies. This yields again a unique threshold on the differential of fixed costs Δ_F, which is now denoted by Δ_F^W. Hence, the choice $i = B$ maximizes welfare if and only if $\Delta_F \geq \Delta_F^W$. To determine whether a given market structure maximizes welfare, it thus remains to compare Δ_F^W with the respective thresholds derived in Proposition 3. We obtain the following results.

Proposition 4. *In the example, the welfare threshold* Δ_F^W *and the threshold values under the different market structures* ω *satisfy the following ordering:*[24]

(i) $\Delta_F^{2,1} < \Delta_F^W$*, if* $c \in \left[0, \min\left\{\frac{1}{\sqrt{3}}, \tilde{c}\right\}\right)$*,*

(ii) $\Delta_F^{1,1} < \Delta_F^W \leq \Delta_F^{2,1}$*, if* $c \in \left[\frac{1}{\sqrt{3}}, \min\left\{\frac{1}{\sqrt{2}}, \tilde{c}\right\}\right)$ *and if* $\widetilde{c} > \frac{1}{\sqrt{3}}$*,*

(iii) $\Delta_F^{2,2} < \Delta_F^W < \Delta_F^{2,1}$*, if* $c \in \left[\frac{1}{\sqrt{2}}, \min\left\{\sqrt{\frac{2}{3}}, \tilde{c}\right\}\right)$ *and if* $\widetilde{c} > \frac{1}{\sqrt{2}}$*, and*

(iv) $\Delta_F^{1,1} < \Delta_F^W \leq \Delta_F^{2,2}$*, if* $c \in \left[\sqrt{\frac{2}{3}}, \tilde{c}\right)$ *and if* $\widetilde{c} > \sqrt{\frac{2}{3}}$*.*

Proof. Social welfare is given by $W^i = \sum_{m \in M} u(x_{1,m}^{*,i}, x_{2,m}^{*,i}) - K_1^i(2x_1^{*,i}) - K_2(2x_2^{*,i})$, with $i \in I$. For $i = A$, equilibrium quantities are $x^{*,A} \equiv x_1^{*,A} = x_2^{*,A}$ and we obtain the social welfare value

$$\begin{aligned} W^A &= 2[2x^{*,A} - \frac{1}{2}(2(x^{*,A})^2 + 2c(x^{*,A})^2)] - 2F^A - 4k^A x^{*,A} \\ &= \frac{3\left(1-k^A\right)^2}{2(1+c)} - 2F^A. \end{aligned}$$

Accordingly, for $i = B$, equilibrium output levels are $x_1^{*,B}$ and $x_2^{*,B}$ and the corresponding

[24]Observe that we only state the adjacent boundaries Δ_F^ω.

social welfare level is

$$W^B = 2(x_1^{*,B} + x_2^{*,B} - \frac{1}{2}((x_1^{*,B})^2 + (x_2^{*,B})^2 + 2cx_1^{*,B}x_2^{*,B}))$$
$$- (F^A - \Delta_F + 2(k^A + \Delta_k)x_1^{*,B}) - (F^A + 2k^A x_2^{*,B})$$
$$W^B = \frac{3}{4}\left(\frac{2(1-k^A-\Delta_k)(1-k^A)}{(1+c)} + \frac{(\Delta_k)^2}{(1-c^2)}\right) - 2F^A + \Delta_F.$$

By comparing W^A and W^B, we obtain the threshold value Δ_F^W for a welfare improving adoption of technology B

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

Comparison of the threshold values derived under the four market structures with Δ_F^W gives: $\Delta_F^W > \Delta_F^{1,1}$ and $\Delta_F^W > \Delta_F^{1,2}$ hold for all $c \geq 0$; $\Delta_F^W \leq \Delta_F^{2,2} \Leftrightarrow c \geq \sqrt{\frac{2}{3}}$ and $\Delta_F^W \leq \Delta_F^{2,1} \Leftrightarrow c \geq \sqrt{\frac{1}{3}}$. By using the results of Proposition 3, this gives the ordering stated in the proposition. **Q.E.D.**

Consider first the case of a bilateral monopoly, for which it holds by Proposition 4 that $\Delta_F^W > \Delta_F^{1,1}$ for all $c \geq 0$. Hence, from a welfare perspective the incentives to choose technology B are too high if both sides are integrated. To see why this is intuitive, recall first that under this market structure the choice of technology always maximizes total industry profits, which, however, neglects consumer rents. Moreover, equilibrium quantities are clearly below first-best levels. As technology A reduces marginal costs and, as can be confirmed by inspection of (12), increases total supply, it becomes (relatively) more attractive from a welfare perspective.

By Proposition 3, the suppliers bias towards choosing technology B becomes even more pronounced if retailers are separated. Conversely, incentives shift in the direction of technology A if suppliers become non-integrated. In analogy to Corollary 1, the precise choice of Δ_F determines now whether a change in the market structure has an effect on welfare and, if so, of which sign this effect is. To single out a particular case, assume that $\Delta_F = \Delta_F^W - \varepsilon$, where $\varepsilon > 0$ is chosen arbitrarily small. Hence, from a welfare perspective choosing technology $i = A$ would be optimal (though only slightly). We then obtain the following results from Propositions 3 and 4.

Corollary 2. *In the example, where $\Delta_F = \Delta_F^W - \varepsilon$, the following welfare results hold:*

(i) All market structures implement the inefficient technology $i = B$, if $c \in \left[0, \min\left\{\frac{1}{\sqrt{3}}, \tilde{c}\right\}\right)$.

(ii) Only market structure $\omega = (2,1)$ implements the efficient technology $i = A$, if $c \in \left[\frac{1}{\sqrt{3}}, \min\left\{\sqrt{\frac{2}{3}}, \tilde{c}\right\}\right)$ *and if* $\tilde{c} > \frac{1}{\sqrt{3}}$.

(iii) Only market structures $\omega = (2,1)$ *and* $\omega = (2,2)$ *implement the efficient technology* $i = A$*, if* $c \in \left[\sqrt{\frac{2}{3}}, \tilde{c}\right)$ *and if* $\widetilde{c} > \sqrt{\frac{2}{3}}$.

4 Conclusion

We determine the equilibrium market structure in intermediary goods markets in a novel way. Our basic point is that a horizontal merger by one side of the market can facilitate the transfer of inframarginal rents from the other side of the market by strengthening the integrated firm's bargaining power. As we exclude monopolization effects of mergers, we are able to derive clear-cut results. Our model predicts upstream firms to merge if goods, which are supplied to retailers, are substitutes, while with complements suppliers prefer to stay non-integrated. If suppliers' cost functions exhibit increasing unit costs, we predict that retailers merge, while with decreasing unit cost retailers prefer to stay non-integrated.

Building on these results we show that market structure affects the technology choice of a supplier. In particular, we show that a supplier facing non-integrated retailers can increase its surplus by trading off higher costs "at the margin" against lower costs at "inframarginal" production levels. We argue that this bias is strongest in industries with a monopolistic supplier facing non-integrated downstream firms, while it is mitigated by upstream competition and downstream integration.

The current analysis has several shortcomings. For expositional clarity we restricted attention to the case with symmetric demand functions. Moreover, as noted above, we assumed that retailers' demand is independent, what excludes monopolization effects due to mergers. These restrictions can be relaxed without changing the underlying framework. The same holds for increasing the number of market participants at either side. Moreover, allowing for entry would not only add more realism, but also introduce some interesting new effects. For instance, if suppliers face highly dispersed sellers and have increasing unit costs, bargaining "at the margin" of the cost function may allow them to extract excessive transfers; i.e., prices for the delivered goods which far outweigh marginal or even average costs. This may create incentives for (excessive) entry. Finally, one may consider the possibility of vertical integration. In our setting, where the choice of integration represented merely a zero-sum game due to the absence of a monopolization effect, this would not be a valuable option. If, however, demand at the outlets becomes dependent this may change.

Appendix

Proof of Lemma 1. Given the previous results, it remains to rule out the case where not all choices $x^*_{n,m}$ are strictly positive. Suppose first that both goods are produced in equilibrium; i.e., that $\sum_{m\in M} x^*_{n,m} > 0$ holds for all $n \in N$. We show by contradiction that this implies $x^*_{n,m} > 0$ for all $n \in N$, $m \in M$. Suppose first that each good n is only supplied to a single outlet m. Without loss of generality assume that $x^*_{1,2} = x^*_{2,1} = 0$. Consider now bargaining between suppliers $n = 1$ and retailer $m = 2$. By assumption, the efficient choice of supply is just zero, which implies in particular that

$$p(0, x^*_{1,1}) + p_2(x^*_{1,1}, 0)x^*_{1,1} - K'_2(x^*_{2,2}) \leq 0. \tag{14}$$

Analogously, it must hold for $n = 2$ and $m = 1$ that

$$p(0, x^*_{2,2}) + p_2(x^*_{2,2}, 0)x^*_{2,2} - K'_1(x^*_{1,1}) \leq 0. \tag{15}$$

On the other side, the first-order conditions for $n = 1$, $m = 1$ and for $n = 2$, $m = 2$ require that

$$p(x^*_{n,m}, 0) + p_1(x^*_{n,m}, 0)x^*_{n,m} - K'_n(x^*_{n,m}) = 0. \tag{16}$$

Summing up, (14)-(16) imply that

$$\begin{aligned} & p(0, x^*_{1,1}) - p(x^*_{1,1}, 0) + x^*_{1,1}\left[p_2(x^*_{1,1}, 0) - p_1(x^*_{1,1}, 0)\right] \\ \leq\ & p(x^*_{2,2}, 0) - p(0, x^*_{2,2}) + x^*_{2,2}\left[p_1(x^*_{2,2}, 0) - p_2(x^*_{2,2}, 0)\right]. \end{aligned} \tag{17}$$

Recall now that we assume that goods are not perfect substitutes. It thus follows that $p_1(x, x') < p_2(x, x')$ (as long as the price is still positive). This implies that the left-hand side of (17) is strictly positive, while the right-hand side becomes strictly negative, which yields a contradiction. Hence, we have rule out the case where $x^*_{1,2} = x^*_{2,1} = 0$. We can now argue analogously to contradict the cases where only one supply $x^*_{n,m}$ becomes zero.

It therefore remains to prove that both goods are indeed supplied in an equilibrium. In what follows we derive implicit conditions which ensure that this is the case. Suppose that $x^*_{n,m} = 0$ for some n and all $m \in M$. We derive first conditions which imply that in this case the other good $n' \neq n$ is indeed supplied. This follows if[25]

$$\max_x \left[p(x, 0)x - K_{n'}(x)\right] > 0. \tag{18}$$

[25] Observe that our equilibrium concept implies the following coordination problem. In case of decreasing marginal costs, the condition is stricter than the requirement $\max_x[2p(x, 0)x - K_{n'}(2x)] > 0$, which would be reasonable if the supplier n could bargain simultaneously with both outlets. We find this problem of coordination not unreasonable, particularly if there were a large number of outlets. Moreover, our bargaining concept side-steps the problem of simultaneous bargaining between more than two players, for which the Nash solution is often not appropriate. For the issue of multiplicity of equilibria in (non-cooperative) multi-person bargaining see, for instance, Osborne and Rubinstein (1990).

We now assume that (18) holds for any $n' \in N$. If good $n' \neq n$ is supplied, it follows by symmetry that $x^*_{n',1} = x^*_{n',2}$ are identical. Moreover, by efficient bargaining the choice of $x^*_{n'} = x^*_{n',m}$ maximizes the industry profits $2p(x_{n'}, 0)x_{n'} - K_{n'}(2x_{n'})$. We can now rule out $x^*_{n,m} = 0$ by assuming that, for this choice of $x^*_{n'}$, it holds that

$$\max_x [p(x, x^*_{n'})x - x^*_{n'}[p(x^*_{n'}, 0) - p(x^*_{n'}, x)] - K_n(x)] > 0. \quad (19)$$

This condition assures that the additional surplus from supplying the good n at outlet $m \in M$ is strictly positive. We assume that (19) holds for any choices of $n, n' \in N$. Summing up, if (18) and (19) hold for all choices of x_n and $x_{n'}$, with $n \neq n'$, $n, n' \in N$, both goods must be supplied in equilibrium, implying the assertion by the previous argument. **Q.E.D.**

Proof of Proposition 3. Consider the bilateral monopoly, $\omega = (1, 1)$. The supplier profit when choosing technology $i \in I$ is

$$S^{*,i}(1,1) = x_1^{*,i}p_1^{*,i} + x_2^{*,i}p_2^{*,i} - \frac{1}{2}[F^i + k^i(2x_1^{*,i}) + F^A + k^A(2x_2^{*,i})]$$

and we obtain from $S^{*,B}(1,1) = S^{*,A}(1,1)$ the threshold

$$\Delta_F^{1,1} = \frac{\Delta_k}{2(1-c^2)}(2(1-c)(1-k^A) - \Delta_k).$$

Consider now $\omega = (2, 2)$. Supplier 1's profits when choosing technology $i \in I$ are given by

$$S_1^{*,i}(2,2) = x_1^{*,i}p_1^{*,i} - x_2^{*,i}(p_2(x_2^{*,i}, 0) - p_2^{*,i}) - (F^i + k^i(x_1^{*,i})),$$

and we obtain from $S_1^{*,B}(2,2) = S_1^{*,A}(2,2)$ the threshold value

$$\Delta_F^{2,2} = \frac{\Delta_k}{4\,(1-c^2)^2}(2(1-c)(1-k^A) - \Delta_k).$$

For $\omega = (2, 1)$ supplier 1's profits for $i \in I$ are

$$S_1^{*,i}(2,1) = x_1^{*,i}p_1^{*,i} - x_2^{*,i}(p_2(x_2^{*,i}, 0) - p_2^{*,i}) - \frac{1}{2}(F^i + 2k^i x_1^{*,i})$$

and we get by setting $S_1^{*,B}(2,1) = S_1^{*,A}(2,1)$ the threshold value

$$\Delta_F^{2,1} = \frac{\Delta_k}{2\,(1-c^2)^2}(2(1-c)(1-k^A) - \Delta_k).$$

Comparison of the threshold values yields: $\Delta_F^{2,2} \geq \Delta_F^{1,1} \Leftrightarrow c \geq (1/\sqrt{2})$; further, $\Delta_F^{2,1} < \Delta_F^{1,2}$, $\Delta_F^{2,1} \geq \Delta_F^{1,1}$, $\Delta_F^{2,2} < \Delta_F^{2,1}$, $\Delta_F^{2,2} \leq \Delta_F^{1,2}$, and $\Delta_F^{1,2} < \Delta_F^{1,1}$ hold for all $c \geq 0$. Moreover,

$\Delta_F^{2,1} = \Delta_F^{1,1}$ and $\Delta_F^{2,2} = \Delta_F^{1,2}$ if and only if $c = 0$. This gives the ordering as stated in the proposition.

We have so far assumed that an equilibrium where both goods are supplied at both outlets exists and is unique. In what follows, we derive restrictions on the parameters k^A, F^A, Δ_k, and Δ_F which ensure that this is indeed the case. (This mirrors the discussion in Lemma 1 and in footnote 16.) In a final step we show that these restrictions are such that the ordering of the threshold values in the proposition is feasible.

To prove uniqueness, we must rule out equilibria where not both goods are supplied. We do so by deriving conditions which imply that players could in this case profitable deviate. As goods are substitutes and as unit costs are decreasing, it is sufficient to consider the case $\omega = (2,2)$. In an asymmetric outcome where at most one good is supplied, we denote the resulting quantities by $\widehat{x}_n^i = 0$ and $\widehat{x}_{n'}^i \geq 0$. The choice of $\widehat{x}_{n'}^i$ maximizes industry profits $2p(x_{n'}^i, 0)x_{n'}^i - K_{n'}^i(2x_{n'}^i)$. For $i = A$, we obtain $\widehat{x}_{n'}^A = \frac{1-k^A}{2}$. For $i = B$ we have to distinguish two asymmetric equilibria: (i) $\widehat{x}_1^B = 0, \widehat{x}_2^B = \frac{1-k^A}{2}$ and (ii) $\widehat{x}_1^B = \frac{1-k^A-\Delta_k}{2}, \widehat{x}_2^B = 0$. We can now rule out these asymmetric equilibria by assuming that, for given $\widehat{x}_{n'}^i$, the additional surplus realized from an agreement between supplier n and a single retailer $m \in M$ is strictly positive; i.e. condition (19) has to be fulfilled. For $i = A$, the maximizer of $p(x, \widehat{x}_{n'}^A)x - \widehat{x}_{n'}^A[p(\widehat{x}_{n'}^A, 0) - p(\widehat{x}_{n'}^A, x)] - K_n^A(x)$ is $\widehat{\widehat{x}}_n^A = \frac{1}{2}(1-c)\left(1-k^A\right)$ and we obtain the following condition such that the additional surplus

$$(1 - \widehat{\widehat{x}}_n^A - c\widehat{x}_{n'}^A)\widehat{\widehat{x}}_n^A - \widehat{x}_{n'}^A[(1 - \widehat{x}_{n'}^A) - (1 - \widehat{x}_{n'}^A - c\widehat{\widehat{x}}_n^A)] - F^A - k^A\widehat{\widehat{x}}_n^A$$

is positive:

$$F^A < \frac{[(1-c)(1-k^A)]^2}{4}. \tag{20}$$

For $i = B$ we must now distinguish between two different cases. Suppose first that case (i) applies, in which $\widehat{x}_1^B = 0, \widehat{x}_2^B = \frac{1-k^A}{2}$. The maximizer, $\widehat{\widehat{x}}_1^B$, of

$$p(x_1, \widehat{x}_2^B)x_1 - \widehat{x}_2^B[p(\widehat{x}_2^B, 0) - p(\widehat{x}_2^B, x_1)] - K_1^B(x_1) \tag{21}$$

is

$$\widehat{\widehat{x}}_1^B = \frac{1}{2}((1-c)\left(1-k^A\right) - \Delta_k).$$

Substituting back this solution into expression (21) gives the condition

$$\begin{aligned} F^B &< \frac{((1-c)(1-k^A) - \Delta_k)^2}{4} \\ \Leftrightarrow F^A - \Delta_F &< \frac{(1-c)^2(1-k^A)^2}{4} - \Delta_k\frac{2(1-c)(1-k^A) - \Delta_k}{4}. \end{aligned} \tag{22}$$

Consider conditions (20) and (22). Given that condition (20) holds, condition (22) is surely satisfied if

$$\Delta_F > \Delta_k \frac{2(1-c)(1-k^A) - \Delta_k}{4}. \tag{23}$$

Summing up the requirements for case (i), it is sufficient that (20) and (23) hold. Inspection reveals that the set of feasible parameters is surely non-empty. More importantly, by

$$\Delta_k \frac{2(1-c)(1-k^A) - \Delta_k}{4} < \Delta_F^{1,2} = \frac{\Delta_k}{4(1-c^2)} \left[2(1-c)(1-k^A) - \Delta_k\right]$$

the restriction (23) on Δ_F does not exclude any of the stated thresholds Δ_F^{ω}.

We now turn to the case (ii) in which $\widehat{x}_1^B = \frac{1-k^A-\Delta_k}{2}, \widehat{x}_2^B = 0$ constitutes the asymmetric equilibrium. The maximizer, $\widehat{\widehat{x}}_2^B$, of

$$p(x_2, \widehat{x}_1^B)x_2 - \widehat{x}_1^B[p(\widehat{x}_1^B, 0) - p(\widehat{x}_1^B, x_2)] - K_2^B(x_2) \tag{24}$$

is

$$\widehat{\widehat{x}}_2^B = \frac{1}{2}((1-c)\left(1-k^A\right) + c\Delta_k).$$

Substituting back this solution into (24) gives the condition

$$F^A < \frac{((1-c)(1-k^A) + c\Delta_k)^2}{4},$$

which is weaker then the requirement (20). **Q.E.D.**

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Figure 1