Buyer Power and Interlocking Vertical Relations

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Abstract

This paper analyzes a contracting game in which competing retailers make take-it-or-leave-it offers to the same set of competing suppliers. I find that if the retailers are restricted to offering tariffs that depend only on the quantity the retailer buys of the supplier's own brand, full intra- and inter-brand coordination is impossible. If three-part tariffs with terms that are contingent on how many contracts the supplier accepts and how many brands the retailer subsequently stocks are feasible, however, competition is fully eliminated and the integrated monopoly outcome is obtained. The firms can thus achieve full intra- and inter-brand coordination even if each contract is independent of trade between the rival manufacturer-retailer pair.

Keywords: vertical relations, buyer power, multi-principal multi-agent contracting, market-share contracts, non-linear tariffs

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1 Introduction

Retailers typically offer more than one brand per product category and the brands offered by competing retailers often overlap to a large extent. For instance, *Tops* and *Walmart*, two competing supermarket chains, both sell *Coca-Cola Coke* and *Pepsi* in the soft drink category. The terms of the supply arrangement between *Tops* and *Coca-Cola* hence affect not only the sales of *Pepsi* at *Tops*, but also those of *Coke* and *Pepsi* at *Walmart*. Despite the prevalence of such "interlocking" vertical relations between suppliers and retailers, economists' understanding of the equilibrium outcomes in industries of this type is still limited. With a few recent exceptions,[1] the existing literature considers either settings in which only a single retailer or a only single supplier has market power, or competition between vertical chains.

This paper will focus on the question what kind of contracts are needed to achieve full dampening of intra- and inter-brand competition, leading to the same prices that a fully integrated monopolist with multiple brands and multiple retail outlets would charge. For instance, do contracts need to depend on the entire industry structure, including trade between a competing retailer and a competing supplier, to achieve full intra- and inter-brand coordination? Are contracts that depend only on the supplier's own quantity sufficient? Similar questions have been successfully addressed in common agency models with either only inter-brand competition (Bernheim and Whinston 1985, 1998) or only intra-brand competition (Rey and Tirole, 2007; Miklós-Thal et al., forthcoming; Rey and Whinston, 2011), but in more realistic settings with both intra- and inter-brand competition the answers to these very basic questions are still unknown.

Throughout the paper, retailers will have the power to make take-it-or-leave-it offers to suppliers.[2] This modeling choice reflects the major shift in bargaining power from suppliers to retail chains in recent years, with powerful retailers like *Walmart* basically dictating contract terms to their suppliers.[3]

Without any prior restriction on the class of allowable contracts, I show that three-part tariff

[1] See Miklós-Thal et al. (2010) for a brief survey of this literature and a discussion of some of the modeling difficulties that have limited progress in this area.

[2] Existing research on interlocking vertical relations uses different assumptions on the bargaining protocol. In Rey and Vergé (forthcoming) and Mouraviev (2008) suppliers make take-it-or-leave-it offers. deFontenay and Gans (2005, 2007) analyze a specific bargaining protocol of sequential negotiations over secret quantity-forcing contracts. Dobson and Waterson (2007) model simultaneous bilateral negotiations, but restrict attention to linear tariffs, which implies that firms adopt bilaterally inefficient contracts. Inderst and Wey (2003, 2007) assume simultaneous but *independent* pairwise negoatiations, which eliminates the possibility of multisided deviations.

[3] See Chen (2007) and Inderst and Mazzarotto (2008) for evidence and surveys of the fast growing literature on buyer power.

with terms that are contingent on how many contracts the supplier accepts as well as how many brands the retailer subsequently decides to stock are sufficient to achieve full intra- and inter-brand coordination. Each three-part tariff combines an upfront fixed fee, which can take the form of a slotting or listing fee that the supplier pays to the retailer, with a two-part tariff that is conditional on actual trade, i.e., on the retailer's decision to order a strictly positive quantity from the supplier. This tariff choice is inspired by related recent work on buyer power in single-supplier multi-retailer settings (Marx and Shaffer, 2007; Miklós-Thal et al., forthcoming; Rey and Whinston, 2011). Miklós-Thal et al. (forthcoming) show that in the simpler single-supplier framework, menus of three-part tariff contracts with an option contingent on the supplier's exclusivity are sufficient to fully dampen intra-brand competition.[4] To induce the retailers to set final prices at the levels an integrated monopolist would choose, wholesale prices have to be at the appropriate levels above marginal cost. Above-cost marginal pricing however gives each retailer an incentive to deviate to a tariff with a marginally lower wholesale price, unless such a deviation induces the other retailer to drastically lower its payment to the common supplier. Conditional fixed fees equal to downstream variable profits at the monopoly outcome achieve the latter by committing each retailer to "exit" the market should its rival attempt to earn a larger slice of the industry profit. Upfront payments from the supplier to the retailers ensure that in spite of the high conditional fixed fees, each retailer can earn a payoff up to its incremental contribution to total industry profit.

Conditional fixed fees play a similar commitment role in the multi-seller multi-buyer setting of this paper. The conditional fixed fees paid in the equilibrium with full intra- and inter-brand coordination equal the retailers' variable profits for each brand. If one of the retailers tried to undercut the monopoly wholesale price, its rival would hence want to drop at least one of the brands to avoid paying the high conditional fixed fee. Conditional fixed fees are a simple way for each retailer to commit to this kind of drastic reaction, which as shown in this paper is always necessary to sustain the integrated monopoly outcome. The fact that each retailer carries multiple brands at the integrated monopoly outcome, however, adds a new dimension to the analysis. Suppose the suppliers accept all contract offers. Then each retailer will prefer to order a positive quantity of only one of the two brands for which it has signed a supply contract whenever this decision leaves the conditional tariff terms unchanged: since upstream brands are substitutes, dropping brand A

[4] Rey and Whinston (2011) show that the result continues to hold if contracts consist merely of a menu of three-part tariffs, without any explicit conditioning on the number of contracts signed by the supplier. In either case, mutiple options are needed to guarantee the existence of a common agency equilibrium. If contracts consist of a single three-part tariffs, exclusion of the weaker retailer is inevitable, as shown by Marx and Shaffer (2007). The discussion in the text focuses on the terms of the common agency tariff option.

allows the retailer to increase the variable profit it makes on brand B above its conditional fixed fee. I show that to rule out this type of deviation, contract terms must depend on how many brands the retailer sells, either directly or indirectly via market-share contracts that specify tariff terms as a function of the supplier's share in the retailer's total sales. Once this kind of flexibility is added to the contracts, full intra- and inter-brand coordination is feasible, i.e., there are no profitable deviations that induce either alternative double common agency outcomes or supply configurations in which some retailer(s) sell only a subset of the available brands or is fully excluded.

These findings have implications for antitrust policy. In particular, the analysis highlights a new role for market-share contracts by showing that they are needed to achieve full intra- and inter-brand coordination in vertically related markets. Market-share contracts can therefore harm consumers by allowing retailers to charge higher prices. On the other hand, however, without market-share contracts there may not exist any equilibrium in which all final products are offered. Hence, the overall welfare assessment is ambiguous.

Section 2 describes the model setting and assumptions. Section 3 contains the main results of the paper, focusing on three-part tariffs but also drawing on some findings about general non-linear tariffs.

2 Framework

Consider a vertically related industry with two suppliers, U_A and U_B, and two retailers, R_1 and R_2. Each supplier produces one brand that is potentially distributed through both retailers. Final consumers view the two brands as well as the two retailers as horizontally differentiated. If both retailers carry both brands, consumers therefore have the choice between four imperfect substitutes ($1A$, $1B$, $2A$, and $2B$). Upstream marginal production costs are constant and equal to $c \geq 0$. Downstream marginal costs are constant and normalized to zero.

The demand for product ij is a function of all four retail prices: $D_{ij} = D\left(p_{ij}, p_{i-j}, p_{-ij}, p_{-i-j}\right)$, where $i \neq -i \in \{1,2\}$ designates the retailer and $j \neq -j \in \{A, B\}$ the brand of a product. The demand function $D(\cdot)$ is assumed to be differentiable, decreasing in own price ($D_1 < 0$), and increasing in the prices of the three substitutes ($D_2, D_3, D_4 > 0$).[5] Direct effects dominates indirect

[5] D_k denotes the derivate of the demand function D with respect to its kth argument ($k \in \{1,2,3,4\}$). The assumption $D_2 > 0$ could be violated if consumers have a strong preference for one-stop shopping (see Caprice and Schlippenbach (2011) for a model in which one-stop shopping transforms substitues into complements). Note that the results would remain unchanged if there were a choke price $\overline{p} > p^M$ such that $D_k < 0$ for $p_k < \overline{p}$ and $D_k = 0$ for $p_k \geq \overline{p}$.

effects: $\sum_{k=1}^{4} D_k \leq 0$.

The two brands as well as the retailers are symmetric. If all four substitutes are offered at the same price, for instance, each final product has a market share of 25%. Note that the symmetry assumption does *not* imply that market shares are $\frac{1}{3}$ if three products are offered. Products $1A$ and $1B$ are closer substitutes than $1A$ and $2B$.

It will be assumed that the industry profits reaches a unique maximum at symmetric prices denoted by $\left(p^M, p^M, p^M, p^M\right) = \mathbf{p}^M$. The profit per product at this maximum will be denoted by Π^M:

$$\begin{aligned} 4\Pi^M &= \max_{(p_{1A}, p_{1B}, p_{2A}, p_{2B})} \sum_{i=1,2} \sum_{j=A,B} (p_{ij} - c) D\left(p_{ij}, p_{i-j}, p_{-ij}, p_{-i-j}\right) \\ &= \sum_{i=1,2} \sum_{j=A,B} (p^M - c) D\left(p^M, p^M, p^M, p^M\right). \end{aligned}$$

Similarly, it will be assumed that the industry profit if only one retailer is active reaches a unique maximum at symmetric prices. The per product profit in this case will be denoted by $\Pi^m_{(2)}$:

$$2\Pi^m_{(2)} = \max_{(p_A, p_B)} \sum_{j=A,B} (p_j - c) D\left(p_j, p_{-j}, \infty, \infty\right),$$

Finally, the industry profit function if only one final product is offered has a unique maximum:

$$\Pi^m_{(1)} = \max_p (p - c) D\left(p, \infty, \infty, \infty\right).$$

The highest attainable industry profit is strictly increasing in the number of products offered:[6]

$$4\Pi^M > 2\Pi^m_{(2)} > \Pi^m_{(1)}. \tag{1}$$

The differentiation between brands and retailers also implies that

$$\Pi^M < \Pi^m_{(2)} < \Pi^m_{(1)}. \tag{2}$$

Throughout the paper, the retailers have all the bargaining power. The timing is as follows:

1. R_1 and R_2 simultaneously make take-it-or-leave-it supply contract offers to U_A and U_B.

2. U_A and U_B simultaneously decide whether to accept both, only one, or none of the contract offers.

[6] Since there are no fixed costs associated with the introduction of another brand, this follows directly from the differentiation between brands and between retailers. The results in this paper would continue to hold in a framework with fixed costs under the assumption that industry profit maximization calls for all four products being offered.

3. The retailers with accepted contracts simultaneously set prices and the relevant contracts are implemented.

The game is one of public monitoring: at the end of each stage, all past actions become common knowledge. The equilibrium concept is subgame perfection.

The following assumptions are made about the price-setting game at stage 3:

Assumption 1 Retail prices are strategic complements.

Assumption 2 Any set of linear wholesale prices $(w_{1A}, w_{1B}, w_{2A}, w_{2B})$ leads to a unique retail equilibrium. There exist wholesale prices $\left(w^M, w^M, w^M, w^M\right)$ such that industry profits reach the upper bound $4\Pi^M$:

$$\left(p^M, p^M\right) = \arg\max_{p_1, p_2} \sum_{i=1,2} \left(p_i - w^M\right) D\left(p_i, p_{-i}, p^M, p^M\right).$$

In the case of linear wholesale prices, it will sometimes be convenient to express the Nash equilibrium prices as a function of the vector of wholesale prices. Define

$$\begin{aligned} & \left(p^*_{iA}\left(w_{iA}, w_{iB}, w_{-iA}, w_{-iB}\right), p^*_{iB}\left(w_{iB}, w_{iA}, w_{-iB}, w_{-iA}\right)\right) \\ = \; & \arg\max_{p_{iA}, p_{iB}} \sum_{j=A,B} \left(p_{ij} - w_{ij}\right) D\left(p_{ij}, p_{i-j}, p^*_{-ij}\left(w_{-ij}, w_{-i-j}, w_{ij}, w_{i-j}\right), p^*_{-i-j}\left(w_{-i-j}, w_{-ij}, w_{i-j}, w_{ij}\right)\right) \end{aligned}$$

for all $i \in \{1, 2\}$. $w_{ij} = \infty$ amounts to product ij not being offered.

Assumption 3 For any set of linear wholesale prices $(w_{1A}, w_{1B}, w_{2A}, w_{2B})$, the retail price of a product is increasing in its wholesale price:

$$\frac{\partial p^*_{ij}}{\partial w_{ij}} \geq 0.$$

3 Three-part tariffs

A three-part tariff consists of an upfront fixed fee and a two-part tariff that is conditional on actual trade. Formally, such a tariff takes the form

$$T(q) = \begin{cases} S & \text{if } q = 0, \\ S + F + wq & \text{if } q > 0, \end{cases}$$

where S is the upfront fixed fee paid upon contract acceptance, F the conditional fixed fee, and w the wholesale price. The upfront fee S can be negative, i.e., be a slotting or listing fee the supplier has to pay the retailer.

Such tariffs have received a lot of attention in the recent literature on games in which competing retailers make offers to a single manufacturer. Marx and Shaffer (2007) show that the stronger retailer can use a three-part tariff to exclude the weaker retailer without resorting to any explicit exclusive dealing provision.[7] By setting the conditional fixed fee F equal to its bilateral monopoly profit, each retailer can commit to exiting the market unless it is the downstream monopolist. The upfront fee is used to transfer the active retailer's incremental contribution to industry profit from the supplier to the retailer.

Equilibria in which both retailers are active cannot exist in Marx and Shaffer (2007) where each contract consists of a single three-part tariff rather than a menu of (potentially contingent) tariffs. Miklós-Thal et al. (forthcoming) however show that once menus of three-part tariffs $\left\{\left(S^C, F^C, w^C\right), \left(S^E, F^E, w^E\right)\right\}$ contingent on whether the supplier deals exclusively with one retailer are allowed, exclusion is no longer the inevitable outcome. There now exist equilibria in which both retailers are active and retail prices are at the levels a fully integrated monopolist would choose. Each retailer can earn its incremental contribution to industry profits in such a common agency equilibrium, which implies that both retailers prefer the common agency equilibrium with full intra-brand coordination to any other equilibrium (with or without exclusion).[8]

The three-part tariffs used to sustain the integrated monopoly outcome in Miklós-Thal et al. (forthcoming) are such that any attempt by one of the retailers to sell a larger quantity (by offering a lower wholesale price) induces the other retailer to stop selling altogether. Each of the conditional fixed fee in the tariff options for common agency is equal to the retailer's variable downstream profits at the equilibrium outcome, so that each retailer prefers to order zero instead of a positive quantity should the other retailer undercut the equilibrium wholesale price. A marginal deviation by one retailer hence induces a discontinuous reaction by its rival.

As also shown in Miklós-Thal et al. (forthcoming), such discontinuous reactions to small deviations are always necessary to fully dampen intra-brand coordination, even without any restrictions

[7] The "strength" of a retailer refers to the size of the bilateral monopoly profit that retailer and the supplier can earn.

[8] Rey and Whinston (2011) show that these results continue to hold if contracts are menus of three-part tariffs, without any explicit conditioning on the supplier's exclusivity. While the present paper does not yet contain an analysis of non-contingent tariff menus, preliminary results suggests that the my findings do not easily extend to menus of non-contingent contracts.

on the class of permissible contracts.[9] Lemma 1 below extends this insight to the multi-supplier multi-retailer setting of this paper, showing that discontinuous best-response functions (at stage 3) are needed for full intra- and inter-brand coordination between the four firms, otherwise each retailer could profitably deviate to an alternative double common agency outcome in which it earns a larger share of industry profits. R_i's stage 3 best-response function in a double common agency situation is defined as

$$\begin{aligned} & \left(p_{iA}^{BR}(p_{-iA},p_{-iB}),p_{iB}^{BR}(p_{-iA},p_{-iB})\right) \\ = \ & \arg\max_{p_{iA},p_{iB}} \sum_{j=A,B} \left[D\left(p_{ij},p_{i-j},p_{-ij},p_{-i-j}\right)p_{ij} - T_{ij}^{C}\left(D\left(p_{ij},p_{i-j},p_{-ij},p_{-i-j}\right)\right)\right] \end{aligned}$$

for all $i \neq -i \in \{1,2\}$, where $T_{ij}^{C}\left(q_{ij}\right)$ is the tariff according to which R_i pays U_j if U_j accepts both retailers' offers.

Lemma 1 *If at $(p_{-iA},p_{-iB}) = (p^M,p^M)$ the best-response functions $\left(p_{iA}^{BR}(p_{-iA},p_{-iB}),p_{iB}^{BR}(p_{-iA},p_{-iB})\right)$ are continuous in either p_{-iA} and/or p_{-iB}, then there exists no subgame perfect equilibrium in which industry profits are $4\Pi^M$.*

Proof. The joint profit of R_i and the two suppliers is:

$$\begin{aligned} \pi_{iAB}\left(p_{iA},p_{iB}\right) = & \sum_{j=A,B} D\left(p_{ij},p_{i-j},p_{-ij}^{BR}(p_{iA},p_{iB}),p_{-i-j}^{BR}(p_{iA},p_{iB})\right)\left(p_{ij}-c\right) \\ & + \sum_{j=A,B} \left[\begin{array}{c} T_{-ij}^{C}\left(D\left(p_{-ij}^{BR}(p_{iA},p_{iB}),p_{-i-j}^{BR}(p_{iA},p_{iB}),p_{ij},p_{i-j}\right)\right) \\ -c_U D\left(p_{-ij}^{BR}(p_{iA},p_{iB}),p_{-i-j}^{BR}(p_{iA},p_{iB}),p_{ij},p_{i-j}\right) \end{array}\right]. \end{aligned}$$

If the tariffs $\left(T_{-iA}^{C},T_{-iB}^{C}\right)$ induce differentiable reaction functions,[10] then

$$\begin{aligned} \frac{d\pi_{iAB}\left(p_{iA},p_{iB}\right)}{dp_{iA}} = & D_{iA} + \left(p_{iA}-c\right)\frac{\partial D_{iA}}{\partial p_{iA}} + \left(p_{iB}-c\right)\frac{\partial D_{iB}}{\partial p_{iA}} + \sum_{j=A,B}\left(\frac{dT_{-ij}^{C}}{dq_{-ij}}-c\right)\frac{\partial D_{-ij}}{\partial p_{iA}} \\ & + \sum_{j=A,B}\left(p_{ij}-c\right)\left(\frac{\partial D_{ij}}{\partial p_{-iA}}\frac{dp_{-iA}^{BR}}{dp_{iA}} + \frac{\partial D_{ij}}{\partial p_{-iB}}\frac{dp_{-iB}^{BR}}{dp_{iA}}\right) \\ & + \sum_{j=A,B}\left[\left(\frac{dT_{-ij}^{C}}{dq_{-ij}}-c\right)\left(\frac{\partial D_{-ij}}{\partial p_{-ij}}\frac{dp_{-ij}^{BR}}{dp_{iA}} + \frac{\partial D_{-ij}}{\partial p_{-i-j}}\frac{dp_{-i-j}^{BR}}{dp_{iA}}\right)\right]. \end{aligned} \quad (3)$$

[9] Three-part tariffs are one way to achieve such drastic reactions, but other non-linear tariffs work as well.

[10] The price response function and tariffs need not be differentiable everywhere for the argument to work. All that's needed is that the retailer's optimal price reacts continuously when the competing retailer deviates to a price slightly below p^M.

By definition, $\left(p^{BR}_{-iA}(p_{iA},p_{iB}),p^{BR}_{-iB}(p_{iA},p_{iB})\right)$ satisfy the following conditions:

$$D_{-iA}+p^{BR}_{-iA}\frac{\partial D_{-iA}}{\partial p_{-iA}}+p^{BR}_{-iB}\frac{\partial D_{-iB}}{\partial p_{-iA}} = \frac{dT^C_{-iA}}{dq_{-iA}}\frac{\partial D_{-iA}}{\partial p_{-iA}}+\frac{dT^C_{-iB}}{dq_{-iB}}\frac{\partial D_{-iB}}{\partial p_{-iA}}, \tag{4}$$

$$D_{-iB}+p^{BR}_{-iB}\frac{\partial D_{-iB}}{\partial p_{-iB}}+p^{BR}_{-iA}\frac{\partial D_{-iA}}{\partial p_{-iB}} = \frac{dT^C_{-iB}}{dq_{-iB}}\frac{\partial D_{-iB}}{\partial p_{-iB}}+\frac{dT^C_{-iA}}{dq_{-iA}}\frac{\partial D_{-iA}}{\partial p_{-iB}}. \tag{5}$$

Using (4) and (5), (3) can be rewritten as

$$\begin{aligned}\frac{d\pi_{iAB}\left(p_{iA},p_{iB}\right)}{dp_{iA}} &= D_{iA}+(p_{iA}-c)\frac{\partial D_{iA}}{\partial p_{iA}}+(p_{iB}-c)\frac{\partial D_{iB}}{\partial p_{iA}}+\sum_{j=A,B}\left(\frac{dT^C_{-ij}}{dq_{-ij}}-c\right)\frac{\partial D_{-ij}}{\partial p_{iA}}\\ &+\sum_{j=A,B}\left(\begin{array}{c}D_{-ij}+(p_{-ij}-c)\frac{\partial D_{-ij}}{\partial p_{-ij}}+(p_{-i-j}-c)\frac{\partial D_{-i-j}}{\partial p_{-ij}}\\ +(p_{ij}-c)\frac{\partial D_{ij}}{\partial p_{-ij}}+(p_{i-j}-c)\frac{\partial D_{i-j}}{\partial p_{-ij}}\end{array}\right)\frac{dp^{BR}_{-ij}}{dp_{iA}}.\end{aligned} \tag{6}$$

At the monopoly prices $\mathbf{p}^M=p^M,p^M,p^M,p^M$:

$$D\left(\mathbf{p}^M\right)+\left(p^M-c\right)D_1\left(\mathbf{p}^M\right)+\left(p^M-c\right)D_2\left(\mathbf{p}^M\right)+\left(p^M-c\right)D_3\left(\mathbf{p}^M\right)+\left(p^M-c\right)D_4\left(\mathbf{p}^M\right)=0. \tag{7}$$

Evaluating (6) at $\mathbf{p}^M$ yields

$$\begin{aligned}\frac{d\pi_{iAB}\left(p_{iA},p_{iB}\right)}{dp_{iA}}\mid_{\mathbf{p}^M} &= D\left(\mathbf{p}^M\right)+\left(p^M-c\right)D_1\left(\mathbf{p}^M\right)+\left(p^M-c\right)D_2\left(\mathbf{p}^M\right)\\ &+\left(\frac{dT^C_{-iA}}{dq_{-iA}}-c\right)D_3\left(\mathbf{p}^M\right)+\left(\frac{dT^C_{-iB}}{dq_{-iB}}-c\right)D_4\left(\mathbf{p}^M\right).\end{aligned} \tag{8}$$

If $\frac{dT^C_{-iA}}{dq_{-iA}}<p^M$ and $\frac{dT^C_{-iB}}{dq_{-iB}}<p^M$, then (7) implies that (8) is strictly negative. To see that this is indeed the case, note that at the monopoly price vector $\mathbf{p}^M$ the first-order conditions of R_i's price-setting decisions in (4) and (5) boil down to

$$D\left(\mathbf{p}^M\right)+p^MD_1\left(\mathbf{p}^M\right)+p^MD_2\left(\mathbf{p}^M\right) = \frac{dT^C_{-iA}}{dq_{-iA}}D_1\left(\mathbf{p}^M\right)+\frac{dT^C_{-iB}}{dq_{-iB}}D_2\left(\mathbf{p}^M\right), \tag{9}$$

$$D\left(\mathbf{p}^M\right)+p^MD_1\left(\mathbf{p}^M\right)+p^MD_2\left(\mathbf{p}^M\right) = \frac{dT^C_{-iB}}{dq_{-iB}}D_1\left(\mathbf{p}^M\right)+\frac{dT^C_{-iA}}{dq_{-iB}}D_2\left(\mathbf{p}^M\right). \tag{10}$$

(9) and (10) imply that $\frac{dT^C_{-iB}}{dq_{-iB}}=\frac{dT^C_{-iA}}{dq_{-iA}}\equiv\frac{dT^C_{-i}}{dq_{-i}}$ and

$$D\left(\mathbf{p}^M\right)+\left(p^M-\frac{dT^C_{-i}}{dq_{-i}}\right)D_1\left(\mathbf{p}^M\right)+\left(p^M-\frac{dT^C_{-i}}{dq_{-i}}\right)D_2\left(\mathbf{p}^M\right)=0. \tag{11}$$

Since $-D_1\left(\mathbf{p}^M\right)>D_2\left(\mathbf{p}^M\right)$, (11) implies that $\frac{dT^C_{-i}}{dq_{-i}}<p^M$. As noted above, it follows that

$$\frac{d\pi_{iAB}\left(p_{iA},p_{iB}\right)}{dp_{iA}}\mid_{\mathbf{p}^M}<0.$$

Hence, there exists a deviation by R_1 that results in a slightly lower p_{iA} and raises the joint profit of R_1 and the two suppliers. Since the upfront fees can be used to share this surplus with the suppliers, R_1 can profitably induce them to accept the deviation contract offers. ■

In the context of three-part tariffs, Lemma 1 implies that for an equilibrium with full dampening of intra- and inter-brand to exist, any attempt by R_i to marginally undercut the monopoly wholesale price w^M must induce R_{-i} to drop at least one brand. In principle, this can be achieved by means of sufficiently high conditional fixed fees. For instance, if $F^C_{-ij} = \left(p^M - w^M\right) D\left(\mathbf{p}^M\right)$ for all $j \in \{A, B\}$, R_{-i} would prefer selling nothing to selling both brands if R_i tried to get a larger share of industry profits by deviating to wholesale prices below w^M. At the same time, however, potential deviations at stage 3 impose an upper bound on conditional fixed fees. Suppose all contract offers are accepted, the vector of wholesale prices is $\mathbf{w}^M$, and R_{-i} sets the prices $\left(p^M, p^M\right)$. In equilibrium, it must be optimal for R_i to also set prices at $\left(p^M, p^M\right)$. This requires that

$$2D\left(p^M, p^M, p^M, p^M\right)\left(p^M - w^M\right) - F^C_{iA} - F^C_{iB} \geq \max_p \left[D\left(p, \infty, p^M, p^M\right)\left(p - w^M\right)\right] - \min\left\{F^C_{iA}, F^C_{iB}\right\}, \tag{12}$$

otherwise R_i would prefer ordering only one brand to setting the monopoly prices $\left(p^M, p^M\right)$ and selling both brands. (12) implies the following upper bound on $\max\left\{F^C_{iA}, F^C_{iB}\right\}$:

$$\max\left\{F^C_{iA}, F^C_{iB}\right\} \leq 2D\left(p^M, p^M, p^M, p^M\right)\left(p^M - w^M\right) - \max_p \left[D\left(p, \infty, p^M, p^M\right)\left(p - w^M\right)\right]. \tag{13}$$

Another necessary condition is

$$F^C_{iA} + F^C_{iB} \leq 2D\left(p^M, p^M, p^M, p^M\right)\left(p^M - w^M\right), \tag{14}$$

otherwise R_i would be better off not selling anything to selling both brands.

The question thus becomes whether given the upper bounds on conditional fixed fees in (13) and (14) a deviation to (common agency) contracts with wholesale prices marginally below w^M by one of the retailers can still induce the other retailer to stock at most one brand at stage 3. If the answer is no, then a menu of three-part tariffs $\left\{\left(S^C, F^C, w^C\right), \left(S^E, F^E, w^E\right)\right\}$ is not sufficiently flexible to obtain industry profit maximization in equilibrium. It is easy to see that following a deviation by R_i to marginally lower wholesale prices, there is no continuation equilibrium in which R_{-i} sells none of the brands, as R_{-i} could profitably deviate from such an equilibrium path by selling one instead of none of the brands at stage 3:

$$\max_p \left[D\left(p, \infty, p^*\left(w^M, w^M, \infty, \infty\right), p^*\left(w^M, w^M, \infty, \infty\right)\right)\left(p - w^M\right)\right] - \min\left\{F^C_{-iA}, F^C_{-iB}\right\} > 0. \tag{15}$$

Since prices are strategic complements, $p^*\left(w^M,w^M,\infty,\infty\right)>p^M$, which implies that

$$\max_p\left[D\left(p,\infty,p^*\left(w^M,w^M,\infty,\infty\right),p^*\left(w^M,w^M,\infty,\infty\right)\right)\left(p-w^M\right)\right]>\max_p\left[D\left(p,\infty,p^M,p^M\right)\left(p-w^M\right)\right].$$

Finally, (14) implies that $\min\left\{F^C_{-iA},F^C_{-iB}\right\}\leq D\left(p^M,p^M,p^M,p^M\right)\left(p^M-w^M\right)$. The inequality in (15) follows.

It remain to investigate whether following R_i's deviation there can be a continuation equilibrium in which R_{-i} sells one of the two brands. A necessary condition for such a continuation equilibrium to exist is that R_{-i} has no incentive to deviate to selling both brands at stage 3, i.e., that

$$\begin{aligned}&\max_p\left[\left(p-w^M\right)D\left(p,\infty,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\right]-\min\left\{F^C_{-iA},F^C_{-iB}\right\}\\ \geq\;&\max_{p_A,p_B}\left[\begin{array}{c}\left(p_A-w^M\right)D\left(p_A,p_B,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\\+\left(p_B-w^M\right)D\left(p_B,p_A,p^*\left(w^M,w^M,\infty,w^M\right),p^*\left(w^M,w^M,w^M,\infty\right)\right)\end{array}\right]-F^C_{-iA}-F^C_{-iB},\end{aligned}$$

which is equivalent to the following lower bound on $\max\left\{F^C_{-iA},F^C_{-iB}\right\}$:

$$\begin{aligned}&\max\left\{F^C_{-iA},F^C_{-iB}\right\}\\ \geq\;&\max_{p_A,p_B}\left[\begin{array}{c}\left(p_A-w^M\right)D\left(p_A,p_B,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\\+\left(p_B-w^M\right)D\left(p_B,p_A,p^*\left(w^M,w^M,\infty,w^M\right),p^*\left(w^M,w^M,w^M,\infty\right)\right)\end{array}\right]\\&-\max_p\left[\left(p-w^M\right)D\left(p,\infty,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\right].\end{aligned}\tag{16}$$

Combining (16) with the necessary equilibrium condition in (13) yields

$$\begin{aligned}&2D\left(p^M,p^M,p^M,p^M\right)\left(p^M-w^M\right)-\max_p\left[D\left(p,\infty,p^M,p^M\right)\left(p-w^M\right)\right]\\ \geq\;&\max_{p_A,p_B}\left[\begin{array}{c}\left(p_A-w^M\right)D\left(p_A,p_B,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\\+\left(p_B-w^M\right)D\left(p_B,p_A,p^*\left(w^M,w^M,\infty,w^M\right),p^*\left(w^M,w^M,w^M,\infty\right)\right)\end{array}\right]\\&-\max_p\left[\left(p-w^M\right)D\left(p,\infty,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\right],\end{aligned}\tag{17}$$

which can be rewritten as

$$\begin{aligned}&\max_p\left[\left(p-w^M\right)D\left(p,\infty,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\right]\\&-\max_p\left[D\left(p,\infty,p^M,p^M\right)\left(p-w^M\right)\right]\\ \geq\;&\max_{p_A,p_B}\left[\begin{array}{c}\left(p_A-w^M\right)D\left(p_A,p_B,p^*\left(w^M,w^M,w^M,\infty\right),p^*\left(w^M,w^M,\infty,w^M\right)\right)\\+\left(p_B-w^M\right)D\left(p_B,p_A,p^*\left(w^M,w^M,\infty,w^M\right),p^*\left(w^M,w^M,w^M,\infty\right)\right)\end{array}\right]\\&-2D\left(p^M,p^M,p^M,p^M\right)\left(p^M-w^M\right).\end{aligned}\tag{18}$$

Assumptions 1 and 3 imply that $p^*\left(w^M, w^M, w^M, \infty\right), p^*\left(w^M, w^M, \infty, w^M\right) > p^*\left(w^M, w^M, w^M, w^M\right) = p^M$. (17) hence holds if R_{-i}'s benefit from adding a second brand is larger when R_i charges $\left(p^M, p^M\right)$ than when R_i charges the higher prices $\left(p^*\left(w^M, w^M, w^M, \infty\right), p^*\left(w^M, w^M, \infty, w^M\right)\right)$. (18) provides another way to interpret the same condition, namely that the benefit to R_{-i} resulting from R_i's decision to increase prices from $\left(p^M, p^M\right)$ to $\left(p^*\left(w^M, w^M, w^M, \infty\right), p^*\left(w^M, w^M, \infty, w^M\right)\right)$ is larger when R_{-i} is restricted to selling one brand than when R_{-i} can sell both brands. This discussion thus implies the following result:

Proposition 1 *If a retailer benefits more from retail price increases by its rival when it can sell two brands than when it is restricted to selling one brand, then there exists no subgame perfect equilibrium in which industry profits are* $4\Pi^M$ *and contract offers are menus of three-part tariffs of the form* $\left\{\left(S^C, F^C, w^C\right), \left(S^E, F^E, w^E\right)\right\}$*, where superscripts refer to how many contract offers the supplier accepts.*

Since in standard models a seller can capitalize on price increases by rivals better if there are no restrictions on how many brands it can sell, Proposition 1 casts doubt on the existence of an equilibrium with full intra- and inter-brand coordination. Contracts that are contingent on the supplier's exclusivity only, as in Miklós-Thal et al. (forthcoming), are insufficient to attain the integrated monopoly outcome if (18) is violated. Making contracts contingent on how many of the retailer's offer are accepted, i.e., the retailer's exclusivity in terms of contract acceptances, does not help: the terms of contracts in which one party is exclusive do not have any impact on the retailers' stage 3 decisions given all contracts have been accepted. What is needed are tariffs that are contingent on how many brands the retailer decides to stock at stage 3 of the game, either directly or indirectly via market share thresholds. Below I show that once such flexibility is added to the contracts, the firms can indeed achieve the integrated monopoly outcome in equilibrium. Importantly, contracts do not need to depend on the entire market structure to achieve joint profit maximization. Both inter- and intra-brand competition can be eliminated although the contract between R_i and U_j depends only on the decisions of the two contracting parties, not the trade between the competing vertical pair $R_{-i} - U_{-j}$.

It is useful to introduce some bounds on equilibrium payoffs prior to the equilibrium analysis. First, note that R_{-i}, U_A, and U_B can earn joint profits of $2\Pi^m_{(2)}$ when R_i is excluded.[11] It follows that R_i cannot obtain more than its contribution to industry profit

$$\Delta_R = 4\Pi^M - 2\Pi^m_{(2)}$$

[11] For instance, R_{-i} could offer only exclusive contracts with a wholesale price c to both suppliers.

in any subgame perfect Nash equilibrium. The joint profits of the suppliers must therefore be at least

$$2\Delta_U = 4\Pi^M - 2\Delta_R = 4\left(\Pi^m_{(2)} - \Pi^M\right) > 0.$$

Proposition 2 *There exists a subgame perfect equilibrium in which industry profit is $4\Pi^M$, each retailer obtains Δ_R, and the contract offers take the following form for all ij:*[12]

- *[Exclusive option] If U_j accepts only R_i's offer, the upfront fixed fee is*

$$S^E = 2\left(\Pi^m_{(2)} - \Pi^M\right).$$

At stage 3, R_i pays U_j for any order $q_{ij} > 0$ according to the following tariff:

$$T^E_{cond}(q_{ij}) = \begin{cases} Z + cq_{ij} & \text{if } i \text{ stocks both brands,} \\ cq_{ij} & \text{if } i \text{ stocks only brand } j. \end{cases}$$

- *[Common agency option] If U_j accepts both retailers' offers, the upfront fixed fee is*

$$S^C = -\frac{\Delta_R}{2} = -\left(2\Pi^M - \Pi^m_{(2)}\right).$$

At stage 3, R_i pays U_j for any order $q_{ij} > 0$ according to the following tariff:

$$T^C_{cond}(q_{ij}) = \begin{cases} \left(p^M - w^M\right) D\left(\mathbf{p}^M\right) + w^M q_{ij} & \text{if } i \text{ stocks both brands,} \\ W + cq_{ij} & \text{if } i \text{ stocks only brand } j. \end{cases}$$

Proof. Suppose that both retailers offer the candidate equilibrium contracts and all contracts are accepted. We need to show that the subgame starting at stage 3 has an equilibrium in which both retailers sell both products at the monopoly price p^M. Suppose R_2 does so. R_1 has three options: either sell both products, only one product, or none. In the first case, it is optimal for R_1 to set both prices equal to p^M (by the definition of w^M) and R_1's continuation profit is 0. If R_1 sells only one product, say brand A, then it earns a continuation profit of

$$-W + \max_p (p - c) D\left(p, \infty, p^M, p^M\right),$$

which is non-positive for large enough W. If R_1 sells nothing, its continuation profit is 0.

Now consider the suppliers' acceptance decisions at stage 2. Suppose supplier U_2 accepts both offers. If U_1 does the same, it will earn $2\Pi^M - \left(4\Pi^M - 2\Pi^m_{(2)}\right) = 2\left(\Pi^m_{(2)} - \Pi^M\right)$. If U_1 accepts only

[12] Deviation offers are not restricted to the class of three-part tariffs.

one offer, it will receive the exact same amount as an upfront fixed fee. If Z is large enough, U_1 cannot receive any additional payment in excess of production costs at stage 3: given Z, no retailer wants to sell both brands if one (or both) of the suppliers accepts only that retailer's contract. Hence, it is optimal for U_1 to also accept both offers.

Finally, consider contract proposals at stage 1. Suppose R_2 offers the candidate equilibrium contracts. To rule out deviations by R_1 to different contract offers, I will go through each possible supply configuration (defined here based on active trade not contract acceptances) that could arise as a result of the deviation. Symmetry reduces the number of possible configurations to seven.

- Deviation to another double common agency outcome

  First, it is easy to see that R_1 cannot profitably deviate to offers that lead to a double common agency outcome where both retailers sell both products. If both of R_2's offers get accepted (as is necessary for double common agency), then R_2 can secure a payoff of $\Delta_R = 4\Pi^M - 2\Pi^m_{(2)}$. Hence, the joint profit of R_1, U_A and U_B following the deviation cannot exceed $4\Pi^M - \Delta_R = 2\Pi^m_{(2)}$. Since each supplier can earn $2\left(\Pi^m_{(2)} - \Pi^M\right)$ by accepting only R_2's offer, R_1 cannot earn more than $2\Pi^m_{(2)} - 4\left(\Pi^m_{(2)} - \Pi^M\right) = \Delta_R$.

- Deviation to exclusivity (deviator is the only active retailer; 2 possible configurations)

  It is easy to see that there is no profitably deviation to supply configurations where R_1 is the exclusive distributor of U_A and U_B: the joint profit of the three firms in the candidate equilibrium is $2\Pi^m_{(2)}$, the maximum profit they could earn if R_1 were excluded.

  Another possible deviation consists of attracting only one supplier while fully excluding the rival retailer. If $2\Pi^M \geq \Pi^m_{(1)}$, then it is evident that such a deviation cannot be profitable, as the joint profit of R_1 and any one of the retailers in the candidate equilibrium ($2\Pi^M$) is higher than their maximum joint profit after the deviation. If $2\Pi^M < \Pi^m_{(1)}$ (brands are close substitutes), then the presence of the second supplier keeps R_1 from deviating. Unless R_1 makes an offer to U_B that allows the latter to earn at least $2\left(\Pi^m_{(2)} - \Pi^M\right)$ (which would clearly make the deviation unprofitable), U_B has a strict incentive to accept R_2's exclusive offer to earn that amount. If U_B accepts only R_2's offer, it is optimal for R_2 to indeed sell brand U_B (note that even if U_A also accepts R_2's offer, R_2 would still want to sell only U_B provided W and Z are "large").

- Deviation to partial exclusion (deviator sells both brands, rival retailer only one)

For high enough W, the deviator cannot induce this supply configuration: the rival retailer prefers to sell nothing to selling only one brand if the supplier accepts to deal with both retailers.

- Deviation to market structures where the deviator sells only one brand and the rival retailer is active (3 possible configurations)

  There are three different market structures of this type, depending on the number and identity of brands sold by the rival retailer. First, it could be that the deviator R_1 sells brand U_A, while R_2 sells U_B. In this case, U_A cannot get any payoff from dealing with R_2 (recall that the upfront fee would be negative if U_A accepted two offers). Hence, for R_1 to be able to profitably deviate to such a situation, the deviation must increase the joint profit of R_1 and U_A above $2\Pi^M$, their joint profit in the candidate equilibrium. (If $2\Pi^M \geq \Pi^m_{(1)}$, such an increase is obviously impossible. However, $2\Pi^M < \Pi^m_{(1)}$ if the final products are close substitutes.) The wholesale fee in the most profitable deviation contract R_1 can offer to U_A must be the best reply to the wholesale fee at which R_2 buys U_B, which is c_U given the candidate equilibrium contracts. (If R_1 tried to induce a higher wholesale price by making an offer that induces U_B to accept two offers, then the "large" W would induce R_2 not to stock U_B at stage 3, so the stipulated supply configuration could not arise.) Denoting R_1's best reply wholesale price by $BR(c)$ and the downstream equilibrium prices as a function of marginal input costs by $\widetilde{p}_{ij}\left(w_{ij}, w_{i-j}, w_{-ij}, w_{-i-j}\right)$ for all ij, the joint profit of R_1 and U_A is

$$\begin{aligned} & \pi_{1A}\left(BR(c), \infty, \infty, c\right) \\ = \quad & \left(\widetilde{p}\left(BR(c), \infty, \infty, c\right) - c\right) D\left(\widetilde{p}\left(BR(c), \infty, \infty, c\right), \infty, \infty, \widetilde{p}\left(c, \infty, \infty, BR\left(c\right)\right)\right). \end{aligned}$$

  Since price are strategic complements when each firm sells only one brand (Assumption 1), $BR(c) \geq c$ (see Bonanno and Vickers, 1988). It follows that[13]

$$\pi_{1A}\left(BR(c), \infty, \infty, c\right) \leq \pi_{1A}\left(BR(c), \infty, \infty, BR(c)\right).$$

  Moreover, the symmetry and brand differentiation assumptions imply that for any $\widetilde{w}$:

$$\pi_{1A}\left(\widetilde{w}, \infty, \infty, \widetilde{w}\right) < 2\Pi^M.$$

  Hence, there is no profitable deviation inducing an industry structure where each retailer is the exclusive distributor of one of the brands.

[13] Assumption 3 implies that R_2 would charge a weakly higher price for brand B if its wholesale price increased from c to $BR\left(c\right)$. Moreover, D_{1A} is increasing in p_{2B}. A standard revealed preference argument implies that retailer 1 is better off if $w_{2B} = BR\left(c\right)$ rather than $w_{2B} = c$.

Second, both retailers could sell only brand U_A. However, for large enough W, R_2 would prefer to sell nothing rather than selling brand U_A only. (Moreover, R_1 cannot profitably keep U_B from accepting R_2's exclusive offer, which would lead to R_2 selling U_B only.)

Third, the rival retailer could sell both brands, while the deviator sells only one. Note first that the above argument ruling out deviations to an alternative double common agency situations implies that there is no profitable deviation to such supply configurations if both suppliers accept *two* contract offers following the deviation. Hence, for the deviation to be profitable, it is necessary that one supplier accepts only the rival retailer's offer. For large enough Z, the rival retailer will prefer to stock none of the brands to stocking both brands.

■

Proposition 2 shows that three-part tariffs that are contingent on how many contracts the supplier signs as well as the retailer's stocking decision are sufficient to eliminate both intra- and inter-brand competition and achieve efficiency from the firms' viewpoint. Such contracts are not the only way to achieve industry profit maximization however. *Market-share contracts*, in which conditional fees depend on the market share of the supplier's brand in the retailer's total category sales, can lead to the same outcome. Denote the total sales of retailer i by $Q_i = q_{i1} + q_{i2}$ and consider the following contract terms:

- If U_j signs two contracts, it pays a listing fee of

$$\frac{\Delta_R}{2} = 2\Pi^M - \Pi^m_{(2)}$$

  to R_i. In exchange, R_i makes the following payment to U_j whenever $q_{ij} > 0$:

$$T^C_{cond}(q_{ij}) = \begin{cases} \left(p^M - w^M\right) D\left(\mathbf{p}^M\right) + w^M q_{ij} & \text{if } q_{ij} \leq y Q_i \\ W + c q_{ij} & \text{if } q_{ij} > y Q_i \end{cases}, \text{ where } y \in \left(\frac{1}{2}, 1\right).$$

- If U_j accepts *only* R_i's offer, then U_j will receive an (upfront) fixed fee of

$$2\left(\Pi^m_{(2)} - \Pi^M\right).$$

  At stage 3, R_i pays U_j according to the following tariff whenever $q_{ij} > 0$:

$$T^E_{cond}(q_{ij}) = \begin{cases} Z + c q_{ij} & \text{if } q_{i1} \leq x Q_i \\ c q_{ij} & \text{if } q_{i1} > x Q_i \end{cases}, \text{ where } x \in \left(\frac{1}{2}, 1\right).$$

It is easy to see that these contracts will lead to the same equilibrium outcome as the contracts in Proposition 2, which in fact are nothing but market share contracts for $q_{i1} = Q_i$ and $q_{i1} < Q_i$.

Inderst and Shaffer (2010) obtain the result that market-share contracts are necessary to achieve full intra- and inter-brand coordination in a different setting. In their model, U_A makes take-it-or-leave-it offers to the retailers while brand B is supplied by a competitive industry at marginal cost. The dominant supplier U_A wants to set above-cost wholesale prices to dampen intra-brand competition between the two retailers. Since the substitute brand is supplied at cost, however, such above-cost pricing will induce the retailer to divert sales to the other brand. Contracts that are conditional on U_A' minimum market share in each retailer's total sales offset this incentive and ensure that the retailers sell the two products at the prices that an integrated multi-product monopolist would choose.

The rationale for market-share contracts in my model is different. Each retailer offers a market-share contract as a commitment to carrying both brands later on. Such commitment is needed because to eliminate intra-brand competition supply contracts must induce drastic (i.e., discontinuous) reactions to any attempt by the rival retailer to undercut the equilibrium wholesale price, which in turn creates an incentive for each retailer to stock only one brand once contracts have been accepted (see Proposition 1). To eliminate their own future deviation incentive, retailers tie their own hands by means of market-share contracts.

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