Reservation Profit Levels and the Division of Supply Chain Profit

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Abstract

We address the problem of supply chain performance when the retailers have bargaining power. In particular, in a supply chain with one supplier selling to multiple competing retailers, we investigate the effect of retailer bargaining power in the allocation of total supply chain profit among all channel members. We model a retailer’s bargaining power through its ability to set reservation profit levels. In this environment, we show that supply chain performance is not maximized and, in some cases, one or more retailers are excluded from trade with the supplier. In equilibrium, retailers’ choices of reservation profit levels may induce the supplier to trade only with a strict subset of the retailers, even when all retailers must be included in order for channel profit to be maximized.

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1. Introduction

The role of bargaining power in supply chains is of interest. In this paper, we address the problem of supply chain performance when the retailers have bargaining power. In particular, in a supply chain with one supplier selling to multiple competing retailers, we investigate the effect of retailer bargaining power in the allocation of total supply chain profit among all channel members.

A standard approach to modeling bargaining power is to assume that the retailers have an exogenous reservation profit level below which they will not participate in the supply chain (see Cachon, 2003). These reservation profit levels are usually assumed to represent the profit that the retailers could achieve by pursuing another opportunity outside the supply chain. Furthermore, they are assumed to be exogenous, i.e., independent of the negotiation process and of the retailers’ opportunities within the supply chain.

A retailer’s outside opportunity may be related, for example, to the amount of shelf space required to stock a supplier’s product. Since shelf space is usually a scarce resource, a retailer could use this space to stock another product, earning revenues from its sales. Thus, the retailer should, at a minimum, set its reservation profit level equal to the potential profit of stocking that other product, i.e., the retailer’s reservation profit outside the supply chain. In general, the retailer could strategically select and announce its reservation profit level to reflect not only the value it can obtain from outside opportunities, but also its bargaining position within the supply chain relative to the other competing retailers.

In this paper, we focus on the ability of retailers to set reservation profit levels. In our model, retailers commit to a reservation profit level prior to the supplier’s final contract offer. In this environment, we show that supply chain performance is not maximized and, in some cases, one or more retailers are excluded from trade with the supplier. In equilibrium, retailers’ choices of reservation profit levels may induce the supplier to trade only with a strict subset of the retailers, even when all retailers must be included in order for channel profit to be maximized. On the supplier’s side, we explicitly incorporate the supplier’s opportunity profit by considering all the retailers that can carry the supplier’s product. That is, by comparing the profit earned by dealing with each subset of retailers, the supplier may choose to distribute its product only through a subset of retailers, excluding the remaining retailer(s) from trade.

We consider a general setting of a supplier distributing a product through multiple com-
peting retailers. The retailers may compete in terms of their prices or the amounts of
inventory they carry. When a supplier distributes its product through multiple retailers that
do not compete, i.e., the retailers are in independent markets, then supply chain profit is
maximized in environments such as those considered in this paper (see, e.g., Segal 1999).
In contrast, when retailers compete against one another, the choices made by one retailer
may impose externalities on its rivals, potentially preventing supply chain profit from being
maximized. In the model we consider, the supplier offers trading contracts to the retailers,
and each retailer establishes a minimum reservation profit level to participate in the relation-
ship. The retailers choosing to trade with the supplier submit the order quantities that
maximize their profits. We begin by considering the case of two competing retailers and then
extend our results to the case of multiple competing retailers. We also explore the effects of
changes in the order in which negotiations between the supplier and retailers unfold. Marx
and Shaffer (2004a,b) consider a similar setting, but in their model reservation profit levels
are exogenous and equal to zero and the retailers have all the bargaining power, including
the ability to set the wholesale price.

We examine two types of contracts in this paper. We begin in Section 2 by focusing
on two-part tariff contracts that consist of a wholesale price and a fixed fee. One can view
these contracts as a convenient way to formalize contracts that have quantity discounts (see
Weng, 1995; and Dolan, 1987). If the buyer purchases a positive quantity, it must pay
the fixed fee, and then it must pay the wholesale price for each unit purchased. Thus, the
more units purchased, the lower is the average price paid. Then, in Section 3.4, we consider
revenue-sharing contracts. These contracts consist of a wholesale price and a revenue share.
A buyer must pay the wholesale price for each unit purchased and then must pay a share
of its revenue from sales of the product to the supplier. Revenue-sharing contracts are a
commonly observed contract form (see, e.g., Cachon and Lariviere, 2005; Dana and Spier,
2001; and Wang et al., 2004). In addition, both contracting mechanisms—two-part tariff
and revenue sharing—have been shown to coordinate supply chains in a variety of settings
(see, e.g., Moorthy, 1987; Bernstein and Federgruen, 2005; and Cachon, 2003). In particular,
revenue-sharing contracts coordinate supply chains in which the retailers compete in terms
of their inventory levels (see Cachon and Lariviere, 2005).

The exclusivity results of this paper suggest that when retailers have bargaining power,
a supplier’s product may be sold through only one retailer, even when the maximization
of channel profits requires that the supplier’s product be sold through multiple retailers.
For example, in the toy industry, where there are powerful retailers such as Wal-Mart and Toys ‘R’ Us, it is not uncommon for toys to be sold exclusively through one of the retailers. According to Pereira and Zimmerman (2004), during the 2004 holiday shopping season, a number of toys, including Mattel’s Hokey-Pokey Elmo, were exclusively available through Toys ‘R’ Us, which has the toy industry’s largest selection with more than 9,000 products.\footnote{The authors thank Greg DeCroix for bringing this article to their attention.} They state that “Exclusives represent about 25% of the items in Toys ‘R’ Us’s inventory this year, up from 20% a year ago.” In addition, the description of Pereira and Zimmerman (2004) indicates that Toys ‘R’ Us could only achieve its required level of profit if it were the monopoly seller of certain toys. They describe Toys ‘R’ Us as “facing shrinking profits and slowing sales,” but say that there has been an “unusual show of support from suppliers,” with suppliers granting Toys ‘R’ Us the exclusive right to sell at least twenty-one toys. The article notes that Wal-Mart is notorious among toy suppliers for driving down prices. In fact, Wal-Mart is known to employ aggressive “loss leader” pricing tactics on popular toys, see Grant (2004). Of course, the contracts negotiated between Toys ‘R’ Us and its suppliers are more complex than those considered here, with contracts including provisions for suppliers to pay for television commercials for certain Toys ‘R’ Us exclusive toys. Other examples of exclusionary agreements include GE vacuum cleaners and a new women’s magazine published by Time, Inc., both of which are exclusively sold at Wal-Mart. (Note that Wal-Mart controls about 15% of sales of single-copy magazines in the U.S.)

A retailer’s bargaining power may also affect the portion of supply chain profit that it claims for itself. For example, in the video rental industry, where revenue-sharing contracts prevail, the particular split of aggregate supply chain profit (determined by the revenue share) depends on the retailers’ bargaining power. According to Alexander (2000), the movie studio DreamWorks and the video rental chain Blockbuster failed to reach an agreement on the terms of the revenue-sharing contract for the movie “American Beauty,” leaving Blockbuster out of the deal. Blockbuster only carried a few copies of this title purchased under a traditional price-only contract, which were off the shelves and behind the counters to reduce demand for a tape that may have been unavailable. However, the studio did establish revenue-sharing contracts with some of Blockbuster’s competitors.

The problem of one supplier selling through multiple competing retailers has received significant attention. The literature on this problem has focused mainly on two issues. One is the demand-stealing effect—each retailer orders more than the supply chain optimal
quantity (see, e.g., Mahajan and van Ryzin, 2001; and Netessine and Zhang, 2003). The other is the design of coordination schemes—contractual arrangements between the parties that allow the decentralized supply chain to perform as well as a centralized one. Several different contract types are known to coordinate a supply chain in this environment. For reviews of this literature, see the chapters by Tsay et al. (1998) and Cachon (2003). The papers addressing supply chain coordination have observed that the coordination schemes allow for an arbitrary allocation of the optimal supply chain profit among the firms in the channel, without focusing on how the allocation is determined.

Our results are consistent across the two different types of contracts, but the results differ from those obtained in the literature. The key difference between our model and those considered in the literature is that we allow the retailers to have bargaining power. For example, Mathewson and Winter (1984) show that when the supplier has all the bargaining power, supply chain profit is maximized in equilibrium (see also Segal, 1999). In contrast, we show that when the retailers have bargaining power, supply chain profit is not maximized. In addition, we show that some retailers may be excluded from trade with the supplier. A related result is obtained by Marx and Shaffer (2004a,b). Much of the vertical contracting literature on exclusive dealing focuses on the role of exclusive dealing provisions in environments with multiple suppliers and one retailer. In this environment, O’Brien and Shaffer (1997) and Bernheim and Whinston (1998) show that exclusion does not arise in equilibrium. Exclusion does sometimes arise in Aghion and Bolton’s (1987) sequential contracting environment when there is uncertainty over the second retailer’s costs. In an environment with one supplier and multiple, independent retailers, Rasmusen, et al. (1991) (and the more careful formalization by Segal and Whinston (2000)) show that exclusion can arise when there are economies of scale in upstream production and coordination failures at the downstream level. In the absence of scale economies, or in the absence of coordination failures, inefficient exclusionary contracts do not arise (Innes and Sexton, 1994). As in Mathewson and Winter (1984) and Segal (1999), we assume that contracts are observable.\footnote{For models with unobservable contracts, see Hart and Tirole (1990), McAfee and Schwartz (1994), Marx and Shaffer (2004c), and the “offer game” of Segal and Whinston (2003).}

There are a number of ways one might try to formalize retailer bargaining power on a supply chain. For example, one might allow the retailer to have a first-mover or last-mover advantage in the contracting sequence or one might allow the retailer to establish outside options to bolster its bargaining position. Caruana and Einav (2003) show that in a model...
with switching costs, players may have commitment power even without having a first-mover advantage. In our model, we allow the retailer to announce a reservation profit level, with commitment to that announcement based on reputational or other concerns. Thus, in our model, a retailer can credibly commit not to trade with the supplier if it does not receive a minimum level of profit from the transaction. This has interesting consequences in environments where there are multiple competing retailers, as in the model we consider. Whether a retailer will achieve its reservation profit level may depend on whether it has competition in the retail market and on the contract terms received by its rivals in the retail market. In particular, the retailer can in some setting use its bargaining power to demand a reservation profit level that can only be achieved if it has the exclusive right to sell the suppliers product in the retail market.

It appears that Van Mieghem (1999) is one of the first papers in the operations management literature to consider bargaining power in supply chains. The author considers bargaining through incomplete contracts. In that setting, firms leave some contract parameters unspecified ex-ante, and the division of surplus is based on the firms’ ex-post bargaining power. In Van Mieghem (1999), the bargaining solution is efficient (production decisions are coordinated) given the investment levels, but investment levels can be distorted. Similarly, in some of our settings, supply chain performance is maximized (efficient outcome) for the subset of retailers that trade with the supplier, but some retailers are excluded from the supply chain. A recent paper by Gurnani and Shi (2005) derives the Nash bargaining solution in a supply chain with asymmetric information. A number of other papers consider the division of supply chain profit. Nagarajan and Bassok (2003) have looked at a negotiation framework that determines the allocation of total profit for each firm in an assembly system. At the same time, this negotiation process allows players to maximize the performance of the supply chain. Corbett et al. (2004) consider a vertical contracting environment with one supplier and one retailer and asymmetric information. They assume that each player has an exogenously given reservation profit level below which they refuse to trade. Ertogral and Wu (2001) also consider a setting with one supplier and one buyer, and model the process of contract negotiation with the presence of outside opportunities for both firms. Our work differs from the latter two papers in that the supplier sells to multiple competing retailers and in that we allow endogenously chosen reservation profit levels for the buyers that may depend on the retailers’ opportunities within the supply chain, rather than taking those reservation profit levels as fixed and dependent only on outside opportunities. Finally, Raz
and Porteus (2005) study endogenously determined supply contracts between a supplier and a price-setting retailer. The return each party receives provides a measure of their bargaining power. Nagarajan and Sosic (2005) provide a survey of papers that use cooperative bargaining models to find the allocation of supply chain profit among firms in a supply chain.

The paper is organized as follows. In Section 2, we describe the model and present our main results for the case of two competing retailers under two-part tariff contracts. In Section 3, we consider alternative settings, including an extension of our results to the case of more than two retailers and to environments where firms trade under revenue-sharing contracts. Section 4 contains concluding comments. All proofs can be found in the appendix.

2. Model and Main Results

We first consider an environment with one supplier and two competing retailers. We defer the analysis of a setting with multiple competing retailers to Section 3.3. The retailers resell the supplier’s product to final consumers and may compete in terms of their prices or the amount of inventory they carry. For example, the two retailers might have outlets in different locations within the same town so that their products are not perfect substitutes, but so that they do compete with one another. We assume that the supplier has constant marginal cost $c \geq 0$. We also assume that a fully integrated firm (horizontally and vertically) would sell positive quantities at both retail outlets. Thus, channel efficiency requires that the supplier’s product be carried by both retailers.

Let $q_i$ be the stocking quantity at retailer $i$, if the product is sold through this retailer. Let $R_i(q)$ denote retailer $i$’s revenue when the stocking levels are given by $q = (q_1, q_2)$. We assume that $R_i(q)$ is differentiable. Finally, let $\Pi(q) = \sum_{i=1}^{2} (R_i(q) - cq_i)$ be the total supply chain profit. We say that retailer $i$ is active when $q_i > 0$, i.e., when retailer $i$ sells the supplier’s product.

The supplier establishes a two-part tariff contract with each of the buyers. Under a two-part tariff $(w_i, F_i)$, $w_i \geq 0$ is the per-unit price at which retailer $i$ can purchase the product and $F_i$ is the fixed fee paid at the time of ordering if and only if a positive quantity is purchased. As is well-known, channel profit can be maximized in many settings by having the supplier choose wholesale prices to offset the negative externality (business-stealing effect) that competing retailers impose on each other (see, e.g., Mathewson and Winter, 1984; and Bernstein and Federgruen, 2002). That is, an appropriately specified set of wholesale prices
coordinates the supply chain. We allow the fixed fee to be positive or negative. When \( F_i < 0 \),
this quantity can be interpreted as a slotting fee, while \( F_i > 0 \) corresponds to a franchise fee.\(^3\)

As in Marx and Shaffer (2004a), we model competition between the retailers in reduced
form. We do not specify the form of competition between the retailers, but instead assume
that each retailer’s profit (as a function of wholesale prices) satisfies certain conditions,
including differentiability. These conditions are satisfied if we model competition as Cournot
or differentiated products Bertrand and make the usual assumptions necessary to guarantee
the uniqueness of the equilibrium. The conditions are also satisfied, for example, in the
competing newsvendor model with fixed retail prices of Lippman and McCardle (1997) (see
Theorem 3 in that paper for conditions for uniqueness of a Nash equilibrium). Other models
of competition could be used, but for models with multiple equilibria, one would need to
specify an equilibrium selection rule that guaranteed that conditions such as differentiability
were satisfied. When wholesale prices are \( w_1 \) and \( w_2 \) and both retailers are active, we let
\( q_i(w_1, w_2) \) denote retailer \( i \)’s quantity and \( R_i(w_1, w_2) \) denote retailer \( i \)’s revenue as a function
of the wholesale prices that result from retailer competition. In addition, for a pair of
wholesale prices \( w_1, w_2 \), let \( \pi_i(w_1, w_2) = R_i(w_1, w_2) - w_i q_i(w_1, w_2) \) denote retailer \( i \)’s flow
payoff when both retailers are active. (Note that \( \pi_i(w_1, w_2) - F_i \) is retailer \( i \)’s profit when
both retailers are active.) For any \( w_j \), we assume there exists \( w_i, i \neq j \), sufficiently large
that retailer \( i \)’s flow payoff is zero. For smaller \( w_i \), if both retailers’ flow payoffs are positive,
we assume that \( \pi_i \) is increasing in \( w_j \), so that retailer \( i \)’s flow payoff is increasing in the
wholesale price of its rival. For example, this would hold when the retailers engage in either
Cournot or differentiated products Bertrand competition.

For a pair of wholesale prices \( w_1, w_2 \), assuming both retailers are active, we can write the
joint payoff of all three firms as

\[
\Pi(w_1, w_2) = \sum_{i=1}^{2} (w_i - c)q_i(w_1, w_2) + \sum_{i=1}^{2} \pi_i(w_1, w_2).
\]

We assume that \( \pi_i(w_1, w_2) \) and \( \Pi(w_1, w_2) \) are differentiable for \( i = 1, 2 \). In addition, we
assume that \( \arg \max_{w_i \geq 0} \Pi(w_1, w_2) \) is unique, and that \( \Pi(w_1, w_2) \) attains a maximum of
\( \Pi^* \equiv \Pi(w_1^*, w_2^*) \), where \( w_1^* = \arg \max_{w_1 \geq 0} \Pi(w_1, w_2^*) \) and \( w_2^* = \arg \max_{w_2 \geq 0} \Pi(w_1^*, w_2) \).\(^4\)

\(^3\)In a setting with exogenous reservation profit levels, Desai (2000) shows that slotting fees may be offered
to ensure retailer participation when retail competition is intense.

\(^4\)Compliance with the Robinson-Patman Act would require defining \( \Pi^* = \max_{w_1 = w_2} \Pi(w_1, w_2) \). All the
Note that \(w^*_i\) will typically exceed marginal cost \(c\). (In standard Cournot and differentiated-products Bertrand oligopoly models, the derivative of \(\Pi(w_1, w_2)\) with respect to \(w_i\) is positive when evaluated at \(w_i = c\), implying that \(w^*_i > c\).)

When only retailer \(i\) is active and the wholesale price is \(w_i\), we let \(q_i(w_i, \infty)\) and \(\pi_i(w_i, \infty)\) denote retailer \(i\)'s optimal quantity and corresponding optimal profit, respectively.\(^5\) If retailer 2 is inactive, we can write the overall joint payoff of the supplier and retailers as \(\Pi(w_1, \infty) = (w_1 - c)q_1(w_1, \infty) + \pi_1(w_1, \infty)\), and if retailer 1 is inactive, we can write the overall joint payoff of all three firms as \(\Pi(\infty, w_2) = (w_2 - c)q_2(\infty, w_2) + \pi_2(\infty, w_2)\). We assume that \(\pi_i(w_i, \infty)\) is differentiable and that \(\Pi(w_1, \infty)\) and \(\Pi(\infty, w_2)\) are differentiable and have unique maxima.\(^6\) In a setting with one active retailer, we denote the overall joint profit maximum by \(\Pi^m_1 \equiv \Pi(w^m_1, \infty)\), where \(w^m_1 = \arg\max_{w_1 \geq 0} \Pi(w_1, \infty)\), if retailer 2 is inactive, and by \(\Pi^m_2 \equiv \Pi(\infty, w^m_2)\), where \(w^m_2 = \arg\max_{w_2 \geq 0} \Pi(\infty, w_2)\), if retailer 1 is inactive. (We use superscript \(m\) to denote a monopolist retailer.) In contrast to the case in which both retailers are active, the joint-profit maximizing wholesale price in these cases is marginal cost. Intuitively, maximization of \(\Pi(w_1, \infty)\) and \(\Pi(\infty, w_2)\) requires that \(w^m_i = c\) to avoid double marginalization downstream.

Without loss of generality, we assume that \(\Pi^m_1 \geq \Pi^m_2\). That is, the two retailers are ordered with respect to their joint profitability with the supplier, if they operated as monopolists in the market. Because we assume the retailers’ products are substitutes, \(\Pi^m_1 + \Pi^m_2 > \Pi^*\). (If the retailers’ products were independent, or if they operated in independent markets, then we would have \(\Pi^m_1 + \Pi^m_2 = \Pi^*\). When the retailers have substitute products and compete against one another, the quantity sold by one retailer imposes a negative externality on the other retailer.) Because we assume that channel profit is maximized when both retailers carry the supplier’s product, i.e., the retailers’ products are not perfect substitutes, \(\Pi^* > \Pi^m_1 \geq \Pi^m_2\). (If the retailers’ products were perfect substitutes, then the supplier would be indifferent between selling through retailer 1, through retailer 2, or some mixture of the two, and we would have \(\Pi^m_1 = \Pi^m_2 = \Pi^*\).)

In what follows, we solve for the subgame-perfect equilibrium of our contracting game (the details of the model described above are assumed to be common knowledge). This results in the paper continue to hold under this restriction.

\(^5\)When the meaning is clear, we abuse notation by writing \(q_i(w_i, \infty)\) and \(\pi_i(w_i, \infty)\) to mean \(q_1(w_1, \infty)\) and \(\pi_1(w_1, \infty)\) if \(i = 1\), and \(q_2(\infty, w_2)\) and \(\pi_2(\infty, w_2)\) if \(i = 2\).

\(^6\)In standard Cournot and differentiated-products Bertrand oligopoly models, \(\Pi(w_1, \infty)\) is concave in the wholesale price \(w_1\), and similarly for \(\Pi(\infty, w_2)\).
solution concept requires that players behave optimally at each stage of the game, taking as given the actions that have already occurred, and looking forward to the remainder of the game. For example, given the actions taken by the players in stage 1, we have a new game, referred to as the “continuation game,” that starts from stage 2, and we require that players behave optimally in this continuation game.

It will be useful to define the supplier’s “disagreement payoff” in its negotiations with a particular retailer. When the supplier negotiates with retailer \( i \), we define its disagreement payoff with respect to retailer \( i \) to be the payoff it would get in the continuation game if it had no contract with retailer \( i \). Thus, the supplier’s disagreement payoff in its negotiations with retailer 1 is the payoff the supplier would get if it rejected retailer 1’s contract offer, or if its offer was rejected by retailer 1, and then it continued to negotiate with retailer 2 in a way that maximized its payoff in the continuation game.

Finally, for simplicity, we assume that each retailer’s opportunity profit outside the supply chain is zero. We denote by \( V_i \) retailer \( i \)’s decision regarding the minimum amount of profit it requires to participate in the supply chain and carry the supplier’s product, i.e., its endogenous reservation profit level. Positive opportunity profits outside the chain can easily be incorporated in our model.\(^7\) Then, in our context, the amount \( V_i \) is not related to any other source of income for retailer \( i \), but rather it is directly related to retailer \( i \)’s bargaining position in the supply chain and it represents the share of aggregate supply chain profit that retailer \( i \) requires to participate.

Although we have in mind that reputational concerns bind the retailers not to trade with the supplier if they cannot obtain a profit at least equal to their reservation profit, to formalize this in our static model, we assume that retailer \( i \) incurs a large cost \( x > \Pi^* \) if it chooses a positive quantity but has profit less than \( V_i \).\(^8\) By adding this cost to the model, we are assuming that it is costly for retailers to announce a reservation profit and then subsequently trade under a contract that does not allow them to meet their reservation profit level. We have in mind that retailers are concerned about their reputations, which we think of as the supplier’s belief about whether a retailer will choose to trade under a given contract, conditional on its announced reservation profit level. We have in mind that the supplier’s beliefs evolve in a way that retailers find it valuable to reject individual contract offers that do not meet their reservation profit levels rather than trade under them. For

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\(^7\)Suppose that \( E_i \) is retailer \( i \)’s opportunity profit from business outside the chain (e.g., stocking another product). Then, the retailer must announce a reservation profit level equal to \( \max\{V_i, E_i\} \).

\(^8\)We discuss later in this section the results for lower penalties.
example, if a retailer ever trades under a contract that does not allow it to achieve its reservation profit, the supplier’s beliefs might change in a way that its future contract offers hold the retailer to even lower profit.

In a repeated-game version of the model, one might endogenize the value of $x$ by allowing the supplier’s beliefs about whether retailers will accept profit levels below their announced reservation profit levels to depend on the observed behavior of the retailers. For example, we could view retailers as having types zero or one, where a type-one retailer never accepts profit less than its announced reservation profit level, but a type-zero retailer accepts any nonnegative profit. Suppose the supplier initially has beliefs over the values of the retailers’ types, but allow it to update its beliefs based on the observed behavior of the retailers. Given this, if a retailer ever accepts profit less than its announced reservation level, it reveals itself to be type zero, and as a result, the supplier extracts all surplus from that retailer in all future repetitions of the game. Thus, if a retailer’s equilibrium profit in the game with binding commitment to the announced reservation profit level is $P$, by accepting profit less than its reservation profit level it forfeits discounted present value of profit equal to $\delta - \delta P$, where $\delta$ is the per-repetition discount factor. This amount forfeit, which is endogenously determined, plays the role of $x$ in our model since it imposes a cost, which is larger than $P$ if $\delta > 1/2$ and potentially very large if $\delta$ is close to one, on the retailer if it reneges on its commitment to its announced reservation profit level. In the video rental industry, some studios (including DreamWorks) negotiate contracts on a title-by-title basis, and so we expect strong incentives to build and maintain a reputation as a tough negotiator.

2.1 Benchmark: Exogenous Reservation Profits

If we assume that each retailer’s alternative to accepting the supplier’s offer is to have profit given by an exogenous reservation profit level, then the supplier can extract all profit in the channel above the retailers’ exogenous profits through fixed fees. For example, consider the following game:

1. The supplier sets wholesale prices $w_1$ and $w_2$.

2. The supplier offers fixed fees $F_1$ and $F_2$.

3. Retailers observe all contract offers and simultaneously choose order quantities. If retailer $i$ chooses quantity $q_i = 0$, it pays nothing to the supplier and has profit equal
to its reservation profit level; but if it chooses \( q_i > 0 \), it pays \( w_i q_i + F_i \) to the supplier and has profit \( \pi_i(1, 2) - F_i \) if \( q_j > 0 \) or \( \pi_i(1) - F_i \) if \( q_j = 0 \).

In this environment, one can easily show that in equilibrium the supplier chooses wholesale prices \((w_1^*, w_2^*)\), channel profit is maximized, and the supplier extracts all the surplus.

**Proposition 1** *With exogenous reservation profits, channel profit is maximized and the supplier extracts all surplus above the retailers’ exogenous reservation profits.*

Using Proposition 1, if the retailers’ exogenous reservation profits are equal to zero, then the supplier’s equilibrium profit is equal to \( \Pi^* \). Channel profit is maximized, and the entire surplus is captured by the supplier.

### 2.2 Endogenous Reservation Profits

We now modify the benchmark model to allow for endogenous reservation profits. As discussed in the Introduction, one can view this as allowing the retailers to have some bargaining power. In the following contracting sequence, the retailers establish their reservation profit levels after learning the supplier’s wholesale price offers. In response to the reservation profit levels, the supplier then sets the fixed fees. Finally, each retailer chooses the quantity to purchase from the supplier, which is zero if its reservation profit level constraint is not met.

Consider then the following contracting sequence:

1. The supplier sets wholesale prices \( w_1 \) and \( w_2 \).
2. Retailers establish their reservation profit levels \( V_1 \) and \( V_2 \).
3. The supplier offers the fixed fees \( F_1 \) and \( F_2 \).
4. Retailers observe all contract offers and simultaneously choose quantities. If retailer \( i \) chooses quantity \( q_i = 0 \), it pays nothing to the supplier and has zero profit; but if it chooses \( q_i > 0 \), it pays \( w_i q_i + F_i \) to the supplier and has profit \( \pi_i(1, 2) - F_i - xI_{\pi_i(1, 2) - F_i < V_i} \) if \( q_j > 0 \) or \( \pi_i(1) - F_i - xI_{\pi_i(1) - F_i < V_i} \) if \( q_j = 0 \), where \( I_a \) is an indicator function that is one if \( a \) is true and zero otherwise.

Note that if \( w_i = w_i^* \), \( i = 1, 2 \), the retailers’ reservation profit levels impose lower bounds on the portion of the coordinated supply chain profit they claim.
As one might expect, in this environment, we can show that the supplier’s equilibrium profit is reduced relative to the benchmark case. Allowing retailers to determine their reservation profit levels effectively increases their bargaining power, and so reduces the amount of surplus that the supplier is able to capture. It is less clear whether allowing retailers to determine their reservation profit levels will affect the efficiency of the channel, but as we now show, channel efficiency is, in fact, reduced.

**Proposition 2** With endogenous reservation profits, channel profit is not maximized. If \( \Pi(w_1, c) \leq \Pi(w_1, \infty) \) and \( \Pi(w_1, \infty) \geq \Pi^m_2 \) for some \( w_1 \geq c \), then the supplier’s profit is \( \Pi^m_2 \); otherwise, the supplier’s profit is less than \( \Pi^m_2 \).

To understand Proposition 2, note that when retailers determine their reservation profit levels, they can extract their incremental contribution to the channel. For example, if only one retailer sells the supplier’s product in equilibrium, then it is clear that channel profit is not maximized. If both retailers sell the supplier’s product, then retailer 1’s incremental contribution is \( \Pi(w_1, w_2) - \Pi(\infty, w_2) \) and retailer 2’s incremental contribution is \( \Pi(w_1, w_2) - \Pi(w_1, \infty) \). If both retailers capture their incremental contributions, then the supplier’s payoff (obtained by subtracting the retailers’ incremental contributions from \( \Pi(w_1, w_2) \)) is \( \Pi(w_1, \infty) + \Pi(\infty, w_2) - \Pi(w_1, w_2) \), which has maximum at wholesale prices less than \((w^*_1, w^*_2)\), and so channel profit is not maximized. Note that the coordinating wholesale price vector \( w^* \) is available to the supplier, as it is when reservation profit levels are exogenous. However, in this setting the supplier has incentive to deviate from the channel maximizing wholesale prices. The conditions of the proposition determine when the supplier’s maximum profit is at or below \( \Pi^m_2 \).

Proposition 2 shows that the channel profit is not maximized. This result relies on our assumption that the retailers can credibly commit to their reservation profit levels. If, for example, we adopt a different assumption similar to that of Muthoo (1996) that allows retailers to accept profit levels less than their reservation profit levels by incurring a penalty that is proportional to the difference between their reservation profit level and their actual

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\(^9\)If the supplier is required to offer equal fixed fees to comply with the Robinson-Patman Act, then the results in Proposition 2 continue to hold. In this setting, the supplier sets the (equal) fixed fees to meet the reservation profit constraint of the weaker retailer, leaving some additional surplus to the other retailer. Then, in an equilibrium where the two retailers are active, only the stronger retailer’s equilibrium profit equals its incremental contribution to the channel. Note that to the extent that equilibria involve exclusion, Robinson-Patman may not prevent discriminatory terms from being offered because a secondary line case under the Robinson-Patman Act can only proceed if the disadvantaged retailer has positive sales.
profit level, then there exist equilibria in which the channel profit is maximized and the supplier captures all the surplus. To understand this result, note that the supplier will always offer fixed fees that extract the maximal surplus from the retailers. When the retailers can credibly commit to their reservation profit levels, the supplier must leave them with at least this level of profit. If the retailers can accept a lower level, taking into account any penalties for reneging on their claimed reservation profit level, then the supplier will hold them to this lower level. Since retailers will trade as long as their payoff, taking into account these penalties, is nonnegative, the supplier can hold them down to zero profit. Given this, the supplier prefers to maximize channel profit, and the retailers cannot profitably deviate.

Proposition 2 gives conditions under which the supplier’s profit is equal to $\Pi^m_2$. These conditions are satisfied if, for example, $\Pi(c, c) \leq \Pi^m_1$, as is the case for Cournot competition with linear demand,\(^\text{10}\) giving us the following corollary.

**Corollary 1** With endogenous reservation profits, if $\Pi(c, c) \leq \Pi^m_1$, then the supplier’s profit is $\Pi^m_2$.

Proposition 2 shows that channel profit is not maximized when reservation profits are endogenous. However, for some parameter values, the result is even stronger. When $\Pi(c, c) \leq \Pi^m_1$, then not only is channel profit not maximized, but the supplier only sells its product through one of the retailers.

**Proposition 3** With endogenous reservation profits, if $\Pi(c, c) \leq \Pi^m_1$, then the supplier only sells its product through retailer 1.

Proposition 3 is similar to the exclusion results of Marx and Shaffer (2004a,b), where reservation profit levels are exogenous and equal to zero and the retailers have all the bargaining power, including the ability to set the wholesale price.

Proposition 3 states that for some environments (for example Cournot competition with linear demand), allowing retailers to determine their reservation profit levels endogenously results in one of the retailers being excluded from trade with the supplier. In equilibrium, the retailers set reservation profit levels such that the supplier prefers to allow the more efficient retailer to have a monopoly at the retail level. In the equilibrium with one retailer,

\(^{10}\)For Cournot competition with linear demand $P(Q) = a - bQ$, one can show that $\Pi(c, c) = \frac{2(a-c)^2}{4b}$ and $\Pi^m_1 = \frac{(a-c)^2}{4b}$, and so for this case $\Pi(c, c) \leq \Pi^m_1$. For an example in which $\Pi(c, c) > \Pi^m_1$, see the differentiated products Bertrand example below.
channel profit is maximized conditional on there only being one retailer. In any equilibrium in which both retailers sell the supplier’s product, endogenous reservation profits prevent channel profit from being maximized (conditional on both retailers selling the product). Thus, under some conditions, the supplier prefers its slice of the maximized one-supplier surplus $\Pi_m^1$ rather than its slice of the two-supplier surplus $\Pi(w_1, w_2) < \Pi^*$. For the special case of symmetric retailers, $\Pi(c, c) = \Pi_m^1 = \Pi_m^2$, so Proposition 2 implies that the supplier’s profit is $\Pi_m^2$ if and only if $\Pi(c, c) \leq \Pi_m^1$, and equilibrium reservation profits are $V_1 = \Pi_m^1 - \Pi_m^2 = 0$ and $V_2 = 0$. Thus, using the exclusion result of Proposition 3, we have the following corollary.

**Corollary 2** With endogenous reservation profits and symmetric retailers, if $\Pi(c, c) < \Pi_m^1 = \Pi_m^2$, then the supplier’s profit is $\Pi_m^2 = \Pi_m^1$, both retailers choose reservation profit levels of zero, and the supplier only sells its product through one retailer.

Corollary 2 implies that symmetric retailers compete away all their surplus in their attempts to be the sole retailer through which the supplier sells its product. Thus, even though the retailers choose their reservation profits, in equilibrium competition from a symmetric rival causes the retailers to bid away all of their surplus to the supplier.

**Example**

Proposition 2 shows that with endogenous reservation profits, whether the supplier’s profit is equal to or less than $\Pi_m^2$ depends on whether $\Pi(c, c)$ is less than or greater than $\Pi_m^1$. As shown in footnote 10, for Cournot competition and linear demand, it is always the case that $\Pi(c, c) < \Pi_m^1$. To give an example in which $\Pi(c, c)$ is sometimes less than and sometimes greater than $\Pi_m^1$, we now consider the case of differentiated products Bertrand competition with symmetric firms and linear demand $Q_i(p_1, p_2) = \frac{a}{1+s} - \frac{1}{1-s^2}p_i + \frac{a}{1-s^2}p_3-i$, where $s \in (0, 1)$ measures the degree of substitutability between the products ($s = 0$ corresponds to independent products and $s = 1$ corresponds to perfect substitutes).

In this environment, one can show that $\Pi(c, c, s) = \frac{2(a-c)^2(1-s)}{(2-s)^2(1+s)}$ and $\Pi_m^1 = \Pi_m^2 = \frac{(a-c)^2}{4}$. Thus, for the case of independent products ($s = 0$), $\Pi(c, c, 0) = \frac{(a-c)^2}{2}$, which implies that $\Pi(c, c, 0) = 2\Pi_m^1$, i.e., channel profit is the sum of the profits in the two independent channels. When the products are perfect substitutes ($s = 1$), the two retail firms compete away all their surplus.

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To generate this demand, we use inverse demand functions $p_i = a - q_i - sq_j$. Similar results hold with asymmetric firms with inverse demand functions $p_i = a_i - q_i - sq_j$, where $a_2 \leq a_1$ and $s \in (0, a_2/a_1)$.
profits, to the benefit of consumers, and so $\Pi(c, c; 1) = 0$. Thus, $\Pi(c, c; 1) < \Pi_1^m < \Pi(c, c; 0)$. Since $\Pi(c, c; s)$ is a continuous, decreasing function of $s$, for $s \in (0, 1)$, it follows that for $s$ sufficiently large (sufficiently strong substitutes), $\Pi(c, c; s) < \Pi_1^m$, and for $s$ sufficiently small (sufficiently weak substitutes), $\Pi(c, c; s) > \Pi_1^m$. In particular, $\Pi(c, c; s) < [>]\Pi_1^m$ if $s$ is greater [less] than approximately 0.61.

This example shows that when the retailers’ products are sufficiently strong substitutes, then, as in the case of Cournot competition where the products are assumed to be perfect substitutes, $\Pi(c, c) < \Pi_1^m$, and so, using Corollary 1 and Proposition 3, in equilibrium the supplier only sells its product through retailer 1, and its profit is $\Pi_2^m$. When the retailers’ products are sufficiently weak substitutes, then the supplier may or may not sell its product through both retailers, but in any case, using Proposition 2, channel profit is not maximized and the supplier’s profit is less than $\Pi_2^m$. When the retailers’ products are weaker substitutes, each retailer’s incremental contribution to channel profit is greater, and the supplier’s option of excluding one retailer and selling only through the other is less valuable, i.e., the supplier’s bargaining position within the supply chain is weaker. Thus, the supplier’s profit is lower in the case of sufficiently weak substitutes.

3. Extensions

In this section, we discuss the implications of different assumptions regarding the order of play, increased retailer bargaining power, and the number of retailers. In addition, we discuss how our results apply to other contracts.

3.1 Retailers Move First

In the settings we have considered so far, the supplier initiates the trading relationship with the retailers by posting the wholesale prices. These define the amount of supply chain profit that can potentially be shared among the channel members. One could also consider environments in which the retailers state their reservation profit levels before any of the contract terms are set. In this case, the reservation profit levels are independent of the negotiation process, that is, they cannot depend on the size of supply chain profit determined by the wholesale prices.

For any pair of reservation profit levels $V_1$ and $V_2$, the supplier will either set wholesale prices equal to marginal cost and fixed fees so that only one retailer is active, or it will set
$w = w^*$ and trade with both retailers. In the first case, the supplier’s equilibrium profit would be $\Pi_m^1 - V_1$ or $\Pi_m^2 - V_2$, whereas in the latter case, its equilibrium profit would be $\Pi^* - V_1 - V_2$. That is, the supplier extracts all surplus above the retailers’ reservation profit levels. There are two possible equilibria in this setting. In one, only the stronger retailer is active, $V_1 = \Pi_m^1 - \Pi_m^1$ and $V_2 = 0$, and the supplier makes a profit of $\Pi_m^2$. In the other equilibrium, both retailers are active, $V_1 = \Pi^* - \Pi_m^2$ and $V_2 = \Pi^* - \Pi_m^2$, and the supplier’s equilibrium profit is $\Pi_m^1 + \Pi_m^2 - \Pi^*$. Note that both retailers are better off in the latter equilibrium, while the supplier is better off when retailer 2 is excluded from trade (since $\Pi_m^1 + \Pi_m^2 - \Pi^* < \Pi_m^2$).

### 3.2 Retailers Set Fixed Fees

In the previous section, we showed that with endogenous reservation profits chosen by the retailers and fixed fees offered by the supplier, the supplier’s profit is less than or equal to $\Pi_m^2$. In particular, there are environments, e.g., Cournot competition or differentiated products Bertrand competition with products that are sufficiently close substitutes, in which the supplier’s profit is equal to $\Pi_m^2$, and there are environments, e.g., differentiated products Bertrand competition with products that are sufficiently weak substitutes, in which the supplier’s equilibrium profit is less than $\Pi_m^2$.

In this section, we modify our assumptions about the negotiation process slightly to allow the retailers to offer the fixed fees. Interestingly, in this case, the supplier’s profit is always equal to $\Pi_m^2$. Thus, when we give the retailers this additional bargaining power, they are unable to extract any additional surplus from the supplier. And, in environments in which the supplier’s profit is less that $\Pi_m^2$ when it offers the fixed fees, the supplier can actually increase its profit by ceding some of the negotiating power to the retailers.

Specifically, consider the following contracting sequence:

1. The supplier sets wholesale prices $w_1$ and $w_2$.

2. Retailers establish their reservation profit levels $V_1$ and $V_2$.

3. Retailers offer fixed fees $F_1$ and $F_2$.

4. The supplier accepts or rejects each offer.
5. Retailers observe all contract offers and simultaneously choose quantities. If retailer
$i$ chooses quantity $q_i = 0$, it pays nothing to the supplier and has zero profit; but if
it chooses $q_i > 0$, it pays $w_i q_i + F_i$ to the supplier and has profit $\pi_i(w_1, w_2) - F_i -
\pi_i(w_1, \infty) - F_i - x I_{\pi_i(w_1, w_2) - F_i < V_i}$ if $q_j > 0$ or $\pi_i(w_1, \infty) - F_i - x I_{\pi_i(w_1, \infty) - F_i < V_i}$ if $q_j = 0$.

Note that the only difference from the contracting sequence considered in Section 2.2 is
that in step 3, it is the retailers rather than the supplier that offer the fixed fees, and that
we add step 4 to allow the supplier to respond to the retailers’ offers. As we now show, with
this change, the channel profit is still not maximized, but the supplier’s profit is greater (or
at least, not lower). We begin by establishing that, in equilibrium, the supplier does not
trade with both retailers.

**Lemma 1** There is no equilibrium in which the supplier sells its product through both re-
tailers.

To see the intuition for Lemma 1, note that a retailer, when choosing its reservation
profit level, can choose a value such that its reservation profit level cannot be met (given the
suppliers’ wholesale prices) unless it is a monopolist in the retail market. Thus, a retailer can
effectively use its contract offer to “demand” a position as monopolist in the retail market.
Given this behavior by the retailers, the supplier’s best response is to accept only one of
the retailers’ offers.

Using Lemma 1, we can prove the following proposition.

**Proposition 4** With endogenous reservation profits and fixed fees chosen by the retailers,
channel profit is not maximized, the supplier only sells its product through retailer 1, and the
supplier’s profit is $\Pi^m_2$.

The intuition for Proposition 4 is similar to that for Proposition 2, except that when the
retailers offer the fixed fees, in equilibrium the retailers choose the fixed fees so that in the
equilibrium of the continuation game the supplier only accepts one of the retailers’ offers. By
choosing wholesale prices equal to $c$, the supplier guarantees that retailer 1 cannot extract
any more surplus than $\Pi^m_1 - \Pi^m_2$, since the supplier could choose to trade only with retailer
2. Thus, if the supplier does trade with retailer 1, this leaves surplus $\Pi^m_2$ for the supplier.

Note that setting the fixed fee does not make the ability to set a reservation profit level
irrelevant. For any pair of wholesale prices $w_i$ and $w_j$, with $\Pi(w_i, \infty) > \Pi(\infty, w_j)$, setting
the fixed fee \( F_i = \pi_i(w_i, \infty) - [\Pi(w_i, \infty) - \Pi(\infty, w_j)] \), does not guarantee retailer \( i \) a profit of \( \Pi(w_i, \infty) - \Pi(\infty, w_j) \). Indeed, if the supplier chose to trade with both retailers, retailer \( i \)'s profit would equal \( \pi_i(w_i, w_j) - F_i = \pi_i(w_i, w_j) - \pi_i(w_i, \infty) + \Pi(w_i, \infty) - \Pi(\infty, w_j) < \Pi(w_i, \infty) - \Pi(\infty, w_j) \), since \( \pi_i(w_i, w_j) < \pi_i(w_i, \infty) \). Thus setting the fixed fee alone does not guarantee a retailer of its reservation profit level.

Retailer 1’s announced reservation profit level serves the role of committing it not to trade if it is not a monopolist in the downstream market. Thus, it is important that \( V_1 \) be greater than the profit that retailer 1 would receive if it were not a monopolist. For example, if \( w_1 = w_2 = c \) and \( F_1 = \Pi^m_2 \), as is the case in our exclusionary equilibrium, then we require \( V_1 > \pi_1(c, c) - \Pi^m_2 \). In addition, since retailer 1’s equilibrium profit is \( \Pi^m_1 - \Pi^m_2 \), \( V_1 \) cannot be greater than this amount. Thus, if \( \pi_1(c, c) - \Pi^m_2 \geq 0 \), there are a continuum of exclusionary equilibria with values of \( V_1 \) such that \( V_1 \in (\pi_1(c, c) - \Pi^m_2, \Pi^m_1 - \Pi^m_2] \). In all of these equilibria, the equilibrium outcome is the same.

Combining Proposition 4 with our previous results, we have the following corollary.

**Corollary 3** With endogenous reservation profits, the supplier’s profit weakly increases (strictly for some environments) if it allows retailers to offer the fixed fees rather than offering them itself.

Corollary 3 highlights the fact that with endogenous reservations profits, the equilibrium outcome may be sensitive to assumptions made about the contracting game.

### 3.3 Multiple Retailers

In this section we explore results for \( N > 2 \) retailers. We restrict the analysis to the case in which retailers have significant bargaining power in the supply chain so that, after establishing their reservation profit levels, they determine the fixed fees that will apply if they trade with the supplier.

Similar to the case with two retailers, we define the quantities \( q_i(w_1, \ldots, w_N) \), revenues \( R_i(w_1, \ldots, w_N) \), retailer profit \( \pi_i(w_1, \ldots, w_N) \), and supply chain profit \( \Pi(w_1, \ldots, w_N) \), resulting in an equilibrium of the continuation game from the wholesale prices \( (w_1, \ldots, w_N) \) set by the supplier, where each \( w_i \in [0, \infty] \) and \( w_i = \infty \) if \( q_i = 0 \), i.e., if retailer \( i \) is not active. In addition, we define \( \Pi^m_i \equiv \max_{w_i \geq 0} \Pi(w_i, w_{-i} = \infty) = \Pi(w^m_i, w_{-i} = \infty) \). We assume, without loss of generality, that retailers are ordered such that \( \Pi^m_1 \geq \Pi^m_2 \geq \ldots \geq \Pi^m_N \), i.e.,
the retailers are ordered with respect to their joint profitability with the supplier, if they
operated as monopolists in the market. Finally, as for the case of two retailers, we assume
that \( \pi_i(w_1, \ldots, w_N) \) is increasing in all \( w_j, \ j \neq i \) and that \( \Pi(w_i, w_{-i} = \infty) \) is unimodal in \( w_i \).

For the case of two-part tariffs, the contracting sequence is as follows:

1. The supplier sets wholesale prices \( w_1, \ldots, w_N \).
2. Retailers establish their reservation profit levels \( V_1, \ldots, V_N \).
3. Retailers offer fixed fees \( F_1, \ldots, F_N \).
4. The supplier accepts or rejects each offer.
5. Retailers observe all contract offers and simultaneously choose quantities. If retailer
   \( i \) chooses quantity \( q_i = 0 \), it pays nothing to the supplier and has zero profit; but if
   it chooses \( q_i > 0 \), it pays \( w_i q_i + F_i \) to the supplier and has profit \( \pi_i(w_i, w_{-i}) - F_i - xI_{\pi(w_i, w_{-i}) < V_i} \), where \( w_j = w_j \) if \( q_j > 0 \) and \( w_j = \infty \) if \( q_j = 0 \).

As in the case of two competing retailers, we first show that in any equilibrium at least
one retailer is excluded from the deal.

**Lemma 2** There is no equilibrium in which the supplier sells its product through all the
retailers.

We now establish that an equilibrium always exists.

**Proposition 5** With endogenous reservation profits and multiple retailers, there exists an
equilibrium in which only the largest retailer (retailer 1) sells the supplier’s product.

We next show that, under this contracting sequence, there can be an equilibrium in which
all retailers trade with the supplier, except for the largest retailer (retailer 1). We present
the result for the case of three retailers. First, we introduce the following condition.

**Condition 1** *(Dominant Retailer)* Consider a set of wholesale prices \( (w_1, w_2, w_3) \). If
\( \Pi(w_i, \infty, \infty) = \max_{k=1,2,3} \Pi(w_k, \infty, \infty) > 0 \) and \( q_k(w_i = \infty, w_{-i}) > 0, \ k \neq i \), then \( \Pi(w_i = \infty, w_{-i}) - \Pi(w_i, w_{-i} = \infty) > 0 \) and for \( k \neq i \), \( \pi_k(w_i, w_k, \infty) < \pi_k(w_i = \infty, w_{-i}) \).
To interpret the Dominant Retailer Condition, suppose that wholesale prices are such that retailers 2 and 3 would choose positive quantities if retailer 1 did not operate, and wholesale prices are such that, conditional on only one retailer operating, the supply chain profit is maximized if that one retailer is retailer 1 (i.e., \( i = 1 \)). Thus, retailer 1 is the “dominant retailer.” Then the condition states that (i) the supply chain profit is greater if retailers 2 and 3 operate and retailer 1 does not than if only retailer 1 operates, and (ii) the flow payoff of retailers 2 and 3 is greater if those retailers operate together with each other, to the exclusion of the dominant retailer, rather than if one of those retailers operates together with the dominant retailer.

Using the Dominant Retailer Condition, we have the following Proposition.

**Proposition 6** Assume that the Dominant Retailer Condition holds for any set of wholesale prices \( w_1, w_2, w_3 \). Then, there exists an equilibrium in which only retailers 2 and 3 trade with the supplier, but retailer 1 is excluded.

For the case of two competing retailers, we showed that if only one retailer trades with the supplier in equilibrium, then that retailer is the more efficient. In contrast, Proposition 6 shows that when multiple retailers compete in the downstream market, the most efficient (dominant) retailer may be excluded from trade in equilibrium.

### 3.4 Revenue-Sharing Contracts

We now look at other possible contracts between the supplier and the retailers. In particular, we consider revenue-sharing contracts in settings where retailers compete with the amount of inventory they carry. The results are still valid in these settings. In general, we believe that the results in previous sections continue to hold as long as the contracting mechanism has two levers, allowing for arbitrary allocations of the supply chain profit.

Under a revenue-sharing contract, each of the retailers pays the supplier a wholesale price \( w_i \geq 0 \) for each unit purchased and retains a proportion \( \alpha_i \) of the revenues it generates. Revenue-sharing agreements are common in the video tape rental industry, see, e.g., Shapiro (1998) and Cachon and Lariviere (2005), but they also apply to other industries, see, e.g., Wang et al. (2004) and Miel (2001). Cachon and Lariviere (2005) show that a continuum of revenue-sharing contracts can coordinate a supply chain with a supplier that sells to multiple competing retailers, when these retailers’ sole decision is the quantity to purchase from the
supplier. In addition, they show that the coordinating revenue-sharing contracts can be implemented as profit-sharing contracts.

The parameters $\alpha$ in these contracts serve the purpose of allocating the profit between the supplier and the retailers. Cachon and Lariviere (2005, p.33) state that, “The particular profit split chosen probably depends on the firms’ relative bargaining power. As the retailer’s bargaining position becomes stronger, one would anticipate $[\alpha]$ increases. As a proxy for bargaining power, each firm may have an outside opportunity profit ... that the firm requires to engage in the relationship.” In that paper, the opportunity profit levels are exogenous.

As was shown for two-part tariff contracts in Proposition 1, when the reservation profits are exogenous and the supplier sets the contract parameters, channel profit is maximized and the equilibrium wholesale prices are $(w_1^*, w_2^*)$. However, a strategic choice of the reservation profit levels may result in a setting in which only one of the retailers trades with the supplier and channel profit is not maximized. Indeed, all the results in the paper continue to hold in the context of profit-sharing contracts if the fixed fee offers are replaced by a share parameter $\alpha_i$ for each retailer $i$.

4. Conclusions

In this paper we consider a supply chain with one supplier trading with multiple competing retailers and address the problem of supply chain performance when the retailers have bargaining power. We model a retailer’s bargaining power through its ability to set a reservation profit level below which it will not participate in the supply chain.

The reservation profit level depends on the negotiation process (e.g., the wholesale prices set by the supplier) and on the retailer’s opportunities within and outside the supply chain. The supplier’s bargaining position within the channel relies on its option to deal with only a subset of the retailers, which forces the retailers to compete away part of their profit in their attempt to trade with the supplier.

The retailers may compete in terms of the prices they charge or in terms of the amount of inventory they carry. We examine two contractual arrangements commonly used in the supply chain contracting literature. Two-part tariffs, which are known to coordinate settings with price competition, and revenue-sharing contracts, which have been shown to coordinate the inventory decisions across firms in a supply chain.

When the retailers have the ability to set reservation profit levels, our results indicate
that supply chain performance is not maximized, or it is maximized for the supplier and the retailers that offer the supplier’s product, but some retailers are excluded from trade.

In settings in which two retailers can carry the supplier’s product, we show that the retailers set their reservation profit levels to extract their incremental contribution to the channel. In equilibria in which only one retailer trades with the supplier, the reservation profit levels are such that the less efficient retailer is excluded. In contrast, when the supplier can distribute its product through multiple retailers, we show that the most efficient retailer may be excluded from trade.

The results in this paper shed light on the question of how supply chain profit is divided according to the firms’ bargaining position within the supply chain. More importantly, our results provide important caution regarding the impact of retailer bargaining power on the ability to maximize supply chain profit (and coordinate the supply chain). We conjecture that as retailers gain more bargaining power, more complex contract schemes may be required to coordinate the channel.
A. Appendix—Proofs

Proof of Proposition 2. Consider first a fixed pair of wholesale prices \((\hat{w}_1, \hat{w}_2)\). For any reservation profit levels \(\hat{V}_1\) and \(\hat{V}_2\) selected by the retailers, the supplier maximizes its payoff in the continuation game by choosing either \(i\) \(F_1 = \pi_1(\hat{w}_1, \infty) - \hat{V}_1\) and \(F_2 = \infty\), \(ii\) \(F_2 = \pi_2(\infty, \hat{w}_2) - \hat{V}_2\) and \(F_1 = \infty\), or \(iii\) \(F_1 = \pi_1(\hat{w}_1, \hat{w}_2) - \hat{V}_1\) and \(F_2 = \pi_2(\hat{w}_1, \hat{w}_2) - \hat{V}_2\). Note that in choice \(i\) \[\text{(ii)}\], the supplier is effectively leaving retailer 2 [1] out of the deal by requesting an exceedingly high fixed fee, while requesting a fixed fee from the other retailer just low enough to satisfy the required reservation profit level constraint. In choice \(iii\), the supplier’s fixed fee offers allow both firms to participate in the resale market, and earn profits exactly equal to their reservation profit levels. In the three cases above, the supplier’s profit is, respectively, \(i\) \(\Pi(\hat{w}_1, \infty) - \hat{V}_1\), \(ii\) \(\Pi(\infty, \hat{w}_2) - \hat{V}_2\), or \(iii\) \(\Pi(\hat{w}_1, \hat{w}_2) - \hat{V}_1 - \hat{V}_2\).

Suppose that \(\Pi(\hat{w}_1, \infty) \geq \Pi(\infty, \hat{w}_2)\).

First, consider the case in which \(\Pi(\hat{w}_1, \hat{w}_2) > \Pi(\hat{w}_1, \infty)\). Anticipating the choice of the supplier, retailers set reservation profit levels \(\hat{V}_1 = \Pi(\hat{w}_1, \hat{w}_2) - \Pi(\infty, \hat{w}_2) > 0\) and \(\hat{V}_2 = \Pi(\hat{w}_1, \hat{w}_2) - \Pi(\hat{w}_1, \infty) > 0\), implying that the supplier is indifferent among trading only with retailer 1, only with retailer 2, and with both retailers. If the supplier chooses to trade with both, then the retailers have no incentive to increase their reservation profit levels since doing so would cause the supplier to trade only with the other retailer, while a decrease in a retailer’s reservation profit level would clearly lead to a lower profit for this retailer. (Note that for any \(0 \leq \delta \leq \hat{V}_2\), the reservation profit levels \(\hat{V}_k(\delta) = \hat{V}_k - \delta, k = 1, 2\), are such that \(\Pi(\hat{w}_1, \infty) - \hat{V}_1(\delta) = \Pi(\infty, \hat{w}_2) - \hat{V}_2(\delta)\), and the supplier is better off trading with both retailers, since \(\Pi(\hat{w}_k, \infty) - \hat{V}_k(\delta) = \Pi(\hat{w}_k, \infty) - \hat{V}_k + \delta = \Pi(\hat{w}_1, \hat{w}_2) - \hat{V}_1 - \hat{V}_2 + \delta < \Pi(\hat{w}_1, \hat{w}_2) - \hat{V}_1(\delta) - \hat{V}_2(\delta)\). However, the retailers’ profits are maximized when \(\delta = 0\).) The supplier then makes fixed fee offers as in \(iii\) above, i.e., \(F_1 = \pi_1(\hat{w}_1, \hat{w}_2) + \Pi(\infty, \hat{w}_2) - \Pi(\hat{w}_1, \hat{w}_2)\) and \(F_2 = \pi_2(\hat{w}_1, \hat{w}_2) + \Pi(\infty, \hat{w}_1) - \Pi(\hat{w}_1, \hat{w}_2)\). That is, in equilibrium, the supplier allows both retailers to participate in the resale market by offering fixed fees low enough to satisfy their reservation profit level constraints. Choices \(i\) and \(ii\) cannot be an equilibrium, since the retailer excluded from the deal (by setting its fixed fee equal to infinity) could then slightly reduce its reservation profit level, making it more profitable to the supplier to deal with this retailer instead. Then, it is an equilibrium of the continuation game for the retailers to set the reservation profit levels \(\hat{V}_1\) and \(\hat{V}_2\), and for the supplier to set fixed fees \(\hat{F}_1\) and \(\hat{F}_2\). Note

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that since $\Pi(\hat{w}_1, \hat{w}_2) > \Pi(\hat{w}_1, \infty)$, the supplier’s profit is

$$
\Pi(\hat{w}_1, \infty) + \Pi(\infty, \hat{w}_2) - \Pi(\hat{w}_1, \hat{w}_2) < \Pi(\infty, \hat{w}_2) \leq \Pi_i^m. \tag{A.1}
$$

Second, if $\Pi(\hat{w}_1, \hat{w}_2) \leq \Pi(\hat{w}_1, \infty)$, then the supplier’s profit is always larger under option (i) than under option (iii), i.e., the supplier does not choose to trade with both retailers in this case. Then, retailer 1 sets $\hat{V}_1 = \Pi(\hat{w}_1, \infty) - \Pi(\infty, \hat{w}_2)$ and retailer 2 sets $\hat{V}_2 = 0$, making the supplier indifferent between options (i) and (ii). In equilibrium, the supplier then offers retailer 2 to be excluded from the deal.

Collecting the possible cases, the supplier chooses wholesale prices $w_1$ and $w_2$ to maximize

$$
\pi_s(w_1, w_2) = \begin{cases} 
\Pi(w_1, \infty) + \Pi(\infty, w_2) - \Pi(w_1, w_2), & \text{if } \Pi(w_1, \infty) \geq \Pi(\infty, w_2) \\
\Pi(\infty, w_2), & \text{if } \Pi(w_1, \infty) \geq \Pi(\infty, w_2) \text{ and } \Pi(w_1, w_2) > \Pi(w_1, \infty) \\
\Pi(w_1, \infty) + \Pi(\infty, w_2) - \Pi(w_1, w_2), & \text{if } \Pi(w_1, \infty) < \Pi(\infty, w_2) \\
\Pi(w_1, \infty), & \text{if } \Pi(w_1, \infty) < \Pi(\infty, w_2) \text{ and } \Pi(w_1, w_2) \leq \Pi(w_1, \infty).
\end{cases}
$$

Note that the constraints and (A.1) guarantee that $\pi_s(w_1, w_2) \leq \Pi_i^m$ (the first and third rows are less than $\Pi_i^m$ by (A.1), the second row is less than or equal to $\Pi_i^m$ by the definition of $\Pi_i^m$, and the fourth row is less than $\Pi_i^m$ by the constraint that $\Pi(w_1, \infty) < \Pi(\infty, w_2) \leq \Pi_i^m$).

If a wholesale price $w_1$ is such that $\Pi(w_1, c) \leq \Pi(w_1, \infty)$ and $\Pi_i^m \leq \Pi(w_1, \infty)$, then the supplier can achieve a payoff of $\Pi_i^m$ (for example, if $\Pi(c, c) \leq \Pi_i^m$, the supplier can choose $w_1 = w_2 = c$). Otherwise, the supplier’s payoff is less than $\Pi_i^m$. If the supplier chooses $(w_1^*, w_2^*)$, its payoff is $\Pi(w_1^*, \infty) + \Pi(\infty, w_2^*) - \Pi(w_1^*, w_2^*)$, since $\Pi(w_1^*, w_2^*) = \Pi(w_i^*, \infty)$ for $i = 1, 2$. Note, however, that $\Pi(w_1, \infty) + \Pi(\infty, w_2^*) - \Pi(w_1, w_2^*)$ is decreasing at $w_1 = w_1^*$, since $w_1^* > c$. Then, the supplier can increase its payoff by decreasing $w_1$ slightly. Thus, there is no equilibrium in which the supplier chooses wholesale prices $(w_1^*, w_2^*)$.

**Proof of Proposition 3.** This result follows from the proof of Proposition 2.

**Proof of Lemma 1.** We show the result for the case of multiple retailers, see Lemma 2.
**Proof of Proposition 4.** Lemma 1 shows that there cannot be equilibrium contracts in which the supplier sells its product through both retailers. Fix now the supplier’s wholesale price offers \( \hat{w}_1, \hat{w}_2 \). Assume w.l.o.g. that \( \Pi(\hat{w}_i, \infty) > \Pi(\infty, \hat{w}_j) \). Then, it is an equilibrium for retailer \( i \) to choose \( \hat{V}_i = \Pi(\hat{w}_i, \infty) - \Pi(\infty, \hat{w}_j) \) and \( \hat{F}_i \), so that \( \pi_i(\hat{w}_i, \infty) - \hat{F}_i = \hat{V}_i \), and for retailer \( j \) to choose \( \hat{V}_j = 0 \) and \( \hat{F}_j = \pi_j(\infty, \hat{w}_j) \). Under these choices, the supplier sells only through retailer \( i \) (as we showed, there is no equilibrium in which the supplier sells through both retailers), and its profit is \( \Pi(\infty, \hat{w}_j) \). It is clear that neither retailer has any incentive to deviate from its reservation profit level and fixed fee. Thus, in general, for any pair of wholesale prices \( \hat{w}_1 \) and \( \hat{w}_2 \), the supplier makes \( \min\{\Pi(\hat{w}_i, \infty), \Pi(\infty, \hat{w}_j)\} \). Clearly, by setting \( \hat{w}_1 = c \) and \( \hat{w}_2 = c \), the supplier makes exactly \( \Pi^m_2 \) (since, by assumption \( \Pi^m_1 > \Pi^m_2 \)). On the other hand, for any \( \hat{w}_1 \) and any \( \hat{w}_2 > c \), the supplier’s profit is \( \min\{\Pi(\hat{w}_1, \infty), \Pi(\infty, \hat{w}_2)\} \leq \Pi(\infty, \hat{w}_2) < \Pi^m_2 \). Then, \((w_1, c)\) is an equilibrium for any \( w_1 \) such that \( \Pi(w_1, \infty) - \Pi^m_2 \geq 0 \), and \((c, c)\) is Pareto preferred (in that it maximizes retailer 1’s profit).

**Proof of Lemma 2.** Let \( V = (V_i)_{i=1,...,N} \), \( w = (w_i)_{i=1,...,N} \), and \( F = (F_i)_{i=1,...,N} \), and let \( D_{-i}(V, w, F) \) be the supplier’s profit if its product is sold through all retailers except for retailer \( i \), i.e., the supplier’s disagreement payoff with retailer \( i \).

We begin by showing that if there is an equilibrium with reservation profits \( \hat{V}_i, i = 1, ..., N \), and contracts \((\hat{w}_i, \hat{F}_i), i = 1, ..., N \), in which all retailers sell the supplier’s product, then the supplier’s profit is \( D_{-1}(\hat{V}, \hat{w}, \hat{F}) = ... = D_{-N}(\hat{V}, \hat{w}, \hat{F}) \). Let \( \hat{D}_{-i} = D_{-i}(\hat{V}, \hat{w}, \hat{F}) \).

The supplier’s equilibrium profit is

\[
M \equiv \sum_{k=1}^{N} \left[ (\hat{w}_k - c)q_k(\hat{w}) + \hat{F}_k \right] = \Pi(\hat{w}) - \sum_{k=1}^{N} \pi_k(\hat{w}) + \sum_{k=1}^{N} \hat{F}_k \geq \hat{D}_{-i}
\]

for \( i = 1, ..., N \), since in this equilibrium the supplier sells to all retailers. In addition, we have that \( \pi_i(\hat{w}) - \hat{F}_i \geq \hat{V}_i, i = 1, ..., N \), since all the retailers sell the product. Suppose \( M > \hat{D}_{-j} \) for some \( j \), and let \( \epsilon \in (0, M - \hat{D}_{-j}) \). Consider a deviation of retailer \( j \) to the reservation profit

\[
\hat{V}_j = \Pi(\hat{w}) - \sum_{k \neq j} \pi_k(\hat{w}) + \sum_{k \neq j} \hat{F}_k - \hat{D}_{-j} - \epsilon,
\]
and fixed payment

\[ \hat{F}_j = \sum_{k=1}^{N} \pi_k(\hat{w}) - \sum_{k \neq j} \hat{F}_k - \Pi(\hat{w}) + \hat{D}_{-j} + \epsilon = \hat{F}_j - M + \hat{D}_{-j} + \epsilon < \hat{F}_j. \]

Under this new contract, the supplier’s profit is \( \sum_{k=1}^{N} (\hat{w}_k - c)q_k(\hat{w}) + \hat{F}_j + \sum_{k \neq j} \hat{F}_k = \sum_{k=1}^{N} (\hat{w}_k - c)q_k(\hat{w}) + \sum_{k=1}^{N} \pi_k(\hat{w}) - \Pi(\hat{w}) + \hat{D}_{-j} + \epsilon = \hat{D}_{-j} + \epsilon. \) This means that, in view of retailer \( j \)'s deviation, the supplier’s profit is equal to \( \hat{D}_{-j} + \epsilon \) if it chooses to sell through all \( N \) retailers. If the supplier chooses to trade only with retailers \( k \neq j \) (or a subset of them), then its profit is no larger than \( \hat{D}_{-j} \). Thus, the supplier chooses to deal with retailer \( j \) (and also possibly with some, or all, other retailers). Retailer \( j \)'s profit under the deviation is at least \( \hat{V}_j \). But note that, \( \hat{V}_j > \pi_j(\hat{w}) - \hat{F}_j \), from the definitions of \( \epsilon \) and \( M \), reaching a contradiction. Then, \( D_{-1}(\hat{V}, \hat{w}, \hat{F}) = \ldots = D_{-N}(\hat{V}, \hat{w}, \hat{F}). \) (It is easy to verify that this result also holds when the supplier sets the fixed fees, as in Section 2.3. Indeed, note that under retailer \( j \)'s deviation to \( \hat{V}_j \), the supplier would choose a fixed fee equal to \( \pi_j(\hat{w}) - \hat{V}_j = \hat{F}_j \) if it accepted to trade with all the retailers.)

We now show that there cannot be equilibrium contracts \((\hat{V}_i, \hat{w}_i, \hat{F}_i), \; i = 1, \ldots, N\), in which the supplier sells its product through all retailers. Assume that this is the case, and let again \( \hat{D}_{-i} = D_{-i}(\hat{V}, \hat{w}, \hat{F}) \). We have that \( \pi_i(\hat{w}) - \hat{F}_i \geq \hat{V}_i \) and that \( \Pi(\hat{w}_{-i}, \infty) = \hat{D}_{-i} + \sum_{k \neq i} \pi_k(\hat{w}_{-i}, \infty) - \sum_{k \neq i} \hat{F}_k \), for all \( i = 1, \ldots, N \). Fix now two retailers \( i \) and \( j \), and note that \( \pi_j(\hat{w}_{-i}, \infty) - \pi_j(\hat{w}) > 0 \), since more competition strictly reduces retailer \( j \)'s profit. Let \( \epsilon \in (0, \pi_j(\hat{w}_{-i}, \infty) - \pi_j(\hat{w})) \). Suppose retailer \( j \) deviates by choosing \( \hat{V}_j = \pi_j(\hat{w}_{-i}, \infty) - \hat{F}_j - \epsilon \) and \( \hat{F}_j = F_j + \epsilon \). Given this contract, retailer \( j \) will not sell the product if all other retailers do, since in that case \( \pi_j(\hat{w}) - \hat{F}_j = \pi_j(\hat{w}) - \hat{F}_j - \epsilon < \hat{V}_j \). If the supplier rejects retailer \( j \)'s offer or if the supplier accepts all offers (in which case retailer \( j \) will choose not to sell the supplier’s product), its profit is \( \hat{D}_{-j} \). If the supplier rejects retailer \( i \)'s contract and chooses to deal with all the other retailers, then its profit is \( \Pi(\hat{w}_{-i}, \infty) - \sum_{k \neq i} \pi_k(\hat{w}_{-i}, \infty) + \sum_{k \neq i} \hat{F}_k + \epsilon = \hat{D}_{-i} + \epsilon = \hat{D}_{-j} + \epsilon. \) Then, in any equilibrium of the continuation game, the supplier accepts the offer of retailer \( j \). Retailer \( j \)'s profit from the deviation is

\[ \hat{V}_j = \pi_j(\hat{w}_{-i}, \infty) - \hat{F}_j - \epsilon > \pi_j(\hat{w}) - \hat{F}_j. \]

Thus, retailer \( j \)'s deviation is profitable, a contradiction. This shows that, in any equilibrium, the supplier does not sell through all retailers.
To understand why this result does not hold under the contracting sequence in Section 2.3, consider the case of two retailers, and assume that \((\hat{V}_k, \hat{w}_k, \hat{F}_k), k = 1, 2,\) are equilibrium contracts in which the supplier trades with both retailers. Then, \(\Pi(\hat{w}_1, \infty) - \hat{V}_1 = \Pi(\infty, \hat{w}_2) - \hat{V}_2,\) and the fixed fees set by the supplier are \(\hat{F}_k = \pi_k(\hat{w}_1, \hat{w}_2) - \hat{V}_k\) for \(k = 1, 2.\) If one retailer, say retailer 1, were to deviate to \(\hat{V}_1 = \pi_1(\hat{w}_1, \infty) - \hat{F}_1 - \epsilon\) with \(0 < \epsilon < \pi_1(\hat{w}_1, \infty) - \pi_1(\hat{w}_1, \hat{w}_2),\) then in any equilibrium of the continuation game the supplier would choose to trade only with retailer 2, since \(\pi_2(\hat{w}_2, \infty) > \pi_1(\hat{w}_1, \hat{w}_2) - \hat{F}_1.\) Thus, under the contracting sequence in which the supplier sets the fixed fees and as shown in Proposition 2, the supplier may trade with both retailers in equilibrium.

\[\text{Proof of Proposition 5.}\] Fix the supplier’s wholesale prices \(\hat{w}_i, i = 1, \ldots, N.\) Let retailer \(k\) be such that \(\Pi(\hat{w}_k, \hat{w}_{-k} = \infty) = \max_{i=1, \ldots, N} \Pi(\hat{w}_i, \hat{w}_{-i} = \infty).\) Consider \(\hat{V}_k = \Pi(\hat{w}_k, \hat{w}_{-k} = \infty) - \max_{i \neq k} \Pi(\hat{w}_i, \hat{w}_{-i} = \infty)\) with fixed fee \(\hat{F}_k = \pi_k(\hat{w}_k, \hat{w}_{-k} = \infty) - \hat{V}_k,\) and \(\hat{V}_i = 0\) with fixed fee \(\hat{F}_i = \pi_i(\hat{w}_i, \hat{w}_{-i} = \infty)\) for \(i \neq k.\) We now show that these represent an equilibrium of the continuation game (conditional on the supplier’s choice of wholesale prices \(\hat{w}_i, i = 1, \ldots, N).\) To see this, note that if the supplier accepts the contract with retailer \(i \neq k\) and some other retailer \(j\) (and possibly additional retailers), then retailer \(i\)’s profit would be \(\pi_i(\hat{w}_i, \hat{w}_j, \hat{w}_{-i,j}) - \hat{F}_i < \pi_i(\hat{w}_i, \hat{w}_{-i} = \infty) - \hat{F}_i = 0 = \hat{V}_i;\) if the supplier accepts the contract with retailer \(k\) and some other retailer \(j,\) then retailer \(k\)’s profit would be \(\pi_k(\hat{w}_k, \hat{w}_j, \hat{w}_{-k,j}) - \hat{F}_k < \pi_k(\hat{w}_k, \hat{w}_{-k} = \infty) - \hat{F}_k = \hat{V}_k.\) That is, if the supplier chooses to deal with more than one retailer, then no retailer would choose to buy from the supplier. The supplier then chooses to deal with one single retailer. The supplier’s profit if it deals with retailer \(k\) is \(\max_{i \neq k} \Pi(\hat{w}_i, \hat{w}_{-i} = \infty),\) which is no smaller than if it deals with any other retailer. Thus, the reservation level and fixed fee choices introduced above represent an equilibrium of the continuation game. Finally, the supplier’s profit is maximized with the choices \(\hat{w}_i = \hat{w}_i^m, i = 1, \ldots, N.\)

\[\text{Proof of Proposition 6.}\] Fix the supplier’s wholesale prices \(\hat{w}_i, i = 1, 2, 3,\) and assume that \(\Pi(\hat{w}_1, \infty, \infty) \geq \Pi(\hat{w}_k, \infty, \infty), k = 2, 3.\) In addition, suppose that \(q_k(\hat{w}_i = \infty, \hat{w}_{-i}) > 0, k \neq i.\) Consider \(\hat{V}_1 = 0\) with fixed fee \(\hat{F}_1 = \pi_1(\hat{w}_1, \infty, \infty),\) and let \(\hat{V}_2, \hat{V}_3 > 0\) be such that \(\hat{V}_2 + \hat{V}_3 = \Pi(\infty, \hat{w}_2, \hat{w}_3) - \Pi(\hat{w}_1, \infty, \infty)\) with corresponding \(\hat{F}_i = \pi_i(\infty, \hat{w}_2, \hat{w}_3) - \hat{V}_i, i = 2, 3.\) We now show that these contracts represent an equilibrium of the continuation game.
If the supplier accepts only retailer 1’s offer, then its profit is \( \Pi(\hat{w}_1, \infty, \infty) \). If the supplier chooses to deal with retailers 1 and 2, then retailer 2 will choose not to sell the supplier’s product since otherwise its profit would be \( \pi_2(\hat{w}_1, \hat{w}_2, \infty) - \hat{F}_2 < \pi_2(\infty, \hat{w}_2, \hat{w}_3) - \hat{F}_2 = \hat{V}_2 \). Similarly, if the supplier chooses to deal with retailers 1 and 3, then retailer 3 will choose to stay out of the deal since in that case the supplier would be better off dealing with retailer 1 only. Then, for this retailer out of the deal, since in that case the supplier would be better off dealing with retailer 1 only. Then, for \( i = 1, 2, 3 \), the reservation profit levels \( \hat{V}_i \) (and the corresponding fixed fees) represent an equilibrium of the continuation game.

In the case that \( q_k(\hat{w}_i = \infty, \hat{w}_{-i}) = 0 \) for some \( k \neq i \), then any equilibrium of the continuation game would render the supplier a profit no larger than \( \Pi(\hat{w}_1, \infty, \infty) \). To see that, first note that this is indeed the case if only one retailer deals with the supplier. Also, \( q_k(\hat{w}) < q_k(\hat{w}_i = \infty, \hat{w}_{-i}) \), which implies that there cannot be an equilibrium of the continuation game in which all three retailers trade with the supplier. If two firms \( (i \text{ and } j) \) sell the supplier’s product and \( \hat{V}_i, i = 1, 2, 3 \) are the equilibrium reservation profit levels, then it is easy to verify that \( \Pi(\hat{w}_i, \hat{w}_j, \infty) - \hat{V}_i - \hat{V}_j = \Pi(\hat{w}_k, \infty, \infty) - \hat{V}_k \) with \( k \neq i, j \). Then, in an equilibrium of the continuation game, the supplier’s profit is bounded above by \( \Pi(\hat{w}_k, \infty, \infty) \leq \Pi(\hat{w}_1, \infty, \infty) \).

If the wholesale prices \( \hat{w}_i, i = 1, 2, 3 \), are such that for \( j = 2 \) or \( j = 3 \), \( \Pi(\hat{w}_j, \infty, \infty) \geq \Pi(\hat{w}_k, \infty, \infty), k \neq j \), then, based on a similar proof, one can show that the supplier’s profit is bounded above by \( \Pi(\hat{w}_j, \infty, \infty) \) in any equilibrium of the continuation game. Since \( \Pi_i^m \geq \Pi_2^m \geq \Pi_3^m \), it is optimal for the supplier to choose, for example, \( \hat{w}_i = w_i^m, i = 1, 2, 3 \) (in which case \( q_k(\infty, w_2^m, w_3^m) > 0 \) for \( k = 2, 3 \)).
References


