

Base Contracts in Games with Ex-Post Observability

Leslie M. Marx and Greg Shaffer*
University of Rochester

May 2002
Duke/UNC Micro-Theory Working Paper #15

Abstract

This paper considers the use of base contracts as a solution to the opportunism problem identified by McAfee and Schwartz (1994) in games with ex-post observability (firms incur sunk costs before observing the terms of their rivals' contracts). We show that the joint-profit maximum can be obtained when an upstream seller offers a base contract to its downstream buyers before privately negotiating discounts with them. In the event of opportunism, a disfavored buyer reverts to the base contract, thwarting the dissipation of its rents.

JEL Classification Codes: D43, D45, L14, L42

Keywords: Multilateral vertical contracting, opportunism

*The authors can be reached at the William E. Simon School of Business, University of Rochester, Rochester, NY 14627, or by e-mail at marx@simon.rochester.edu or shaffer@simon.rochester.edu.

1 Introduction

Opportunism is an important issue in vertical contracting when a seller of an essential input contracts with two or more buyers who subsequently compete with each other in a product market. In such circumstances, Hart and Tirole (1990), O'Brien and Shaffer (1992), McAfee and Schwartz (1994), and others have shown that a seller who can make take-it-or-leave-it offers would like to commit publicly to contracts that maximize overall joint payoff because otherwise it may have an incentive privately to offer contracts that instead maximize bilateral joint payoffs.¹ This can lead to rent shifting among downstream firms and make buyers wary of contract offerings.

Buyers have reason to be wary because, after agreeing to contract terms with one firm, the seller may then have an incentive to negotiate (or renegotiate) terms with another firm so as to shift rents from one downstream buyer to another. Unless the seller can commit not to engage in this kind of opportunism, each downstream buyer runs the risk of agreeing to contract terms that may leave it worse off, either in an absolute sense, or relative to its rivals. Since no firm wants to operate at a cost disadvantage, or make sunk investments if there is little prospect of recoupment, it may be difficult to align all parties' interests so as to maximize overall joint payoff.

Many solutions to this problem have been proposed in the literature. Hart and Tirole (1990) suggest that the seller may want to vertically integrate with its downstream buyers, thus bringing all firms under common ownership. O'Brien and Shaffer (1992) suggest that the seller may want to divide the market into non-overlapping geographic territories, or, if legal, enforce a common resale price to eliminate the buyers' flow payoffs. And McAfee and Schwartz (1994) argue that the fear of opportunism may explain why a seller would want to commit to uniform contracts across multiple markets (even if this would be suboptimal on a market-by-market basis).

However, each of these proposed solutions has difficulties. Vertical integration

¹See also Cremer and Riordan (1987), O'Brien and Shaffer (1994), Alexander and Reiffen (1995), Segal (1999), Marx and Shaffer (2001), and Corts and Neher (2002).

may not be feasible in many circumstances, especially when the downstream buyers are not dedicated to the upstream firm's product (e.g., when they sell numerous other products). Similarly, the assignment of non-overlapping geographic territories may not be possible or enforceable if consumers are sufficiently mobile. The adoption of resale price maintenance has legal difficulties and may distort the incentives of the downstream firms to promote the product or otherwise hinder non-price competition. And the suggestion of uniform contracts across multiple markets is suboptimal if there are regional differences in demand so that conditions vary from market to market.

In this paper, we show that when contract terms are observable ex post (after sunk investments are made but before the downstream buyers compete in the product market), a simple alternative to these solutions exists: base contracts. We show that a seller can solve the opportunism problem if, in addition to its privately negotiated contracts, it offers a base contract that buyers can select in the event of opportunism.

The literature distinguishes between games in which contract terms are unobservable (firms never learn the terms of their rival's contracts) and games in which contract terms are observable ex post. Yet although both games capture different aspects of reality,² the distinction is thought not to matter qualitatively because, in both cases, there exists an incentive for the seller to engage in opportunism (e.g., when buyers incur sunk investments without knowing each other's terms, the fact that a buyer may be able to adjust its quantity choices if a rival's contract turns out to be something other than anticipated only mitigates but does not eliminate the seller's incentive). As a result, the remedies proposed in the literature (vertical integration, non-overlapping territories, resale price maintenance) have been the same.

The solution we propose exploits the distinction between the two cases. The idea is that if the buyers can learn of the opportunism before participating in the product market (or, in a dynamic setting, soon after the rival signs its contract), then they

²The former may describe situations in which contracts are negotiated frequently and for which commitment is lacking. The latter may describe situations in which rivals have long-term contracts, the terms of which buyers come to learn over time (but not before having incurred sunk costs).

will want to choose the contract from their menu of choices that best allows them to thwart the dissipation of their rents. By choosing the base contract (the contract that buyers would want to revert to if they detected opportunism) appropriately, the seller can sufficiently alter its payoff structure to defacto achieve its public commitment.

There is a sense in which there is an obvious remedy to opportunism in games with ex-post observability—the seller could write contracts in which every provision in each firm’s contract is specified in advance and in which there are large penalties in the event of breach. However, with uncertainty, this would require complete state-contingent contracts, which may not be feasible. Alternatively, the seller could promise not to engage in opportunism by specifying in advance each buyer’s effective input price. But this would burden the legal system with determining which parts of the contracts affect marginal incentives and which parts do not, which may be difficult. For example, the seller might be able to hide its opportunism in things such as free cases of goods, advertising allowances, or other demand-enhancing programs.

Our solution has two advantages in this regard. First, it is simple. One can think of the base contract as the seller’s initial contract offer to its buyers before it privately negotiates discounts with them. To prevent opportunism, the seller need only allow each buyer to operate under the base contract if it subsequently suspects opportunism. Second, the solution is easily enforceable. The courts need only uphold the right of each buyer to operate under the base contract if it chooses. There does not have to be any inquiry as to whether alleged opportunism did or did not occur.

The rest of the paper proceeds as follows. In Section 2, we describe the seller’s opportunism problem. In Section 3, we show how the seller can maximize overall joint payoff by allowing each buyer to choose (after the contracts of all firms become known) between the base contract or its privately accepted contract. In Section 4, we illustrate our results using a linear demand example, and we discuss the welfare implications of offering base contracts. We offer concluding remarks in Section 5.

2 The Opportunism Problem

Suppose an upstream monopolist supplies an essential input to two potential downstream firms. The downstream firms use the inputs to produce substitute products for resale to final consumers. The monopolist produces at constant marginal cost $z \geq 0$ and has no fixed cost. The downstream firms' costs depend on the terms at which they can purchase the inputs. For simplicity, we assume the monopolist can make take-it-or-leave-it offers which consist of wholesale prices and fixed fees.

We model a lack of commitment on the monopolist's part by treating the offers as being made simultaneously and "secretly." In particular, we assume that after the monopolist publicly announces a base contract, which is observed by both firms, the monopolist simultaneously offers each firm a "secret" two-part tariff contract. Denote the monopolist's individual offer to firm i as the pair (r_i, f_i) , where r_i is the wholesale price of the input and f_i is a fixed fee. Denote the base contract as (r^b, f^b) .

Firms simultaneously accept or reject their individual offers. If a firm accepts, it spends $k \geq 0$ on relationship-specific assets (k is sunk) and commits to operate under its contract. If a firm rejects, it exits the market and earns zero. After individual contract offers are accepted or rejected, firms that have accepted contracts learn of all offers and decisions. A firm can then either exit or participate in the product market. If it exits, its continuation payoff is zero but it loses its sunk cost k . Otherwise, it competes in the product market under the terms of its accepted contract.

We assume the product market equilibrium is unique for any distribution of wholesale prices $\mathbf{r} = (r_1, r_2)$ in which both firms are active, with firm i 's equilibrium flow payoff given by $\pi_i(\mathbf{r})$. For r_i sufficiently large, firm i 's flow payoff is zero. Otherwise, if firms i and j are both active, we assume that π_i is decreasing in r_i and increasing in r_j for $i \neq j$, so that a firm's flow payoff is decreasing in its own wholesale price and increasing in the wholesale price of its competitor. We also assume

$$\frac{\partial^2 \pi_i(r_1, r_2)}{\partial r_1 \partial r_2} < 0, \tag{1}$$

which implies that firm i 's flow payoff is less sensitive to a decrease in its own wholesale price (does not increase as much) the lower is the wholesale price of a competitor.³

Let $q_i(\mathbf{r})$ denote firm i 's equilibrium input demand as a function of the wholesale prices. Then the monopolist's flow payoff is $\sum_{i=1}^2 (r_i - z)q_i(\mathbf{r})$ and, assuming both firms are active, the overall joint payoff of the monopolist and downstream firms is

$$\Pi(\mathbf{r}) \equiv \sum_{i=1}^2 (r_i - z)q_i(\mathbf{r}) + \sum_{i=1}^2 (\pi_i(\mathbf{r}) - k).$$

In contrast, the joint payoff of the monopolist and firm i excluding fixed fees is

$$u_i(\mathbf{r}) \equiv \Pi(\mathbf{r}) - (\pi_j(\mathbf{r}) - k), \quad j \neq i.$$

We assume $\Pi(\mathbf{r})$ and $u_i(\mathbf{r})$ are twice differentiable, concave in r_i , and have the property that own price effects dominate cross price effects, i.e., $\left| \frac{\partial^2 \Pi}{\partial r_i^2} \right| > \left| \frac{\partial^2 \Pi}{\partial r_i \partial r_j} \right|$ and $\left| \frac{\partial^2 u_i}{\partial r_i^2} \right| > \left| \frac{\partial^2 u_i}{\partial r_i \partial r_j} \right|$ for $j \neq i$. We also assume the downstream firms' flow payoffs are symmetric. That is, given r' and r'' , we assume $\pi_1(r', r'') = \pi_2(r'', r')$.

Let $r^* \equiv \arg \max_{r \geq 0} \Pi(r, r)$, so $\Pi(r^*, r^*)$ is the maximum overall joint payoff. If there are no sunk costs (i.e., $k = 0$) the monopolist can obtain the joint-payoff maximum by offering each firm the overall joint-payoff-maximizing contract (r^*, f^*) , where $f^* \equiv \pi(r^*, r^*) - k$.⁴ It is a weakly dominant strategy for each firm to accept its offer, and the monopolist has no incentive to engage in opportunism because any lower wholesale price offered to firm i would cause firm j to exit the market.

However, if there are sunk costs (i.e., $k > 0$), a firm will think twice before accepting its offer because it may stand to lose in the event of opportunism. Because this is a game of simultaneous offers, a firm must decide whether to accept or reject its individual offer without knowing the contract offered to its competitor. In a perfect Bayesian-Nash equilibrium, a firm's beliefs about the contract offered to its competitor will be correct, but to pin down how a firm might revise its beliefs about

³Intuitively, a firm benefits from a decrease in its wholesale price in proportion to how much it produces. In many standard models of competition, the lower a competitor's wholesale price, the lower a firm's output, and therefore the less the firm gains from a decrease in its wholesale price.

⁴Symmetry allows us to drop the subscript on π when all firms have a common wholesale price.

the offer made to its rival, we must specify out-of-equilibrium beliefs. To do this, we assume passive beliefs.⁵ Under passive beliefs, if a firm is offered a contract other than its equilibrium offer, it continues to believe that its competitor was offered its equilibrium contract. Thus, when a firm observes a deviation by the monopolist, it believes that this was the only deviation made by the monopolist.

We are now able to state the monopolist's opportunism problem: given passive beliefs, the overall joint-payoff maximum cannot be supported in equilibrium if $k > 0$. To see this, suppose the monopolist offers firm 1 the contract (r^*, f^*) , and let $\tilde{r}_2(r_1, f_1)$ be the wholesale price that maximizes the joint payoff of the monopolist and firm 2 given the wholesale price and fixed fee for firm 1 (assuming it is active), i.e.,

$$\tilde{r}_2(r_1, f_1) \in \arg \max_{r \geq 0} u_2(r_1, r) + f_1 \quad (2)$$

subject to firm 1's participation constraint:

$$\pi_1(r_1, r) - f_1 \geq 0. \quad (3)$$

Then, given that firm 2 believes (correctly) that firm 1 has been offered the contract (r^*, f^*) , and with passive beliefs, the monopolist's payoff-maximizing wholesale price to firm 2 is $\hat{r} \equiv \tilde{r}_2(r^*, f^*) < r^*$.⁶ Thus, it cannot be an equilibrium for the monopolist to offer (r^*, f^*) to both downstream firms because, given it is offering (r^*, f^*) to firm 1, it can earn higher payoff by lowering firm 2's wholesale price and raising its fixed fee to extract the extra surplus: $\hat{f} > f^*$, where $\hat{f} \equiv \pi_2(r^*, \hat{r}) - k$. The monopolist ignores the reduction in firm 1's payoff from cutting price to firm 2, an effect internalized when solving r^* . Ultimately, however, the monopolist's payoff falls short of the joint-payoff maximum because in equilibrium each firm will anticipate the monopolist's incentive for opportunism and adjust its accept or reject decision accordingly.

In fact, when the firms have passive beliefs, equilibrium contracts must be such that the monopolist and each downstream firm maximize their joint payoff given the

⁵See McAfee and Schwartz (1994, p. 219).

⁶The inequality follows from the fact that $k > 0$ implies that (3) is not binding when both firms have the contract (r^*, f^*) , and the concavity of u_2 implies that $\frac{\partial u_2(r^*, r^*)}{\partial r_2} = \frac{\partial \Pi(r^*, r^*)}{\partial r_2} - \frac{\partial \pi_1(r^*, r^*)}{\partial r_2} < 0$.

wholesale price and fixed fee of the other downstream firm, i.e., the wholesale prices must satisfy $u_1(r_1, r_2) \geq u_1(r'_1, r_2)$ and $u_2(r_1, r_2) \geq u_2(r_1, r'_2)$ for any $r'_i, i \in \{1, 2\}$.

The equilibrium wholesale prices in this case have been referred to by McAfee and Schwartz (1994) as the *pairwise-proof* prices. More formally, we say that the vector of wholesale prices $\mathbf{r}^p = (r_1^p, r_2^p)$ is pairwise-proof if $r_1^p \in \arg \max_{r \geq 0} u_1(r, r_2^p)$ and $r_2^p \in \arg \max_{r \geq 0} u_2(r_1^p, r)$. Our assumption of symmetry ensures that $r_1^p = r_2^p = r^p$.

Letting $f^p \equiv \pi(r^p, r^p) - k$, it follows that $\tilde{r}_2(r^p, f^p) = r^p$. Thus, if firm 1 has the contract (r^p, f^p) , then the monopolist can do no better than to offer firm 2 the contract (r^p, f^p) , and vice versa. The pairwise-proof wholesale prices are generally well below the joint-payoff-maximizing wholesale prices,⁷ resulting in ultimate gain for consumers in the form of lower retail prices, but lost profit for the monopolist.

The monopolist's failure to obtain the joint-payoff maximum in this and similar settings is well known, and the result has sparked an interest in how the opportunism problem might be solved. Several remedies have been proposed. For example, it has been suggested that the monopolist might want to vertically integrate in order to internalize all profit incentives (Hart and Tirole, 1990), impose non-overlapping geographic territories on its buyers in order to make their payoffs independent (O'Brien and Shaffer, 1992), or refrain from customizing contracts across markets in order to assuage its downstream firms' fears of opportunism (McAfee and Schwartz, 1994).

However, the use of the initial public offer as a potential solution has gone unnoticed. Indeed, in the game considered above, the initial offer plays no role in the equilibrium outcome. In discussing the case of games with ex-post observability, McAfee and Schwartz (p. 218) note that commitment is a problem even if firms eventually learn of the other's contract because of the usual difficulties with complete contracts: "To retain flexibility, the monopolist thus may assure each firm only about the terms of its contract (subject to bilaterally acceptable renegotiation). Initial offers, even if public, would then convey little about what rivals' costs ultimately will be."

⁷To see this, note that $\frac{\partial u_2(r^p, r^p)}{\partial r_2} = 0$ implies that $\frac{\partial \Pi(r^p, r^p)}{\partial r_2} > 0$, which implies that $r^p < r^*$.

3 The role of base contracts

In this section, we show that the opportunism problem has a simple solution, one that highlights the role of the initial public offer, i.e., the base contract. As before, the monopolist first announces a base contract (r^b, f^b) , which is observed by both firms. Then the monopolist simultaneously offers each firm a “secret” two-part tariff contract. As before, firms simultaneously accept or reject their individual offers. If a firm accepts its offer, it spends $k \geq 0$ on relationship-specific assets but commits only to operate under its secret contract or the base contract. If a firm rejects its offer, it can choose to operate under the base contract (and pay $k \geq 0$) or it can exit the market and earn zero. After individual contract offers are accepted or rejected, all contract offers and the decisions are observed. Firms then simultaneously choose under which contract to operate (if any) and participate in the product market game.

With this slight modification, and assuming firms have passive beliefs, it follows that the monopolist can obtain the joint-payoff-maximizing outcome in equilibrium. To see this, suppose the monopolist offers a base contract (r^b, f^b) with a high wholesale price and low fixed fee ($r^b > r^*$ and $f^b < f^*$) such that a firm operating under the base contract (r^b, f^b) has positive payoff if the other firm operates under (r^b, f^b) ,

$$\pi_1(r^b, r^b) - f^b - k > 0, \quad (4)$$

and zero payoff if the other firm operates under (r^*, f^*) ,

$$\pi_1(r^b, r^*) - f^b - k = 0. \quad (5)$$

(Note that by symmetry, (5) implies $\pi_2(r^*, r^b) - f^b - k = 0$.) Then suppose the monopolist offers (r^*, f^*) individually to each downstream firm.

It is a weakly dominant strategy for each firm to accept its individual offer. In equilibrium, firm 1 believes that firm 2 is offered the contract (r^*, f^*) . Thus, firm 1 believes that if firm 2 operates, it must be under either (r^*, f^*) or (r^b, f^b) . Because $\pi_1(r^b, r^*) - f^b - k = 0$, $\pi_1(r^b, r^b) - f^b - k > 0$, and $\pi_1(r^b, \infty) - f^b - k > 0$, firm 1

can obtain a nonnegative payoff by operating under the base contract, regardless of whether firm 2 operates under (r^*, f^*) , (r^b, f^b) , or not at all, and similarly for firm 1.

Once both firms accept the contract (r^*, f^*) , it is an equilibrium of the continuation game (in weakly dominant strategies) for both to operate under the terms (r^*, f^*) —given that its competitor operates under (r^*, f^*) , a firm is indifferent between operating under (r^*, f^*) and (r^b, f^b) . And if its competitor operates under (r^b, f^b) , a firm earns strictly higher payoff operating under (r^*, f^*) .⁸ In this equilibrium, the monopolist gets a payoff of $\Pi(r^*, r^*)$ and overall joint payoff is maximized.

It remains to show that the monopolist cannot earn higher payoff by acting opportunistically. We sketch the intuition here and leave a formal proof to the appendix. Suppose the monopolist were to offer (r^*, f^*) to one firm and the opportunistic contract (\hat{r}, \hat{f}) , to the other firm (where $\hat{r} < r^*$ and $\hat{f} > f^*$, as depicted in Figure 1). Then, each firm will accept its offer given its belief that the other has received (r^*, f^*) , and once both firms accept their offers, it is an equilibrium of the continuation game (in weakly dominant strategies) for the first firm to operate under the base contract (r^b, f^b) and for the second firm to operate under the opportunistic contract (\hat{r}, \hat{f}) .

To see this, note that if the first firm operates under (r^*, f^*) then the second firm is indifferent between operating under (\hat{r}, \hat{f}) and (r^b, f^b) (its payoff in both cases is zero). If the first firm operates under (r^b, f^b) , then the second firm earns strictly higher payoff operating under (\hat{r}, \hat{f}) .⁹ Thus, it is a weakly dominant strategy for the second firm to operate under its opportunistic contract. In this case, we see from Figure 1 that if the second firm operates under the opportunistic contract, then because (r^b, f^b) is in the shaded area denoting contracts that give the first firm higher payoff than (r^*, f^*) when the second firm operates under (\hat{r}, \hat{f}) , the first firm strictly prefers to operate under the base contract (r^b, f^b) rather than under the contract (r^*, f^*) . In

⁸To see this, note that if firm 1 operates under (r^b, f^b) , firm 2's continuation payoff under (r^*, f^*) , $\pi_2(r^b, r^*) - \pi_2(r^*, r^*) + k$, is greater than its continuation payoff under (r^b, f^b) , $\pi_2(r^b, r^b) - \pi_2(r^*, r^b) + k$, because $\frac{\partial^2 \pi_2(r_1, r_2)}{\partial r_1 \partial r_2} < 0$ implies that $\pi_2(r^b, r^*) - \pi_2(r^b, r^b) > \pi_2(r^*, r^*) - \pi_2(r^*, r^b)$.

⁹The reasoning is the same as in the previous footnote, with (\hat{r}, \hat{f}) substituted for (r^*, f^*) .

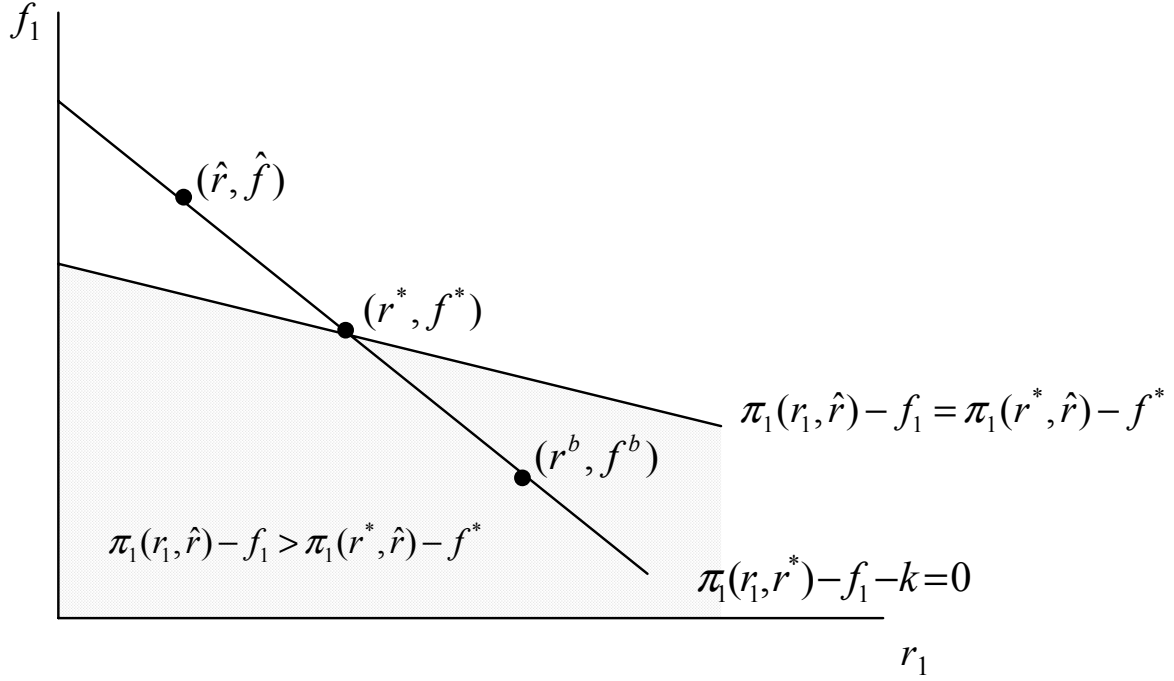


Figure 1: Illustration of the relation of the base contract to the opportunistic contract and the overall-joint-payoff-maximizing contract.

other words, if the monopolist were to offer one firm the contract (\hat{r}, \hat{f}) , the rival firm on seeing this deviation would choose to operate under the base contract, thwarting the dissipation of its rents. The monopolist's opportunistic behavior is prevented by choosing a base contract that makes opportunism unprofitable.

Proposition 1 *If each firm is allowed to operate under either its privately accepted contract offer or the base contract after observing its competitor's terms, then there exists an equilibrium with passive beliefs in which overall joint payoff is maximized.*

Proof. See the Appendix.

It is widely believed that in games with ex-post observability, as in games with unobservable contract terms, the monopolist cannot obtain the joint-payoff-maximizing outcome in equilibrium when secret discounts are possible and offers are made simul-

taneously. In contrast, Proposition 1 implies that a key distinction should be made between these two games. When contract terms are observable ex post, a slight modification in which the monopolist allows each buyer to revert to the base contract in the event of opportunism solves the opportunism problem. Instead of offering a base contract of (r^*, f^*) and then trying to guard against opportunistic discounting,¹⁰ the monopolist offers a base contract with a relatively high wholesale price ($r^b > r^*$) and a relatively low fixed fee ($f^b < f^*$) and then offers the joint-payoff-maximizing contract individually to each firm. Opportunism is prevented because if the monopolist were to deviate from (r^*, f^*) with one downstream firm in a way that would increase its payoff if the rival downstream firm were to operate under (r^*, f^*) , the rival firm would simply switch to the base contract, making the deviation unprofitable.

4 Percentage discounts and welfare implications

To understand the welfare implications of base contracts, and to compare the magnitude of discount from r^b to r^* , it is useful to consider a linear demand example. This allows us to sign the welfare effects of moving from a situation in which base contracts are not feasible, and the best the monopolist can do if it sells to both downstream firms is to offer the pairwise-proof wholesale prices, to a situation in which base contracts are feasible. It also allows us to calculate the range of values for the base contract such that the equilibrium outcome is for the monopolist to offer the contract (r^*, f^*) as a “secret discount” and for both firms to operate under this contract.

For the purposes of our example, we assume that the monopolist’s input is transformed into final output in fixed proportions, and we let consumer demand for firm i ’s product be $x_i(p_1, p_2) = a - 2p_i + p_{3-i}$, for $i \in \{1, 2\}$, where demand for firm i ’s

¹⁰The monopolist cannot obtain the joint-payoff-maximizing outcome by offering (r^*, f^*) as the base contract. To see this, note that it is not an equilibrium for the monopolist to offer (r^*, f^*) as the base contract and (r^b, f^b) individually to each firm because given the firms’ passive beliefs, the monopolist could profitably deviate by offering instead the opportunistic contract (\hat{r}, \hat{f}) to firm 2 and an unchanged contract (r^*, f^*) to firm 1. Each firm would be “surprised” by its out-of-equilibrium offer, but each would accept it given its belief that its rival had been offered (r^b, f^b) .

product is decreasing in its own price and increasing in its rival's price, with own effects dominating cross effects. In this case, we can write firm i 's payoff as

$$(p_i - r_i)(a - 2p_i + p_{3-i}) - f_i - k.$$

Assuming the firms compete in prices, firm i 's Nash equilibrium price is

$$p_i^*(\mathbf{r}) = \frac{5a + 8r_i + 2r_{3-i}}{15}.$$

Substituting in for $p_i^*(\mathbf{r})$, we can solve for firm i 's equilibrium input demand,

$$q_i(\mathbf{r}) = x_i(p_1^*(\mathbf{r}), p_2^*(\mathbf{r})) = \frac{2(5a - 7r_i + 2r_{3-i})}{15},$$

firm i 's equilibrium flow payoff,

$$\pi_i(\mathbf{r}) = \frac{2(5a - 7r_i + 2r_{3-i})^2}{225},$$

the overall joint payoff of the monopolist and downstream firms,

$$\Pi(\mathbf{r}) = \sum_{i=1}^2 (r_i - z) \frac{2(5a - 7r_i + 2r_{3-i})}{15} + \sum_{i=1}^2 \left(\frac{2(5a - 7r_i + 2r_{3-i})^2}{225} - k \right),$$

and the joint payoff of the monopolist and firm i excluding fixed fees,

$$u_i(\mathbf{r}) = \sum_{i=1}^2 (r_i - z) \frac{2(5a - 7r_i + 2r_{3-i})}{15} + \frac{2(5a - 7r_i + 2r_{3-i})^2}{225} - k.$$

Using symmetry, we find that the overall-joint-payoff-maximizing contract is

$$(r^*, f^*) = \left(\frac{a + 3z}{4}, \frac{(a - z)^2}{8} - k \right),$$

the payoff-maximizing contract with the pairwise-wise proof wholesale prices is

$$(r^p, f^p) = \left(\frac{a + 15z}{16}, \frac{25(a - z)^2}{128} - k \right),$$

the payoff-maximizing opportunistic contract given (r^*, f^*) is (\hat{r}, \hat{f}) , where

$$\hat{r} = \begin{cases} \frac{13a + 99z}{112}, & \text{if } k \geq \frac{27(a-z)^2}{1568} \\ \frac{1}{8}(-13a + 15\sqrt{(a-z)^2 - 8k} + 21z), & \text{otherwise,} \end{cases}$$

and the corresponding opportunistic fixed fee, $\pi_2(r^*, \hat{r}) - k$, is

$$\hat{f} = \begin{cases} \frac{25(a-z)^2}{128} - k, & \text{if } k \geq \frac{27(a-z)^2}{1568} \\ \frac{1}{16} \left(-212k + \left(65(a-z) - 63\sqrt{(a-z)^2 - 8k} \right) (a-z) \right), & \text{otherwise.} \end{cases}$$

There are two possible expressions for the opportunistic wholesale price and fixed fee because it is defined as the solution to a constrained optimization problem (see the program in (2) and (3)) and the constraint can bind. In what follows, it will be useful to define the unconstrained opportunistic wholesale price, $\hat{r}^u \equiv \frac{13a+99z}{112}$.

4.1 Percentage discounts

In this subsection, we calculate the range of values for the base contract such that the equilibrium outcome is for the monopolist to offer contract (r^*, f^*) as a “secret discount” and for both firms to operate under this contract. We then compare the lower bound of this range to r^* to gain a sense of the percentage discount the monopolist must offer each firm in order to support the joint-payoff maximum. In our example, we find that the minimum percentage varies from zero to approximately 14%.

We begin by noting that the set of feasible base contracts must satisfy three conditions. First, the base contract must give a firm positive payoff when its rival has wholesale price r^b , i.e., $\pi_1(r^b, r^b) - f^b - k > 0$. Second, the base contract must extract all surplus from a firm when its rival has wholesale price r^* , i.e., $\pi_1(r^b, r^*) - f^b - k = 0$. Third, it must be that the monopolist’s payoff is higher if both firms have contract (r^*, f^*) than if one firm has contract (r', f') such that $r' < r^*$ and $f' = \pi_1(r', r^*) - k$, and the other has contract (r^b, f^b) , i.e., for all $r' < r^*$, it must be that

$$\Pi(r^*, r^*) \geq (r' - z)q_1(r', r^b) + f' + (r^b - z)q_2(r', r^b) + f^b. \quad (6)$$

Using the definition of the unconstrained opportunistic wholesale price, \hat{r}^u , it is sufficient for (6) that the inequality is satisfied when $r' = \hat{r}^u$. Thus, substituting in $r' = \hat{r}^u$, $f' = \pi_1(\hat{r}^u, r^*) - k$, and $f^b = \pi_2(r^*, r^b) - k$, it is sufficient that

$$\Pi(r^*, r^*) \geq (\hat{r}^u - z)q_1(\hat{r}^u, r^b) + \pi_1(\hat{r}^u, r^*) + (r^b - z)q_2(\hat{r}^u, r^b) + \pi_2(r^*, r^b) - 2k. \quad (7)$$

The inequality in (7) defines a lower bound on r^b , denoted \bar{r}^b , where

$$\bar{r}^b \equiv \frac{139a + 15(a - z)\sqrt{2633} + 2997z}{3136}.$$

Let $\bar{f}^b \equiv \pi_2(r^*, \bar{r}^b) - k$. Then we know from (6) and (7) that when the monopolist uses a base contract of (\bar{r}^b, \bar{f}^b) and offers contract (r^*, f^*) to each firm as a “secret discount,” it can obtain the joint-payoff-maximizing outcome. In this case, the monopolist’s “secret discount” involves a percentage discount in wholesale price of

$$\frac{\bar{r}^b - r^*}{\bar{r}^b} = 1 - \frac{784(a + 3z)}{139a + 15(a - z)\sqrt{2633} + 2997z}.$$

The percentage discount is a function of the vertical intercept of demand a and the monopolist’s marginal cost z . For example, if we normalize the intercept term to one and set the monopolist’s marginal cost to zero, then the required discount is 14%.¹¹

More generally, we can graph $\frac{\bar{r}^b - r^*}{\bar{r}^b}$ as a function of a single parameter by letting $z = \lambda a$, where $\lambda \in [0, 1]$. Thus, λ measures whether the monopolist’s marginal cost is low or high relative to the size of the market. (To construct the graph below, we also set $a = 1$.)

Figure 2: Graph of $\frac{\bar{r}^b - r^*}{\bar{r}^b}$ as a function of λ .

Because we assume $k \leq \frac{(a-z)^2}{8}$, so that overall joint payoff is maximized when both firms operate, we set $k = 0.01$ and consider $\lambda \in [0, \bar{\lambda}]$, where $\bar{\lambda} \equiv 0.717$ ($\bar{\lambda}$ is

¹¹If $a = 1$ and $z = 0$, the joint-profit-maximizing outcome can be achieved with a base contract of $(\bar{r}^b, \bar{f}^b) = (0.29, 0.107 - k)$ and “secret discounts” to each firm of $(r^*, f^*) = (0.25, 0.125 - k)$.

such that $k = \frac{(a-\bar{\lambda}a)^2}{8}$ when $k = 0.01$ and $a = 1$). In this case, Figure 2 shows that when z is small relative to a , i.e., $\lambda = 0$, the contracts offered to the firms individually will involve a substantial (approximately 14%) discount relative to the base contract. But as z increases relative to a , the required discount monotonically decreases.

4.2 Welfare implications

To consider the welfare implications of base contracts, we need to know what would happen in their absence. Previous literature has suggested that the monopolist might resort to vertical integration, non-overlapping geographic territories, or resale price maintenance as a way of solving the opportunism problem. To the extent that these options are feasible, the monopolist will choose the option that minimizes its transactions costs. Thus, the welfare effect of base contracts depends on the transactions costs associated with each option. If one of the other options entails lower transactions costs, then base contracts will not be observed and there is no welfare loss associated with them. On the other hand, if base contracts are observed because they entail the lowest transactions costs, then it must be that they are welfare improving.

A more interesting comparison occurs when the other options are not feasible but base contracts are feasible. In this case, one of two outcomes are possible in the absence of base contracts. Either the monopolist will sell to both firms at the pairwise-proof wholesale prices, or it will sell to only one firm (if necessary, the monopolist can give this firm an exclusive territory contract) at a wholesale price equal to z .

If the monopolist would sell to both firms at the pairwise-proof wholesale prices, then base contracts necessarily decrease welfare (retail prices are higher when wholesale prices are r^* than when they are r^p). However, if the monopolist would sell to only one firm, then the effect of base contracts on welfare is more complicated. In addition to affecting retail prices, which may be higher or lower when the monopolist sells to both firms than when it only sells to one firm, the use of base contracts would then also increase the number of firms selling the monopolist's product.

Let $\Pi(r^*, r^*)$ be the maximized overall joint payoff, $\Pi(z, \infty)$ be the monopolist's payoff if only one firm operates, and let $\Pi(r^p, r^p)$ be the monopolist's payoff under the pairwise-proof contracts. Then, in our linear demand example, we have

$$\Pi(r^*, r^*) = \frac{(a - z)^2}{2} - 2k,$$

$$\Pi(z, \infty) = \frac{3(a - z)^2}{8} - k,$$

and

$$\Pi(r^p, r^p) = \frac{15(a - z)^2}{32} - 2k.$$

It follows that for all $\lambda \leq \bar{\lambda}$, $\Pi(r^*, r^*) \geq \max\{\Pi(z, \infty), \Pi(r^p, r^p)\}$, and for all $\lambda > \bar{\lambda}$, $\Pi(z, \infty) > \max\{\Pi(r^*, r^*), \Pi(r^p, r^p)\}$. It also follows that there exists $\lambda' < \bar{\lambda}$ such that for $\lambda \leq \lambda'$, $\Pi(r^p, r^p) \geq \Pi(z, \infty)$ and for $\lambda > \lambda'$, $\Pi(r^p, r^p) < \Pi(z, \infty)$,¹² which implies that the monopolist prefers to have both firms operate under the pairwise-proof contracts rather than have only one firm operate if and only if $\lambda < \lambda'$.

$\Pi(r^*, r^*)$	$\Pi(r^*, r^*)$	$\Pi(z, \infty)$
$> \Pi(r^p, r^p)$	$> \Pi(z, \infty)$	$> \Pi(r^*, r^*)$
$> \Pi(z, \infty)$	$> \Pi(r^p, r^p)$	$> \Pi(r^p, r^p)$
0	λ'	$\bar{\lambda}$
		1

The interesting case occurs when $\lambda \in (\lambda', \bar{\lambda})$, in which case the monopolist would sell to only one downstream firm to combat the opportunism problem if the use of a base contract was not feasible, but if the use of a base contract were feasible, the monopolist would use it, and in equilibrium both firms would operate under the contract (r^*, f^*) .

If there were no opportunism problem, the monopolist would sell to both firms for $\lambda \leq \bar{\lambda}$ and sell to only one firm for $\lambda > \bar{\lambda}$. But with the opportunism problem, if base

¹²In our numerical example with $a = 1$ and $z = 0$, $\lambda' = 0.673$.

contracts are not feasible, the monopolist sells to only one firm for all $\lambda > \lambda'$, which is a larger range of parameter values than if there were no opportunism problem.

We can now fully characterize the welfare implications of base contracts. Under the pairwise-proof contracts, both firms charge a retail price of $\frac{3+5\lambda}{8}$. When both firms have contract (r^*, f^*) , both firms charge a retail price of $\frac{1+\lambda}{2}$, which is also the retail price when only one firm operates with a wholesale price of z . Thus, given opportunism, the retail outcome with and without base contracts is as follows:

	$\lambda \leq \lambda'$	$\lambda' < \lambda \leq \bar{\lambda}$
no base contracts	$p = \frac{3+5\lambda}{8}$, 2 firms	$p = \frac{1+\lambda}{2}$, 1 firm
base contracts	$p = \frac{1+\lambda}{2}$, 2 firms	$p = \frac{1+\lambda}{2}$, 2 firms

As the table above shows, base contracts decrease welfare when $\lambda \leq \lambda'$ (because it causes retail prices to increase with no change in the number of firms selling the monopolist's product), but base contracts increase welfare when $\lambda' < \lambda \leq \bar{\lambda}$ (because more firms are selling the monopolist's product and there is no effect on retail prices). These results are surprising because it is often thought that the kind of opportunism considered in this paper is good for welfare (because $r^p < r^*$ and so opportunism can lead to lower retail prices). Instead, we find that when possible changes in market structure are considered, this is not always the case. For example, if the monopolist were to respond to the opportunism problem by selling to only one firm, then consumers would have less choice than they would otherwise, and welfare might be higher if the monopolist were able to use base contracts to eliminate opportunism.

5 Conclusion

We have established that an upstream monopolist can achieve the joint-payoff maximum by allowing its downstream firms to operate under a base contract if they suspect opportunism. In effect, each downstream firm is given the choice of operating under one of two contracts, its individually offered contract or the base contract.

If the firms learn of their rival's terms before participating in the product market, and if they suspect opportunism, then they will want to choose the contract from their menu of contract options that best allows them to mitigate their loss. By choosing the base contract and individually offered contract appropriately, the monopolist can sufficiently alter its payoff structure to defacto achieve its public commitment.

We have also established that the use of base contracts to solve the opportunism problem need not decrease welfare because it may result in an increase in the number of firms selling the monopolist's product, which increases consumer choice. In the absence of base contracts, we have shown that the monopolist may resort to cutting back on the number of downstream firms it serves, and this can harm consumers.

A Appendix: Proofs

Proof of Proposition 1. Let r^b be sufficiently large that $\pi_1(r^b, r_2) = 0$ for all $r_2 \leq r^*$, and let $f^b \equiv \pi_1(r^b, r^*) - k$. Suppose the monopolist offers a base contract of (r^b, f^b) and then offers each firm the contract (r^*, f^*) . As discussed in the text, it is a weakly dominant strategy for each firm to accept the monopolist's offer, and it is an equilibrium of the continuation game for both to operate under contract (r^*, f^*) , giving the monopolist a payoff of $\Pi(r^*, r^*)$.

Taking the base contract (r^b, f^b) as given, suppose the monopolist can profitably deviate by offering (r'_1, f'_1) and (r'_2, f'_2) . Profitability of the deviation implies that at least one firm has negative payoff and that both firms operate (if only one firm operates, its payoff is bounded below by $\pi_1(r^b, \infty) - f^b - k$, which is positive). Suppose firm 1 rejects its offer. Because firm 1 operates, it must have nonnegative payoff and operate under (r^b, f^b) . Given this, firm 2's payoff is bounded below by $\pi_2(r^b, r^b) - f^b - k > 0$. Thus, both firms have nonnegative payoff, a contradiction. A similar contradiction results if firm 2 rejects its offer. Thus, both firms accept their offers, and each firm operates under either the contract offered to it or the base contract. Because the firms have positive payoff when they both operate under (r^b, f^b) , at least one firm must operate under the deviation contract offered to it.

Suppose firm 1 operates under the base contract. Then firm 2 operates under (r'_2, f'_2) rather than (r^b, f^b) , so it must be that

$$\pi_2(r^b, r'_2) - f'_2 \geq \pi_2(r^b, r^b) - f^b = \pi_2(r^b, r^b) - \pi_2(r^*, r^b) + k. \quad (\text{A.1})$$

In this case, the monopolist's payoff is

$$\begin{aligned} & \Pi(r^b, r'_2) - (\pi_1(r^b, r'_2) - f^b - k) - (\pi_2(r^b, r'_2) - f'_2 - k) \\ & \leq \Pi(r^b, r'_2) - \pi_1(r^b, r'_2) + \pi_1(r^b, r^*) - \pi_2(r^b, r^b) + \pi_2(r^*, r^b) \\ & = \Pi(r'_1, r'_2) - \pi_1(r^b, r'_2) - \pi_2(r^b, r^b) \\ & < \Pi(r^*, r^*), \end{aligned}$$

where the first inequality uses the definition of f^b and (A.1) and the equality uses the definition of r^b . Because the monopolist's payoff is less than $\Pi(r^*, r^*)$, the deviation is not profitable, a contradiction. A similar contradiction arises if firm 2 operates under the base contract. Thus, it must be that both firms operate under their deviation contracts.

If $\min\{r'_1, r'_2\} \geq r^*$, then firm 1's payoff is bounded below by $\pi_1(r^b, r'_2) - f^b - k$, which is positive, and similarly for firm 2, a contradiction. Thus, $\min\{r'_1, r'_2\} < r^*$. Suppose $r'_2 < r^*$. Because firm 1 operates under (r'_1, f'_1) rather than (r^b, f^b) ,

$$\pi_1(r'_1, r'_2) - f'_1 \geq \pi_1(r^b, r'_2) - f^b = \pi_1(r^b, r'_2) - \pi_1(r^b, r^*) + k. \quad (\text{A.2})$$

Because firm 2 operates under (r'_2, f'_2) rather than (r^b, f^b) ,

$$\pi_2(r'_1, r'_2) - f'_2 \geq \pi_2(r'_1, r^b) - f^b = \pi_2(r'_1, r^b) - \pi_2(r^*, r^b) + k. \quad (\text{A.3})$$

In this case, the monopolist's payoff is

$$\begin{aligned} & \Pi(r'_1, r'_2) - (\pi_1(r'_1, r'_2) - f'_1 - k) - (\pi_2(r'_1, r'_2) - f'_2 - k) \\ & \leq \Pi(r'_1, r'_2) - \pi_1(r^b, r'_2) + \pi_1(r^b, r^*) - \pi_2(r'_1, r^b) + \pi_2(r^*, r^b) \\ & = \Pi(r'_1, r'_2) - \pi_2(r'_1, r^b) \\ & < \Pi(r^*, r^*), \end{aligned}$$

where the first inequality uses (A.2) and (A.3) and the equality uses the definition of r^b and $r'_2 < r^*$. Once again since the monopolist's payoff is less than $\Pi(r^*, r^*)$, we have a contradiction. A similar contradiction arises if $r'_1 < r^*$. Thus, given base contract (r^b, f^b) , there is no profitable deviation in the continuation game. To complete the proof, suppose the monopolist can increase its payoff by choosing a base contract other than (r^b, f^b) . Then at least one downstream firm has negative expected payoff in the equilibrium of continuation game, which is a contradiction. Q.E.D.

References

- Alexander, C. and D. Reiffen (1995), “Vertical Contracts as Strategic Commitments: How Are They Enforced?,” *Journal of Economics and Management Strategy*, 4, 623–649.
- Corts, K. and D. Neher (2002), “Credible Delegation,” *European Economic Review*, forthcoming.
- Cremer, J. and M. Riordan (1987), “On Governing Multilateral Transactions with Bilateral Contracts,” *Rand Journal of Economics*, 18, 436–451.
- Hart, O. and J. Tirole (1990), “Vertical Integration and Market Foreclosure,” *Brookings Papers on Economic Activity: Microeconomics*, 205–276.
- Marx, L. M. and G. Shaffer (2001), “Opportunism and Nondiscrimination Clauses,” Working Paper, University of Rochester.
- McAfee, R. P. and M. Schwartz (1994), “Opportunism in Multilateral Vertical Contracting: Nondiscrimination, Exclusivity, and Uniformity,” *American Economic Review* 84, 210–230.
- O’Brien, D.P. and G. Shaffer (1992), “Vertical Control with Bilateral Contracts,” *Rand Journal of Economics*, 23, 299–308.
- O’Brien, D.P. and G. Shaffer (1994), “The Welfare Effects of Forbidding Discriminatory Discounts: A Secondary Line Analysis of Robinson-Patman,” *Journal of Law, Economics and Organization*, 10, 296–318.
- Segal, I. (1999), “Contracting with Externalities,” *Quarterly Journal of Economics*, 64, 337–388.