Opportunism and Menus of Two-Part Tariffs

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Abstract

We show that a menu of two-part tariffs can solve the opportunism problem identified by McAfee and Schwartz (1994) in vertical games with sequential contracting, provided the sunk costs incurred by the first firm to invest are not too large. If the seller were to engage in opportunism with a second firm in an attempt to shift rents from the first firm, the first firm could mitigate the dissipation of its rents by choosing from its menu of contract options the tariff with the higher marginal price and lower fixed fee. The prospect of the first firm’s choosing the ‘wrong’ two-part tariff in the event of opportunism is, in some environments, sufficient to make opportunism unprofitable for the seller.

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1 Introduction

Opportunism is an important issue in vertical contracting when a seller of an essential input contracts with downstream firms that 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 the seller may have an incentive to engage in rent-shifting among the downstream firms when it cannot publicly commit to its contracts. \(^1\) Ultimately, this lack of commitment can reduce overall joint payoff and make firms wary of accepting the seller’s contract offerings.

The downstream firms have reason to be wary because each knows that it may be harmed if it makes relationship-specific investments before knowing the terms agreed to by its rival. The problem is that once a firm invests, the seller may then have an incentive to engage in rent-shifting by offering better terms (e.g., a lower marginal price) to its rival. This decreases the committed firm’s expected payoff and threatens to make its initial sunk investment unprofitable. Unless the seller can commit ex-ante not to engage in this kind of opportunism, each firm runs the risk of agreeing to contract terms that may subsequently leave it worse off relative to its rival. Since no firm wants to operate at a cost disadvantage, or make relationship-specific investments if there is little prospect of recoupment, the seller faces the potentially difficult problem of how to align all parties’ interests to maximize overall joint payoff.

Several solutions to this problem have been proposed in the literature. Hart and Tirole (1990) suggest that the seller may want to integrate vertically with its downstream firms, 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 firms’ flow payoffs. And McAfee and Schwartz (1994) argue that the fear of opportunism may explain why a seller might 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 may not be feasible, especially if the downstream firms trade with more than one upstream firm. The assignment of non-overlapping geographic territories may be costly to enforce if consumers are mobile, and the use of resale price maintenance may violate antitrust laws. Resale price maintenance may also distort the incentives of the downstream firms to promote the seller’s product, and hinder non-price competition. Lastly, the adoption of uniform contracts across markets may be suboptimal if there are regional differences in demand so that conditions vary from market to market.

The literature distinguishes between games in which the seller’s contract terms are unobservable (firms never learn the terms of their rivals’ contracts) and games in which the contract terms are observable ex post (after sunk costs are incurred but before firms compete in the product market). In the former case, firms are unable to adjust their quantity choices in the event of opportunism. In the latter case, adjustment is possible. But the distinction is thought not to matter qualitatively because the literature until now suggests that in both cases the seller has an incentive to engage in opportunism. As a result, the proposed remedies (vertical integration, non-overlapping territories, resale price maintenance) are the same in the two cases.

In this paper, we consider a model of sequential contracting with one seller and two downstream firms and show that a simple alternative to these solutions exists if the contract terms are observable prior to the product market game and the sunk costs incurred by the first firm to invest are not too large. In particular, we show that a seller should offer the first firm a menu of two-part tariffs and allow it to choose its contract terms from among this menu after it observes its rival’s contract. By giving the first firm the option of purchasing its inputs under a two-part tariff with a

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2 The 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.

3 For example, the fact that a firm can adjust its quantity choices under ex-post observability in the event of opportunism is thought to mitigate, but not eliminate, the seller’s incentive.
higher marginal price and lower fixed fee (than the one it chooses in equilibrium) in the event of opportunism, the seller can, sometimes, solve the opportunism problem.

The solution we propose suggests that the distinction is important. If the first firm can learn of the opportunism before competing in the product market, it will choose the contract from its menu of choices that best allows it to thwart the dissipation of its rents. If the seller were to engage in opportunism with the second firm in an attempt to shift rents from the first firm, the first firm could mitigate the dissipation of its rents by choosing to purchase under the contract with the higher marginal price (lower fixed fee). By choosing this contract appropriately, the seller may be able to alter its payoff incentives to achieve defacto its public commitment. That is, the prospect of the first firm’s choosing the ‘wrong’ two-part tariff in the event of opportunism is, in some environments, sufficient to make the opportunism unprofitable for the seller.

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 fixing each firm’s effective input price. But fixing prices in advance is generally inefficient unless done in a state-contingent manner, and moreover, 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. To prevent opportunism, the seller need only offer a menu of two-part tariffs to the first firm. Second, the solution is easily enforced. The courts need only uphold the right of the first firm, if it suspects opportunism, to operate under a different two-part tariff than the one under which it would have operated otherwise. Moreover, there does not
have to be a fact-finding inquiry as to whether the alleged opportunism did or did not occur.

The rest of the paper proceeds as follows. We describe the seller’s opportunism problem in Section 2. In Section 3, we show how the seller can maximize overall joint payoff by allowing the first firm to choose from among a menu of two-part tariff contracts (after both firms’ contracts become known). In Section 4, we extend the model to allow other nonlinear contracts. We offer concluding remarks in Section 5.

2 The Opportunism Problem

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 the inputs 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. Each offer specifies a wholesale price and fixed fee.

The upstream firm contracts with each downstream firm in sequence, first with firm 1, and then with firm 2. We model a lack of commitment on the monopolist’s part by assuming that firm 1 must make relationship-specific investments, or exit the market, after seeing its contract terms but before the monopolist makes its offer to firm 2. All investments are sunk and non-contractible. For now, we assume the monopolist offers a single two-part tariff to each firm. Denote the monopolist’s offer to firm \( i \) as the pair \((r_i, f_i)\), where \( r_i \) is firm \( i \)'s wholesale price and \( f_i \) is its fixed fee.

The timing of the game is as follows. In stage one, the monopolist offers \((r_1, f_1)\) to firm 1, allowing firm 1 to purchase inputs at a cost \( T_1(0) = 0 \) and \( T_1(q) = r_1 q + f_1 \) for all \( q > 0 \), where \( q \) is the quantity of inputs purchased. After observing its offer, firm 1 must either exit the market (at no cost) or invest \( k \geq 0 \) in relationship-specific investments. Participation in the product market requires making the investments.
The investments are sunk, non-contractible, and must be made before stage two commences. In stage two, firm 2 observes firm 1’s offer and investment decision and is offered \((r_2, f_2)\) by the monopolist. Define \(T_2(q)\) analogously to \(T_1(q)\). Firm 2 must then either exit the market (at no cost) or invest \(k \geq 0\) in relationship-specific investments. In stage three, all contracts become observable. Firms that have exited the market earn zero. Firms that have made the required investments compete in the product market and order inputs. Competition may occur in prices or quantities.

We assume the product market equilibrium is unique for any distribution of wholesale prices \(r = (r_1, r_2)\) in which both firms are active \(q > 0\), with firm \(i\)’s equilibrium flow payoff given by \(\pi_i(r)\). For \(r_i\) sufficiently large, firm \(i\)'s flow payoff is zero. Otherwise, if firms \(i\) and \(j\) are both active, we assume that \(\pi_i\) 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

\[
\frac{\partial^2 \pi_i(r_1, r_2)}{\partial r_1 \partial r_2} < 0,
\]

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. Intuitively, firm \(i\) benefits from a decrease in its wholesale price in proportion to how much it produces. In many standard models of downstream competition, i.e., Cournot or differentiated Bertrand, 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.

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

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

In contrast, the joint payoff of the monopolist and firm \(i\), excluding \(f_j\), is

\[
u_i(r) \equiv \Pi(r) - (\pi_j(r) - k), \quad j \neq i.
\]
We assume $\Pi(r)$ and $u_i(r)$ are twice differentiable, concave in $r_i$, and have the property that own price effects dominate cross price effects. That is, we assume

$$\left| \frac{\partial^2 \Pi}{\partial r_i^2} \right| > \left| \frac{\partial^2 \Pi}{\partial r_i \partial r_j} \right| \quad \text{and} \quad \left| \frac{\partial^2 u_i}{\partial r_i^2} \right| > \left| \frac{\partial^2 u_i}{\partial r_i \partial r_j} \right|,$$

for $j \neq i$.

We also assume flow payoffs are symmetric: given $r'$ and $r''$, $\pi_1(r', r'') = \pi_2(r'', r')$.

Let $r^* \equiv \arg \max_{r \geq 0} \Pi(r)$, so $\Pi(r^*, r^*)$ is the maximum overall joint payoff. Let $\Pi_i^m$ be the maximized joint payoff when only downstream firm $i$ operates, i.e., $\Pi_i^m \equiv \max_{r_i \geq 0} (r_i - z)q_i(r_i, \infty) + \pi_i(r_i, \infty) - k$. We assume

$$\sum_{i=1}^2 ((r^* - z)q_i(r^*, r^*) + \pi_i(r^*, r^*)) > \max_{r_i \geq 0} (r_i - z)q_i(r_i, \infty) + \pi_i(r_i, \infty),$$

so that for $k > 0$ sufficiently small, overall joint payoff is maximized when both downstream firms operate, i.e., $\Pi(r^*, r^*) > \Pi_i^m$. We also assume $\pi_i(r^*, r^*) > 0$, so firms’ flow payoffs are positive when overall joint payoff is maximized.

If there are no sunk costs (i.e., $k = 0$) the monopolist can obtain the joint-payoff maximum by offering each firm the contract $(r^*, f^*)$, where $f^* \equiv \pi(r^*, r^*) - k$.\footnote{Symmetry allows us to drop the subscript on $\pi$ when all firms have a common wholesale price.} The monopolist has no incentive to engage in opportunism in this case because any wholesale price lower than $r^*$ offered to firm 2 would cause firm 1 to choose $q_1 = 0$.

However, if there are sunk costs (i.e., $k > 0$), the joint-payoff maximum cannot be supported in equilibrium. To see this, suppose firm 1 invests $k$ after the monopolist offers it the contract $(r^*, f^*)$, and let $\tilde{r}_2(r_1, f_1)$ be the wholesale price that maximizes the bilateral joint payoff of the monopolist and firm 2 (assuming firm 1 is active), i.e.,

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

subject to firm 1’s choosing $q_1 > 0$ when it competes in the product market:

$$\pi_1(r_1, r) - f_1 \geq 0. \quad (4)$$

Evaluating $\tilde{r}_2$ at $(r^*, f^*)$, we have $\tilde{r}_2(r^*, f^*) < r^*$.\footnote{The inequality follows from the fact that $k > 0$ implies that (4) is not binding when both firms have the contract $(r^*, f^*)$, and the concavity of $u_2$ implies that $\frac{\partial^2 u_2(r^*, f^*)}{\partial f_2} \leq \frac{\partial^2 u_2(r^*, f^*)}{\partial r_1} - \frac{\partial^2 u_2(r^*, f^*)}{\partial r_2} < 0.$} 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, and firm 1 invests, the monopolist can earn higher payoff by lowering firm 2’s wholesale price below \(r^*\) and raising its fixed fee above \(f^*\) to extract the extra surplus. In particular, the monopolist can earn higher payoff by offering \((\hat{r}, \hat{f})\) to firm 2, where \(\hat{r} \equiv \tilde{r}_2(r^*, f^*)\) and \(\hat{f} \equiv \pi_2(r^*, \hat{r}) - k\). The monopolist’s incentive to engage in opportunism against firm 1 arises because, after firm 1’s investment, the monopolist can safely ignore at the margin the reduction in firm 1’s payoff from cutting price to firm 2 (it need only ensure that firm 1 chooses \(q_1 > 0\)). Ultimately, however, the monopolist loses because a wary firm 1 will exit the market (without investing) on observing \((r^*, f^*)\) and the monopolist will fail even to earn \(\Pi(r^*, r^*)\).

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 in the literature. For example, it has been suggested that the monopolist might want to integrate vertically in order to internalize all profit incentives (Hart and Tirole, 1990), adopt resale price maintenance in order to eliminate flow payoffs (O’Brien and Shaffer, 1992), impose non-overlapping geographic territories in order to make flow payoffs independent (O’Brien and Shaffer, 1992), or refrain from customizing contracts across markets in order to assuage fears of opportunism (McAfee and Schwartz, 1994).

Notably, however, it has been shown that the monopolist cannot solve the opportunism problem by offering \((r^*, f^*)\) to firm 1 initially and then allowing it to operate under the contract terms of firm 2 in the event of opportunism, e.g., by giving firm 1 a most-favored-customer clause. As pointed out by McAfee and Schwartz, this intuition fails because firm 1’s payoff if it keeps its original contract terms (although reduced) is greater than its payoff if it operates under the same terms as firm 2:

\[
\pi_1(r^*, \hat{r}) - f^* > \pi_1(\hat{r}, \hat{r}) - \hat{f},
\]

which follows from rearranging terms, imposing symmetry, and noting that \(\pi_1(\hat{r}, r^*) - \pi_1(r^*, r^*) > \pi_1(\hat{r}, \hat{r}) - \pi_1(r^*, \hat{r})\) by the negative cross-partial derivative of \(\pi_1\). Although firm 1 would prefer to have firm 2’s lower wholesale price, it is not willing to pay firm
2’s higher fixed fee to get it.

What has been missed in the literature is that the same logic involving cross-partial derivatives implies that firm 1 would be willing to accept a higher wholesale price than $r^*$ in the event of opportunism if it could reduce its fixed fee burden. In the next section, we exploit this idea to show that a fairly straightforward contractual solution sometimes exists to prevent opportunism in the sequential contracting game.

3 Menus of Two-Part Tariffs

We propose solving the opportunism problem by allowing the monopolist to offer more general nonlinear contracts. In this section, we show that if the sunk costs incurred by the first firm to invest are not too large, the monopolist can solve the opportunism problem by offering firm 1 a menu of two-part tariffs. The prospect of the first firm’s choosing the ‘wrong’ two-part tariff in the event of opportunism is, in some environments, sufficient to make the opportunism unprofitable for the seller.

The modified game is as follows. In stage one, the monopolist offers the menu $((r_1, f_1), (r'_1, f'_1))$ to firm 1, allowing firm 1 to purchase inputs at a cost $T_1(0) = 0$ and $T_1(q) = r_1q + f_1$ for all $q > 0$ if it purchases under $(r_1, f_1)$, and $T_1(0) = 0$ and $T_1(q) = r'_1q + f'_1$ if it purchases under $(r'_1, f'_1)$. After observing its offer, firm 1 must either exit the market or invest $k \geq 0$ in relationship-specific investments. In stage two, firm 2 observes firm 1’s offer and investment decision, and is offered $(r_2, f_2)$ by the monopolist, allowing firm 2 to purchase inputs at a cost $T_2(0) = 0$ and $T_2(q) = r_2q + f_2$ if $q > 0$.\footnote{Since firm 2 is the last firm to invest, there is no loss of generality in restricting the monopolist to offering firm 2 a single two-part tariff.} Firm 2 must then either exit the market or invest $k \geq 0$ in relationship-specific investments. In stage three, firm 1 observes firm 2’s contract and firm 2 observes which contract firm 1 will operate under. Firms that have exited the market earn zero. Firms that have made the required investments compete in the product market and order inputs. Competition may occur in prices or quantities.
To make the problem non-trivial, we assume that the relationship-specific investments are non-contractible, and that the monopolist cannot make the investments for the downstream firms (otherwise, there is no opportunism problem).\footnote{In a previous version of this paper, we showed that \(((r_1^1, f_1^1), (r_1', f_1')) = ((r^*, f^*), (\infty, -k))\), in which the monopolist simply reimbursed all of firm 1’s relationship-specific investments in the event of opportunism was sufficient to obtain the overall joint-payoff-maximizing outcome.} Thus, we restrict attention to two-part tariffs in which the fixed fees are non-negative: \(f_1, f_1' \geq 0\).

### 3.1 Solving the opportunism problem

Suppose that in stage one, the monopolist offers firm 1 the menu \(((r^*, f^*), (r^b, f^b))\), where \(r^b > r^*\) and \(f^b < f^*\) such that firm 1 earns zero payoff whether it operates under the contract \((r^*, f^*)\) or \((r^b, f^b)\) if firm 2 operates under the contract \((r^*, f^*)\):

\[
\pi_1(r^b, r^*) - f^b - k = 0 \quad \text{and} \quad \pi_1(r^*, r^*) - f^* - k = 0. \tag{5}
\]

![Figure 1: Relation among the contracts \((r^*, f^*), (r^b, f^b),\) and \((\hat{r}, \hat{f})\).](image)

Assuming firm 1 accepts its terms (invests \(k\)), if the monopolist offers \((r^*, f^*)\) \(f_1\) \(r_1\)
to firm 2 in stage two, then it is an equilibrium of the continuation game for firm 2 to invest \( k \) and for both firms to operate under \((r^*, f^*)\) in stage three (firm 1 is indifferent between \((r^*, f^*)\) and \((r^b, f^b)\) by (5)), giving the monopolist a payoff of \( \Pi(r^*, r^*) \). Thus, the monopolist can obtain the joint-payoff maximum if it so chooses.

The interesting question, of course, is whether the monopolist can do better by acting opportunistically. Suppose the monopolist offers \((\hat{r}, \hat{f})\) to firm 2, (recall \( \hat{r} < r^* \) and \( \hat{f} > f^* \)). Then, as seen in Figure 1, it is an equilibrium of the continuation game for firm 2 to invest \( k \geq 0 \) in stage two and for firm 1 to operate under \((r^b, f^b)\) in stage three.\(^8\) If firm 2 operates under the opportunistic contract \((\hat{r}, \hat{f})\), then because \((r^b, f^b)\) is in the shaded area denoting contracts that give the firm 1 higher payoff than \((r^*, f^*)\) when firm 2 operates under \((\hat{r}, \hat{f})\), firm 1 strictly prefers \((r^b, f^b)\) to \((r^*, f^*)\).

The monopolist’s payoff in this case is given by the overall joint payoff, \( \Pi(r^b, \hat{r}) \), minus firm 1’s payoff, \( \pi_1(r^b, \hat{r}) - f^b - k \), minus firm 2’s payoff, \( \pi_2(r^b, \hat{r}) - \hat{f} - k \):

\[
\Pi(r^b, \hat{r}) - (\pi_1(r^b, \hat{r}) - f^b - k) - (\pi_2(r^b, \hat{r}) - \hat{f} - k) \\
\leq \Pi(r^b, \hat{r}) - (\pi_1(r^b, \hat{r}) - f^b - k) \\
\leq \Pi(r^b, \hat{r}) + k,
\]

where the first inequality uses the non-negativity of firm 2’s payoff when firm 1 operates under \((r^b, f^b)\), i.e., \( \pi_2(r^b, \hat{r}) - \hat{f} - k \geq 0 \), and the second inequality uses the non-negativity of firm 1’s payoff in the product market, i.e., \( \pi_1(r^b, \hat{r}) - f^b \geq 0 \). Thus, comparing \( \Pi(r^*, r^*) \) to \( \Pi(r^b, \hat{r}) + k \), we see that for \( k \) sufficiently small, the monopolist’s opportunistic behavior can be prevented by choosing \((r^b, f^b)\) to make the opportunism unprofitable (see Proposition 1 for a formal proof). Note that offering firm 1 the menu \( ((r^*, f^*), (r^b, f^b)) \) does not prevent firm 1 from being hurt by opportunism (firm 1’s payoff if firm 2’s contract is \((\hat{r}, \hat{f})\) and firm 1 operates under \((r^b, f^b)\) is negative),\(^9\) and so does not insure firm 1 against losses; however, the menu

\(^8\)It is a weakly dominant strategy for firm 2 to invest \( k \geq 0 \) in the second stage. To see this, note that when firm 2 operates under \((\hat{r}, \hat{f})\), its payoff is either zero if firm 1 operates under \((r^*, f^*)\) or \( \pi_2(r^b, \hat{r}) - \pi_2(r^*, \hat{r}) > 0 \) if firm 1 operates under \((r^b, f^b)\).

\(^9\)To see this, note that \( \hat{r} < r^* \) and (5) imply \( \pi_1(r^b, \hat{r}) - f^b - k < \pi_1(r^b, r^*) - f^b - k = 0 \).
prevents the monopolist from having an incentive to impose losses on firm 1.

**Proposition 1** There exists $\bar{k} > 0$ such that for all $k < \bar{k}$, overall joint payoff is maximized when the monopolist can offer firm 1 a menu of two-part tariffs.

*Proof.* See the Appendix.

Comparing $\Pi(r^*, r^*)$ to $\Pi(r^b, \hat{r}) + k$, we can interpret these terms as reflecting the benefits and costs of opportunism. Intuitively, $k$ represents the maximum possible gain from opportunism, i.e., the amount of firm 1’s sunk costs. If the monopolist were to attempt to extract any more surplus from firm 1, firm 1 would simply shut down and not compete in the product market.\(^{10}\) Offsetting this gain is the cost of the monopolist’s opportunism, which is the distortion that must be engendered in the overall joint payoff, $\Pi(r^*, r^*) - \Pi(r^b, \hat{r})$. When the cost of the opportunism exceeds the gain, i.e., the loss in overall joint payoff exceeds $k$, opportunism is unprofitable.

Previous literature on vertical contracting suggests 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 it is unable to commit publicly to its contracts. Proposition 1 suggests otherwise. When contract terms are observable ex post, an expansion of the contract set allows the monopolist to solve the opportunism problem if $k$ is not too large. Instead of offering firm 1 the contract $(r^*, f^*)$, the monopolist offers the menu $\{(r^*, f^*), (r^b, f^b)\}$, where $(r^b > r^*)$ and $(f^b < f^*)$. For sufficiently small $k$, opportunism is prevented when the monopolist contracts with firm 2 because, if the monopolist deviated from $(r^*, f^*)$ with firm 2 in a way that increased its payoff if firm 1 operated under $(r^*, f^*)$, firm 1 would simply switch to its other contract, making the deviation unprofitable.

\(^{10}\)The monopolist’s gains from opportunism are limited to expropriating a downstream firm’s relationship-specific investment, $k$, because firm 1 does not have to pay its fixed fee $f$ to the monopolist until after it observes firm 2’s contract. Essentially, by offering a menu to firm 1, the monopolist allows firm 1 to choose a contract with a lower fixed fee if it sees that firm 2 has obtained a wholesale price below $r^*$. As noted by one of the referees, in other environments it may make sense to assume that the firm must pay some fixed fee to the monopolist before learning its rival’s costs.
3.2 Linear demand example with bounds on $k$

It is useful to illustrate Proposition 1 with a linear demand example in order to get a sense for how small $k$ must be for the opportunism to be prevented.

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 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

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

Substituting in for $p^*_i(r)$, we can solve for firm $i$’s equilibrium input demand,

$$q_i(r) = x_i(p^*_1(r), p^*_2(r)) = \frac{2(5a - 7r_i + 2r_{3-i})}{15},$$

firm $i$’s equilibrium flow payoff,

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

and the overall joint payoff of the monopolist and downstream firms,

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

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

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

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

$$\hat{f} = \begin{cases} \frac{13a + 99z}{112}, & \text{if } k \geq \frac{27(a-z)^2}{1968} \\ \frac{1}{8}(-13a + 15 \sqrt{(a-z)^2 - 8k + 21z}), & \text{otherwise}. \end{cases}$$
and the corresponding opportunistic fixed fee is \( \hat{f} = \pi_2(r^*, \hat{r}) - k \). There are two possible expressions for the opportunistic wholesale price \( \hat{r} \) because it is defined as the solution to a constrained optimization problem (see the program in (3) and (4)) and the constraint can bind. In what follows, it will be useful to define the unconstrained opportunistic wholesale price, \( \hat{r}^u \equiv \frac{13a + 99z}{112} \).

The contract \((r^b, f^b)\) must satisfy three conditions. First, it must be that \( f^b \geq 0 \). Second, it must extract all surplus from firm 1 when firm 2 has wholesale price \( r^* \), i.e., \( \pi_1(r^b, r^*) - f^b - k = 0 \). Third, the monopolist’s payoff must be higher if both firms have contract \((r^*, f^*)\) than if firm 2 has contract \((r', f')\) such that \( r' < r^* \) and \( f' = \pi_2(r^*, r') - k \), and firm 1 has contract \((r^b, f^b)\), i.e., for all \( r' < r^* \), it must be that

\[
\Pi(r^*, r^*) \geq (r^b - z)q_1(r^b, r^*) + f^b + (r' - z)q_2(r^b, r^*) + f'.
\]  

(6)

It is sufficient for (6) that the inequality is satisfied when \( r' = \hat{r}^u \). Thus, substituting in \( r' = \hat{r}^u, f' = \pi_2(\hat{r}^u, \hat{r}^u) - k \), and \( f^b = \pi_1(r^b, r^*) - k \), it is sufficient that

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

(7)

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

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

Let \( \hat{f}^b \equiv \pi_1(\hat{r}^b, r^*) - k \). For now, assume \( \hat{f}^b \geq 0 \). Then we know from (6) and (7) that when the monopolist offers a menu of two-part tariffs \((r^*, f^*), (\hat{r}^b, \hat{f}^b)\) to firm 1, it can obtain the joint-payoff-maximizing outcome by offering the single two-part tariff \((r^*, f^*)\) to firm 2. It remains only to show the range of \( k \) for which \( \hat{f}^b \geq 0 \).

To illustrate the upper bound on \( k \), let \( a = 1 \) and \( z = 0 \). The joint-profit-maximizing outcome can be achieved with a menu of contracts to firm 1 of

\[
((r^*, f^*) = (0.25, 0.125 - k), (\hat{r}^b, \hat{f}^b) = (0.29, 0.107 - k))
\]

and a contract of \((r^*, f^*) = (0.25, 0.125 - k)\) to firm 2. In this case, each firm’s flow payoff is 0.125. Thus, our assumption that overall joint payoff is maximized
when both downstream firms operate implies that $k < .125$. If $k \in [0, .107]$, i.e., as long as relationship-specific investments consume no more than 85% of a firm’s flow payoff given the overall-joint-payoff-maximizing wholesale prices, then $\bar{f}^b \geq 0$, so the monopolist can ensure against its own opportunism without actually paying for firm 1’s investment.\(^{11}\) If $k \in (0.107, .125)$, then $\bar{f}^b < 0$, and the monopolist would have to pay firm 1 in order to maximize overall joint payoff.

### 4 Other Nonlinear Contracts

We have shown that if investment costs are not too large, the monopolist can achieve the joint-payoff maximum by offering a menu of two-part tariffs to firm 1. The idea is that the monopolist can construct the menu so that any attempted opportunism ex- post leads to a discrete change in firm 1’s purchase order, causing overall joint payoff to fall by more than $k$, which is the maximum amount available for rent-shifting.

This idea is not restricted to a menu of two-part tariffs. For example, suppose the monopolist offers the contracts $T_1(q)$ to firm 1 and $T_2(q)$ to firm 2. Let $\Pi(q_1, q_2)$ denote overall joint payoff, and let $\pi_i(q_1, q_2) - T_i(q_i) - k$ denote firm $i$’s payoff. Let $q^* \equiv \arg\max_{q \geq 0} \Pi(q, q)$, so $\Pi(q^*, q^*)$ is the maximum overall joint payoff. Then, assuming an analogous three-stage game to the one described previously, the monopolist can maximize the overall joint payoff for sufficiently small $k$ by offering firm 1 a two-quantity quantity-forcing contract with quantities $q^*$ and $q^b < q^*$ such that

$$\pi_1(q^b, q^*) - T_1(q^b) - k = 0 \quad \text{and} \quad \pi_1(q^*, q^*) - T_1(q^*) - k = 0. \quad (8)$$

If the monopolist offers $T_2(0) = 0$, $T_2(q^*) = \pi_2(q^*, q^*) - k$, $T_2(q) = \infty$ for all other $q > 0$ to firm 2 in stage two, then it is an equilibrium of the continuation game for firm 2 to invest $k$ and for both firms to purchase $(q^*, q^*)$ in stage three. If the

\(^{11}\)Note that having a sufficiently small $k$ both satisfies the assumption that overall joint payoff is maximized when both downstream firms operate and guarantees that the opportunism problem is solved. However, the assumption that $k$ is sufficiently small that overall joint payoff is maximized when both downstream firms operate is not sufficient to eliminate the opportunism problem.
monopolist acts opportunistically, offering a contract to firm 2 that induces firm 2 to invest $k \geq 0$ in stage two and to purchase $q' > q^*$ in stage three, then it is an equilibrium of the continuation game for firm 1 to purchase $q^b$ units in stage three.$^{12}$

The monopolist’s payoff in the former case is $\Pi(q^*, q^*)$. Its payoff in the latter case is bounded above by $\Pi(q^b, q') + k$. Since $\Pi(q^*, q^*) > \Pi(q^b, q')$, it follows that for sufficiently small $k$ the monopolist’s opportunistic behavior can be prevented.

5 Conclusion

We have shown that a menu of two-part tariffs (and other nonlinear contracts) can solve the opportunism problem identified by McAfee and Schwartz (1994) in vertical games with multilateral sequential contracting, provided the contracts become observable before inputs are ordered and the sunk costs are not too large. In McAfee and Schwartz’s model, contracts are assumed to be two-part tariffs. In this case, if firm 1 has the contract required for overall-joint-payoff maximization, the monopolist seller can always offer a contract to firm 2 that causes firm 1 to make an arbitrarily small adjustment in its quantity, resulting in a small (second order) decrease in overall joint payoff, but a first order shift in rents from the firms to the monopolist. Thus, the restriction to two-part tariffs means that the opportunism problem prevents overall joint payoff from being maximized. In contrast, by offering firm 1 a menu of two-part tariffs, the monopolist can ensure that any attempt to opportunistize causes a discrete jump in firm 1’s quantity choice. This discontinuity is the key to our result. We show that, when the sunk costs are small, firm 1’s menu can always be chosen in such a way that this jump in firm 1’s quantity choice renders unprofitable any attempt by the monopolist to opportunistize. By offering such a menu of two-part tariffs to firm 1, the monopolist effectively commits itself not to behave opportunistically in the future, and allows it to extract the maximum surplus from the firms.

$^{12}$This follows because $\pi_1(q^b, q') - T^*(q^b) - k > \pi_1(q^*, q') - T^*(q^*) - k$ is implied by the definitions of $T^*(q^b), T^*(q^*)$, and the relation $\pi_1(q^*, q') - \pi_1(q^b, q') < \pi_1(q^*, q^*) - \pi_1(q^b, q^*)$. 

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Our results suggest that games with ex-post observable contracts are qualitatively different from games with unobservable contracts in ways that affect the monopolist’s opportunistic incentives. In the latter case, quantity adjustments are not possible in response to opportunism because the opportunism is discovered too late, and so the idea presented here cannot be implemented. However, when the opportunism would be discovered before input orders are made, it is relatively straightforward for the monopolist to design appropriate incentive contracts. In contrast, the previous literature has suggested more complex ways to solve the problem, including vertical integration, non-overlapping geographic territories, and resale price maintenance.

Menus of two-part tariffs are often posited to arise in retail contracts when the downstream firms have private information about their types, or when the upstream firm is attempting to evade Robinson-Patman prohibitions against overt price discrimination among downstream firms of different sizes (see Schwartz, 1986). The menus serve an obvious purpose: to induce self-selection among retailers in order to better extract surplus, and for this reason are thought to be profitable for the upstream firm. In contrast, our results suggest another explanation for their use. Menus of two-part tariffs may be offered by the upstream firm to discourage its own opportunism, and may be optimal even when the downstream firms are ex-ante identical.
Appendix

Proof of Proposition 1. Given firm 1’s contract, firm 2’s payoff in any equilibrium of the continuation game starting from firm 2’s decision whether to accept or reject the contract offered by the monopolist is nonnegative since otherwise firm 2 could profitably deviate by rejecting the monopolist’s offer. Suppose the monopolist offers firm 1 a menu of two-part tariffs such that in the equilibrium of the continuation game, the monopolist’s payoff is greater than \( \Pi(r^*, r^*) \). Then it must be that the payoff of either firm 1 or firm 2 is negative. Because the payoff of firm 2 cannot be negative, it must be that the payoff of firm 1 is negative, implying that firm 1 can profitably deviate by rejecting the monopolist’s offer. This is a contradiction. Thus, the monopolist’s payoff must be less than or equal to \( \Pi(r^*, r^*) \).

We now show that the monopolist can achieve a payoff of \( \Pi(r^*, r^*) \) for \( k \) sufficiently small. Let \( \Pi_2^m \) denote the maximum overall joint payoff when only firm 2 operates, i.e., \( \Pi_2^m \equiv \max_{r_2} (r_2 - z)q_2(\infty, r_2) + \pi_2(\infty, r_2) - k \). By (2),

\[
\Delta \equiv \sum_{i=1}^2 ((r^* - z)q_i(r^*, r^*) + \pi_i(r^*, r^*)) - \max_{r_2} ((r_2 - z)q_2(\infty, r_2) + \pi_2(\infty, r_2)) > 0.
\]

Thus, \( \exists k' > 0 \) such that \( \forall k < k', \Pi(r^*, r^*) > \Pi_2^m \). Let \( \varepsilon \in (0, \Delta) \). Note that \( \varepsilon \) is independent of \( k \), and that for all \( k < \frac{\varepsilon}{2} \),

\[
\Pi_2^m + \frac{\varepsilon}{2} < \Pi_2^m + \varepsilon - k < \Pi_2^m + \Delta - k = \Pi(r^*, r^*),
\]

(A.1)

where the first inequality uses \( k < \frac{\varepsilon}{2} \), the second inequality uses \( \varepsilon < \Delta \), and the equality uses the definition of \( \Delta \).

Let \( \bar{r}(k) \) be defined implicitly by \( \pi_1(\bar{r}, r^*) = k \). Let \( k'' > 0 \) be such that \( \forall k < k'' \),

\[
\max_{r_2 \leq r^*} \Pi(\bar{r}(k), r_2) < \Pi_2^m + \frac{\varepsilon}{4}.
\]

(A.2)

To see that such a \( k'' \) exists, note that as \( k \) approaches zero, \( \bar{r}(k) \) increases towards the choke price for firm 1 associated with \( r_2 = r^* \), which is also a choke price for any
\[ r_2 < r^*. \] Thus,

\[
\lim_{k \to 0} \max_{r_2 \leq r^*} \Pi(\tilde{r}(k), r_2) - \Pi^m_2 = \lim_{k \to 0} \max_{r_2 \leq r^*} ((\tilde{r}(k) - z)q_1(\tilde{r}(k), r_2) + (r_2 - z)q_2(\tilde{r}(k), r_2) + \pi_1(\tilde{r}(k), r_2) + \pi_2(\tilde{r}(k), r_2) - 2k) - \max_{r_2} ((r_2 - z)q_2(\infty, r_2) + \pi_2(\infty, r_2) - k) = \max_{r_2 \leq r^*} ((r_2 - z)q_2(\infty, r_2) + \pi_2(\infty, r_2)) - \max_{r_2} ((r_2 - z)q_2(\infty, r_2) + \pi_2(\infty, r_2)) \leq 0.
\]

Let \( \bar{k} \equiv \min \{ k', k'', \frac{\epsilon}{\bar{q}}, \pi_1(r^*, r^*) \} \), and note that \( \bar{k} > 0 \).

Suppose \( k < \bar{k} \). Note that \( \pi_1(r^*, r^*) > k = \pi_1(\tilde{r}(k), r^*) \), which implies that \( \tilde{r}(k) > r^* \).

Suppose the monopolist offers firm 1 the menu \( ((r^*, f^*), (\tilde{r}(k), 0)) \). Then, as shown in the text, if the monopolist offers firm 2 the contract \( (r^*, f^*) \) and firm 2 accepts, then firm 1 is indifferent between operating under contract \( (r^*, f^*) \) and contract \( (\tilde{r}(k), 0) \) (both give firm 1 a flow payoff of \( k \)), so there is an equilibrium of the continuation game in which firm 1 chooses to operate under contract \( (r^*, f^*) \), and so the monopolist’s payoff is \( \Pi(r^*, r^*) \). Note that there is no equilibrium in which firm 1 chooses to operate under contract \( (\tilde{r}(k), 0) \) since then the monopolist’s payoff is less than \( \Pi(r^*, r^*) \), and so the monopolist could profitably deviate by instead offering firm 1 the menu \( ((r^*, f^* - \delta), (\tilde{r}(k), 0)) \) for some \( \delta > 0 \) sufficiently small.

It remains to be shown that, given that firm 1 accepts \( ((r^*, f^*), (\tilde{r}(k), 0)) \), it is a best reply for the monopolist to offer the contract \( (r^*, f^*) \) to firm 2. Suppose instead the monopolist offers firm 2 the contract \( (r', f') \), where \( r' < r^* \). If firm 1 operates under contract \( (r^*, f^*) \) in the continuation game, then it must be that firm 1’s flow payoff is weakly greater under contract \( (r^*, f^*) \) than under contract \( (\tilde{r}(k), 0) \), i.e.,

\[
\pi_1(r^*, r') - f^* \geq \pi_1(\tilde{r}(k), r'). \tag{A.3}
\]

Recall that we assume \( \frac{\partial^2 \pi}{\partial r_1 \partial r_2} < 0 \), so \( \tilde{r}(k) > r^* \) implies that \( \frac{\partial \pi_1(r^*, r_2)}{\partial r_2} > \frac{\partial \pi_1(\tilde{r}(k), r_2)}{\partial r_2} \) (as long as at least the left side is non-zero), which implies that \( \forall r_2 < r^* \),

\[
\pi_1(r^*, r^*) - \pi_1(\tilde{r}(k), r^*) > \pi_1(r^*, r_2) - \pi_1(\tilde{r}(k), r_2). \tag{A.4}
\]
(To see that the left side in (A.4) is non-zero, note that $\pi_1(r^*, r^*) > 0$.) It follows that
\[
\pi_1(r^*, r') - f^* = \pi_1(r^*, r') - \pi_1(\tilde{r}(k), r') + \pi_1(\tilde{r}(k), r') - f^*
\]
\[
< \pi_1(r^*, r^*) - \pi_1(\tilde{r}(k), r^*) + \pi_1(\tilde{r}(k), r') - f^*
\]
\[
= \pi_1(r^*, r^*) - k + \pi_1(\tilde{r}(k), r') - f^*
\]
\[
= \pi_1(\tilde{r}(k), r'),
\]
where the first equality adds and subtracts $\pi_1(\tilde{r}(k), r')$, the first inequality uses $r' < r^*$ and (A.4), the second equality uses the definition of $\tilde{r}(k)$, and the last equality uses the definition of $f^*$. This contradicts (A.3). Thus, it must be that firm 1 operates under contract $(\tilde{r}(k), 0)$ in the continuation game.

Given that firm 1 operates under contract $(\tilde{r}(k), 0)$, the monopolist’s payoff is
\[
\Pi(\tilde{r}(k), r') - (\pi_1(\tilde{r}(k), r') - k) - (\pi_2(\tilde{r}(k), r') - f' - k)
\]
\[
\leq \Pi(\tilde{r}(k), r') - (\pi_1(\tilde{r}(k), r') - k)
\]
\[
\leq \pi_2(\tilde{r}(k), r') + k
\]
\[
\leq \max_{r_2 \leq r^*} \Pi(\tilde{r}(k), r_2) + k
\]
\[
< \pi_2^m + \frac{\varepsilon}{2}
\]
\[
< \Pi(r^*, r^*),
\]
where the first inequality uses the non-negativity of firm 2’s payoff, the second inequality uses the non-negativity of firm 1’s flow payoff $\pi_1(\tilde{r}(k), r')$, the third inequality uses $r' < r^*$, the fourth inequality uses (A.2) and $k < \frac{\varepsilon}{4}$, and the last inequality uses (A.1). This completes the proof that, given that firm 1 accepts $((r^*, f^*), (\tilde{r}(k), 0))$, it is a best reply for the monopolist to offer the contract $(r^*, f^*)$ to firm 2 rather than some contract $(r', f')$ with $r' < r^*$.

To complete the proof, we must show that, given that firm 1 accepts $((r^*, f^*), (\tilde{r}(k), 0))$, it is a best reply for the monopolist to offer the contract $(r^*, f^*)$ to firm 2 rather
than some contract \((r', f')\) with \(r' > r^\star\). Suppose the monopolist offers firm 2 the contract \((r', f')\), where \(r' > r^\star\). If firm 1 operates under either contract \((r_1, f_1) \in \{(r^\star, f^\star), (\tilde{r}(k), 0)\}\) in the continuation game, then the monopolist’s payoff is

\[
\Pi(r_1, r') - (\pi_1(r_1, r') - f_1 - k) - (\pi_2(r_1, r') - f' - k) \\
\leq \Pi(r_1, r') - (\pi_1(r_1, r') - f_1 - k) \\
< \Pi(r_1, r') - (\pi_1(r_1, r^\star) - f_1 - k) \\
= \Pi(r_1, r') \\
< \Pi(r^\star, r^\star),
\]

where the first inequality uses the non-negativity of firm 2’s payoff, the second inequality uses \(r' > r^\star\), the equality uses \(f_1 = \pi_1(r_1, r^\star) - k\) for \((r_1, f_1) \in \{(r^\star, f^\star), (\tilde{r}(k), 0)\}\), and the last inequality uses the definition of \(r^\star\). Thus, it is a best reply for the monopolist to offer the contract \((r^\star, f^\star)\) to firm 2 rather than any other contract \((r', f')\). It follows that firm 1 accepts the monopolist’s offer of the menu \(((r^\star, f^\star), (\tilde{r}(k), 0))\), and the monopolist’s equilibrium payoff is \(\Pi(r^\star, r^\star)\). Q.E.D.
References


