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NONDISCRIMINATION GUARANTEES AND HOLDUP IN LONG-TERM CONTRACTS

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Abstract

A firm controls access to the market for some good. Rather than produce the good itself, the firm purchases it from homogeneous and risk-neutral suppliers, and resells it to final consumers. Because suppliers invest in specific capital, the firm has ex post market power even though ex ante the market for suppliers is competitive. By promising each supplier "most" favorable treatment, the firm binds itself to a policy of nondiscrimination, and commits not to pit suppliers against one another in an effort (ex post) to secure more favorable terms. Under appropriate circumstances, these promises can be used in lieu of complex contingent-claims contracts.

1. INTRODUCTION

This paper models the market power arising with durable and relation-specific investments. Marshall (1890) first identified this problem, and more recent discussions include Williamson (1975) and Klein, Crawford, and Alchian (1978). To illustrate, suppose a firm hires suppliers who must invest in long-lived and relation-specific capital. Once these suppliers sink resources into a relationship with this firm, they cannot economically seek other outlets for their products. The market power which the firm wields after specific investments are made therefore differs from the power which may or may not exist beforehand. Without commitments outlining the ex post division of quasi-rents, suppliers contemplate that the value of their capital will fall as their ex post bargaining power diminishes. Hence, they balk at making these investments.

Commitment by the firm can take a variety of forms. Suppliers could be protected by detailed contingent-claims contracts. The firm could agree to exclusive contracts or to a bond which would assure performance. It could provide suppliers with some recourse to terminate their contracts and demand compensation for their investments if the firm behaves opportunistically. It could agree to fund some or all of the specific investment. Reputational considerations could also mitigate suppliers' concerns. Each option has well-known problems, but all appear in practice.

The merits of most-favored-treatment guarantees are less well-known. A supplier with such a provision is assured that if any other supplier subsequently receives terms more favorable than its own, then its contract will be adjusted to become as favorable. If all suppliers receive this assurance, the outcome is nondiscrimination. The firm effectively commits not to pit suppliers against one another once they invest in specific capital.

The provisions prevent the firm from holding up individual suppliers (see also Mulherin, 1986). At the same time they protect the firm from being held up, since suppliers know that the firm cannot renegotiate individual contracts. Recontracting occurs only when the firm negotiates with all suppliers collectively, and many nondiscrimination guarantees come with arrangements allowing a supplier representative to make binding agreements on behalf of all suppliers.

While the provisions are simple and effective, their implementation requires special circumstances. Suppliers must perform standardized tasks and be monitored at low cost. Equal treatment is not warranted when suppliers are heterogeneous or perform different tasks, and cannot be enforced when monitoring is costly.

Most-favored-treatment and nondiscrimination terms therefore appear infrequently. In labor markets, for example, assembly line workers often receive such promises, while managers do not. Managerial tasks and performance vary widely, making it difficult to outline and enforce objective measures of equal treatment. Hence, explicit nondiscrimination provisions among managers are less frequent, less comprehensive, and less effective.

The model developed here focuses on most-favored-treatment, nondiscrimination, and collective bargaining agreements. However, the discussion in Section 5 suggests that with some modifications the model could also address other contractual tools. Two promising applications include seniority and resale price maintenance.

The next section provides some background on most-favored-treatment provisions. Section 3 provides an example, and Section 4 outlines a formal model. Section 5 discusses several modifications, including heterogeneity and supplier risk aversion. A conclusion follows.

2. BACKGROUND ON MOST-FAVORED-TREATMENT PROVISIONS

Although most-favored-treatment and nondiscrimination provisions appear in many economic contexts, their scope is often restricted. Retailers, for example, often limit best-price (BP) guarantees to the same brand name and model, and to specific time periods and geographic areas. Three-party BP provisions (or "meet-the-competition" clauses) guarantee the best price offered by any party. Two-party versions apply only to the price offered by the party involved in the original transaction.

Explanations for most-favored-treatment provisions focus on output markets. There are four competing hypotheses.¹ First, most-favored-treatment provisions may enhance tacit collusion. Firms offering best-price provisions to their customers commit themselves to pay out rebates if they subsequently cut price. This commitment reduces rivalry for new customers.

Second, most-favored-treatment provisions address information asymmetries. Suppose a retailer knows what prices will be in the next period, but customers do not. Even if the retailer has no market power, customers are reluctant to pay full price, since they might miss out on a subsequent sale. Best-price provisions permit them to buy in the current period and still take advantage of any lower price offered in the next.

Risk-sharing provides a third motive. In the example just mentioned, BP provisions shift price risks between the retailer and customers in a way that could enhance efficiency.² Finally, most-favored-treatment provisions commit the firm not to attempt to discriminate intertemporally. This is the explanation often given for these provisions in international commodity agreements and long-term supply contracts for natural gas.

This paper models the nondiscrimination hypothesis. Although no effort is made to test this model, the issue is reconsidered in the conclusion.

3. AN EXAMPLE WITH PERFECT CERTAINTY

Two purposes appear to be served by the favored-nation clause: first, it equalizes the bargaining positions of different sellers at the time the contract is negotiated; second, it enables sellers to obtain in otherwise firm agreements, some upward adjustment of contract prices to reflect levels which may prevail in the future. The ... provision equalizes the seller bargaining position by removing the gain to the buyer from any ability to differentiate or discriminate among sellers. (Neuner, 1960, p. 93)

Historically, natural gas pipelines have been "private carriers," meaning that they purchase gas under long-term contracts from producers, and then resell it to buyers downstream. Most of these contracts contain most-favored-treatment provisions guaranteeing each producer the highest price and output of any producer within the area. An early analysis by Edward Neuner (1960) proposes two explanations for the provisions: they prevent pipelines from discriminating, and they adjust contract terms over time.

This section adopts a certainty framework to demonstrate the first of these explanations. Consider a natural gas pipeline which has a monopoly in its downstream markets. To simplify the exposition, assume the following:

- (i) the pipeline operates for two periods, denoted $t=1$ and $t=2$;
- (ii) a regulator sets downstream price at \$4000/million cubic feet (MMCF);
- (iii) at \$4000/MMCF, demand is 600 at $t=1$ and 875 at $t=2$; and
- (iv) the pipeline has an obligation to serve all downstream demand.

These assumptions reasonably portray rate regulation, and they simplify the pipeline's objectives. Whatever its other costs (e.g., transportation, distribution), the pipeline seeks to acquire 600 MMCF of gas at $t=1$ and 875 MMCF at $t=2$ at minimum cost.

Rather than produce the gas itself, the pipeline purchases it from risk-neutral and homogeneous suppliers (independent oil companies). Let q_t^s

equal the time- t output of a producer of vintage s , and let p_t^s be the corresponding unit price. For the time being, there is no discounting and the supply market (ex ante) is competitive.

All producers, regardless of vintage, face operating costs given by

$$(1) \quad C(q_t^s) = \begin{cases} 0 & \text{if } q_t^s = 0 \\ 12,000 + 400(q_t^s) & \text{if } 25 > q_t^s > 0 \\ 12,000 + 400(q_t^s) + (43)(q_t^s - 25)^2 & \text{if } q_t^s \geq 25 \end{cases}$$

These operating costs are illustrated in Figure 1. In addition, each producer must also invest \$14,000 in relation-specific capital (a buried pipe linking the producer's well with the pipeline). In contrast to fixed costs, the costs associated with specific investments are incurred even if output is zero.

Figure 1 about here

The pipeline's total cost, TC , is given by

$$(2) \quad TC = x_1 [p_1^1 q_1^1 + p_2^1 q_2^1] + x_2 [p_2^2 q_2^2]$$

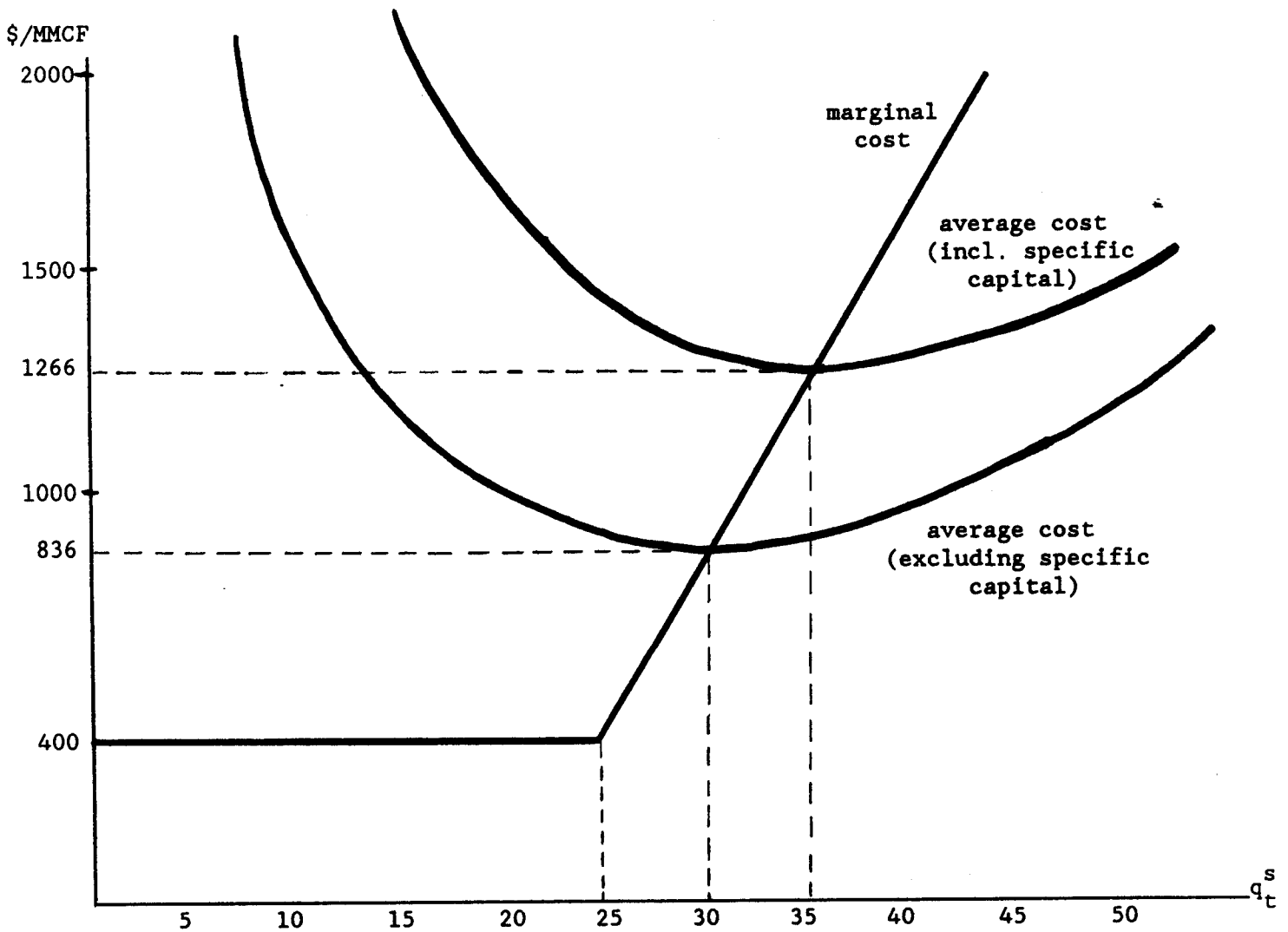
The first bracketed right-hand-side term equals total payments to each of the x_1 producers contracting with the pipeline at time $t=1$. The second bracketed term equals the payments to the x_2 new time-2 producers.

Total production in each period must equal total sales: $x_1 q_1^1 = 600$ and $x_1 q_2^1 + x_2 q_2^2 = 875$. The pipeline also faces two other constraints:

$$(3) \quad [p_1^1 q_1^1 - C(q_1^1)] + [p_2^1 q_2^1 - C(q_2^1)] = 14,000$$

$$(4) \quad p_2^2 q_2^2 - C(q_2^2) = 14,000$$

FIGURE 1: MARGINAL AND AVERAGE PRODUCTION COSTS



The bracketed terms on the left-hand-side of equation (3) equal the net returns in periods 1 and 2, respectively, of a vintage-1 producer. These returns must compensate for \$14,000 of specific investments. The left-hand-side of equation (4) represents the net returns of vintage-2 producers. These must also compensate for all specific investments.

The pipeline minimizes total cost (subject to all constraints) by contracting with 20 producers at time $t=1$, and by dividing output equally among them. Hence, $x_1 = 20$ and $q_1^1 = 30$. At time $t=2$, demand growth justifies five new producers ($x_2 = 5$), and again output is prorated ($q_2^2 = q_2^1 = 35$). Prices serve only to allocate quasi-rents, and as described below, may be chosen in any manner satisfying equations (3) and (4).

This outcome could be achieved by signing long-term contracts with 20 vintage-1 producers. Such contracts would specify $q_1^1 = 30$ and $q_2^1 = 35$. Producers would then be willing to sign long-term contracts with the firm if, for example, the contracts set $p_1^1 = \$836$ and $p_2^1 = \$1266$. At time $t=2$, the pipeline should then sign 5 additional contracts specifying that $q_2^2 = 35$ and $p_2^2 = \$1266$.

Spot supply contracts pose greater problems. To illustrate, consider the first scenario outlined in Table 1. Time-1 contracts set $p_1^1 = \$1302$ and $q_1^1 = 30$, but make no provision for prices and quantities at time $t=2$. Under this arrangement, $p_1^1 q_1^1 = (1302)(30) = [C(30) + 14,000]$. Since vintage-1 producers receive full compensation for their specific investments at the outset, they require a second-period price, p_2^1 , of only $\$866 - C(35)/35$. No amount of rivalry among producers in the second period could prevent full recovery of all costs.

Table 1 about here

TABLE 1: SHORT-TERM PRODUCER-PIPELINE CONTRACTS

Scenario	Time-1 Contracts		Time-2 Contracts Assuming No Opportunistic Behavior		Time-2 Contracts Assuming "Worst-Case" Opportunistic Behavior	
	x_1	q_1	x_2	q_2	x_2	q_2
1. Short-term contracts; <u>Full</u> compensation at t=1 for specific investments. (Source of opportunism: producers)	20	\$1302	5	\$866	5	\$1266
	$(x_1 p_1^1 q_1^1 = \$0.78$ million)	30	$(x_1 p_2^1 q_2^1 + x_2 p_2^1 q_2^1 = \0.83 million)	35	$(x_1 p_2^1 q_2^1 + x_2 p_2^1 q_2^1 = \1.10 million)	35
2. Short-term contracts; <u>No</u> compensation at t=1 for specific investments. (Source of opportunism: pipeline)	20	\$836	5	\$1266	5	\$866
	$(x_1 p_1^1 q_1^1 = \$0.50$ million)	30	$(x_1 p_2^1 q_2^1 + x_2 p_2^1 q_2^1 = \1.10 million)	35	$(x_1 p_2^1 q_2^1 + x_2 p_2^1 q_2^1 = \0.83 million)	35
3. Short-term contracts; <u>No</u> compensation at t=1 for specific investments; most favored-treatment guarantee.	20	\$836	5	\$1266	No Opportunistic Behavior Possible.	No Opportunistic Behavior Possible.
	$(x_1 p_1^1 q_1^1 = \$0.50$ million)	30	$(x_1 p_2^1 q_2^1 + x_2 p_2^1 q_2^1 = \1.10 million)	35		

Yet this arrangement may prove costly to the pipeline: by colluding in the second period, incumbent producers could command a price as high as \$1266, equal to the price paid to vintage-2 suppliers. In other words, perfect collusion could yield $p_2^1 - p_2^2 = \$1266 = [C(35) + 14,000]/35$.

To avoid this problem, the pipeline could pursue the second scenario. It could set $p_1^1 = \$836$ and $q_1^1 = 30$, so that $p_1^1 q_1^1 = (836)(30) = C(30)$. Since vintage-1 producers receive no up-front compensation for their specific investments, they accept this arrangement only if they believe that $p_2^1 = \$1266 = [C(35) + 14,000]/35$. Yet the pipeline has no incentive to pay this price. Instead it will discriminate among producers in the second period by purchasing all supplies from producers offering the lowest price, and nothing from those who charge high prices. The ensuing rivalry among producers could drive p_2^1 as low as \$866 ($= C(35)$).

Even if the parties adopt a compromise, so that producers receive partial compensation for their specific investments at the outset, the problem remains. Producers will attempt to collude in the second period to drive up prices, and the pipeline will discriminate in an effort to drive prices lower. The problem can be resolved only through a commitment covering second-period prices and quantities.

Table 1 outlines a third scenario in which most-favored-treatment provisions provide this commitment. Suppose the pipeline sets $p_1^1 = \$836$ and $q_1^1 = 30$, so that $p_1^1 q_1^1 = (836)(30) = C(30)$. Suppose the pipeline also offers most-favored-treatment guarantees: no producer at time $t=2$ will receive a higher price or quantity than any of the original x_1 producers. When the pipeline signs new contracts at time $t=2$, it follows that $p_2^1 \geq p_2^2$ and $q_2^1 \geq q_2^2$. Together with equation (4), this implies that $p_2^1 q_2^1 \geq C(q_2^1) + 14,000$. Hence, incumbent producers at time $t=2$ receive full

compensation for all specific investments, and cannot be held up by the pipeline. At the same time, the pipeline's recourse to new supply contracts protects it from collusion among these incumbents.

In return for a simple pledge of nondiscrimination, producers are willing to postpone compensation for their specific investments, and grant the pipeline complete discretion to vary output at time $t-2$. This flexibility is the key to the second explanation of most-favored-treatment provisions offered by Neuner (1960) at the outset of this section. This explanation is highlighted in the model developed in Section 4. The model offers the following changes:

- (i) future (opportunity) cost and demand conditions are uncertain;
- (ii) time horizons extend beyond two periods;
- (iii) new contracts may not be signed in all periods;
- (iv) recipients of the provisions need not be perfectly homogeneous; and
- (v) all parties discount future cash flows.

Since most-favored-treatment provisions appear in many unregulated settings, the model also drops the assumption of downstream price regulation.

After setting out cost and demand conditions, the section describes complete contingent-claims contracts. These contracts serve as a benchmark against which most-favored-treatment agreements are measured. When demand growth justifies new supply contracts in all periods, simple most-favored-treatment agreements replicate complete contingent-claims contracts. The section then considers more realistic circumstances: either new supply contracts are signed only in early periods or new supply contracts are uncertain. The provisions remain practicable, though less effective.

4. THE MODEL

The model has T periods. A firm controls access to the market for some good. Its revenues at time $t \in (1, \dots, T)$ are given by $R_t = R_t(Q_t, \omega_t)$, where Q_t is time- t output and ω_t is a random variable. This function is twice differentiable, strictly increasing in ω_t , and concave in Q_t .

Rather than produce the good itself, the firm purchases it from risk-neutral and homogeneous producers. It then resells the good to final consumers. A supplier's time- t output, q_t , is produced at cost $C_t = C_t(q_t)$. Marginal cost is positive and increasing. For all new time- t suppliers, there is a specific investment of K_t , which has no salvage value if the relationship ends. The firm and all suppliers share a common discount rate, β . Regardless of their vintage, all suppliers operate through time T .

Let q_t^{t-s} and p_t^{t-s} denote the period- t output and unit price, respectively, of a producer of vintage $t-s$. By construction, $Q_t = \sum_s q_t^{t-s}$. Let x_t indicate the number of new suppliers at time t , and let $y_t = \sum_s x_s$ represent the total number of time- t suppliers. Assume that all parties observe ω_t before negotiating new time- t contracts. Finally, let $\Omega_t = (\omega_1, \dots, \omega_t)$ be the vector of realized demands through time t .

In order to attract suppliers, the firm must satisfy the following individual rationality constraint for all t :

$$(5) \quad (p_t^t q_t^t - C_t(q_t^t)) + E_t \sum_{s=t+1}^T \beta^{(s-t)} (p_s^t q_s^t - C_s(q_s^t)) - K_t$$

The firm's expected discounted profit from time t onward is given by

$$(6) \quad \Pi_t = (R_t(Q_t, \omega_t) - \sum_{k=1}^t x_k p_t^k q_t^k)$$

$$+ E_t \sum_{s=t+1}^T \beta^{(s-t)} \left\{ R_s(Q_s, \omega_s) - \sum_{k=1}^s x_k p_s^k q_s^k \right\}$$

The x_t contracts signed at time t specify a means for adjusting prices and quantities through time T and must satisfy equation (5). All terms must be non-negative, and x_t is integer constrained. The firm chooses x_t and structures contracts to maximize Π_t .

The remainder of this section compares complete contingent-claims contracts with contracts employing most-favored-treatment provisions.

■ **Complete contingent-claims contracts.** Suppose the firm can costlessly write and enforce contingent-claims contracts. Let $x_t^* = x_t^*(\Omega_t)$ be the profit-maximizing choice of x_t . Each new time- t contract outlines contingent prices and quantities through time $t=T$. The profit-maximizing choice of price and quantity for the initial contract period can be represented by $p_t^{t*} = p_t^{t*}(\Omega_t)$ and $q_t^{t*} = q_t^{t*}(\Omega_t)$. Profit-maximizing prices and quantities for subsequent periods ($s \geq t+1$) can be represented by $p_s^{t*} = p_s^{t*}(\Omega_s)$ and $q_s^{t*} = q_s^{t*}(\Omega_s)$. Let Π_t^* represent maximum expected profits, and let $y_t^* = \sum_s x_s^*$. Proposition 1 proves (in the Appendix) that optimal contracts involve prorationing.

Proposition 1. If the firm can costlessly employ contingent-claims contracts, it maximizes expected profits by prorationing all suppliers regardless of vintage. In other words, $q_t^{k*} = Q_t^*/y_t^*$ for all k and t .

With homogeneous suppliers and increasing marginal cost, cost-minimization implies equal production. Hence, the notation q_t^* can be substituted for q_t^{k*} . Prices serve only to allocate quasi-rents, and are not unique.

■ Most-favored-treatment provisions when $x_t^* > 0$ for all t . Suppose time- t contracts specify price and quantity only in the initial period. Thereafter they guarantee most-favored-treatment:

$$(7) \quad p_s^t = \text{Max}_k p_s^k ; q_s^t = \text{Max}_k q_s^k \quad \text{for all } s$$

The firm retains the right to contract with new suppliers, and to vary prices and quantities subject to equation (7). All suppliers receive such promises, so the result is nondiscriminatory treatment.

For the moment, suppose $x_t^* > 0$ for all t and for all Ω_t . When new time- t suppliers negotiate time- t prices and quantities, the best of these terms extends to all incumbent suppliers. By equations (5) and (7), cost-minimization implies a single uniform price, p_t^I :³

$$(8) \quad p_t^s = p_t^I = \left(\frac{1}{q_t} \right) [C_t(q_t) + (K_t - \beta K_{t+1})] \quad \text{for all } s$$

The superscript I indicates that price equals incremental cost. This becomes evident by rearranging terms:

$$(9) \quad p_t^I q_t = C_t(q_t) + [K_t - \beta K_{t+1}]$$

The left-hand-side of this equation is the firm's time- t payment to each supplier. The right-hand-side equals production costs plus the "rental" cost of specific capital (i.e., the cost of adding one new supplier at time t rather than waiting until time $t+1$). From (9), it follows that

$$(10) \quad \frac{\partial p_t^I q_t}{\partial q_t} = C_t'(q_t)$$

With most-favored-treatment provisions, marginal factor payments equal marginal production costs. On the margin the firm equates the cost of

expanding output through the addition of new suppliers (equation (9)), and through increased output from incumbent suppliers (equation (10)).

Proposition 2 (proved in the appendix) demonstrates that this scheme is time consistent and replicates contingent-claims contracts.

Proposition 2. Assume $x_t^* > 0$ for all $t = 1, \dots, T$ and all Ω_t . If the firm employs most-favored-treatment provisions from the outset, then the outcome is identical to complete contingent-claims contracts. In other words, $x_t = x_t^*(\Omega_t)$ and $q_t^k = q_t^*(\Omega_t)$ for all k and t , and $\Pi_t = \Pi_t^*$.

Intuitively, most-favored-treatment provisions operate much like other indexation schemes. Incumbent suppliers delegate to new suppliers the responsibility for bargaining on their behalf in future periods. Table 2 shows how prices and quantities evolve in time- t contracts. Because factor payments fully reflect costs, and because the monopolist cannot incite rivalry among suppliers, all choice variables are set precisely as they would be if the firm had instead employed more complicated contingent contracts.

Table 2 about here

Furthermore, prices evolve exactly as they would in well-functioning spot markets. To make this point, suppose (just for the moment) that any supplier investing K_t in capital at time t can recoup K_{t+s} by selling off this capital at time $t+s$. In other words, suppose investments are not specific. Then price must equal p_t^I in equilibrium. If $p_t > p_t^I$, then a supplier could earn rents by operating for a single period: an investment of K_t yields a time- t payoff of $p_t q_t > p_t^I q_t = C_t(q_t) + [K_t - \beta K_{t+1}]$; the sale of this capital in the next period nets K_{t+1} . The expected discounted return is strictly positive. With competitive markets, p_t must fall.

TABLE 2: THE EVOLUTION OF A TIME-t SUPPLY CONTRACT

<u>Time</u>	<u>Supplier's Time-s Payoff</u>	<u>Supplier's Time-s Costs</u>	<u>Time-s Discounted Return (Net of Costs)</u>
$s - t$	$C_t(q_t) + [K_t - \beta K_{t+1}]$	$C_t(q_t)$	$[K_t - \beta K_{t+1}]$
$s - t+1$	$C_{t+1}(q_{t+1}) + [K_{t+1} - \beta K_{t+2}]$	$C_{t+1}(q_{t+1})$	$\beta [K_{t+1} - \beta K_{t+2}]$
$s - t+2$	$C_{t+2}(q_{t+2}) + [K_{t+2} - \beta K_{t+3}]$	$C_{t+2}(q_{t+2})$	$\beta^2 [K_{t+2} - \beta K_{t+3}]$
\vdots	\vdots	\vdots	\vdots
$s - T-1$	$C_{T-1}(q_{T-1}) + [K_{T-1} - \beta K_T]$	$C_{T-1}(q_{T-1})$	$\beta^{T-2} [K_{T-1} - \beta K_T]$
$s - T$	$C_T(q_T) + [K_T - \beta(0)]$	$C_T(q_T)$	$\beta^{T-1} [K_T]$

Total
Expected
Discounted
Return:

K_t

Similarly, if $p_t < p_t^I$, then the expected return is strictly negative, and price must rise. This argument serves as a proof of Proposition 3:

Proposition 3. Assume $x_t^* > 0$ for all $t = 1, \dots, T$ and all Ω_t . If the firm employs most-favored-treatment provisions from the outset, then prices in all periods are the same as if no investments were specific and all resources were allocated in spot market transactions.

■ **Most-favored-treatment provisions when $x_t^* > 0$ for all $t \leq t' < T$.**
Suppose new suppliers contract with the firm each period, but only during an initial development phase. Formally, $x_t^* > 0$ for all $t \leq t'$ and $x_t^* = 0$ for all $t > t'$. For periods 1 through $t'-1$, contracts proceed as before, with prices and quantities set according to equations (7) and (8). Suppliers contract with the firm for the last time at time t' , so prices and quantities are set contingently for all $s > t'$. The firm sets prices to satisfy equation (5), and sets $q_s^{t'} = q_s^*(\Omega_s)$. This leads to Proposition 4:

Proposition 4. Suppose $x_t^* > 0$ for all $t = 1, \dots, t'$, and all Ω_t . Then contracts with most-favored-nation provisions can be used through time $t'-1$ to replicate complete contingent-claims contracts.

For $t < t'$, incumbent suppliers delegate to new suppliers the responsibility for negotiating time- t prices and quantities on their behalf. At time t' , incumbents delegate to new suppliers the responsibility for negotiating contingent prices and quantities for all remaining periods.

■ **Most-favored-treatment provisions when new contracts are uncertain.**
Most-favored-treatment provisions remain practicable when the firm may not sign new contracts in all future periods. In such cases, contracts may set prices to be operative until the firm negotiates new contracts. Formally,

suppose time- t contracts set prices for periods $s > t$ as follows:

$$(11) \quad p_s^t = \begin{cases} \bar{p}_s & \text{if } x_s = 0 \\ \text{Max}_k p_s^k & \text{if } x_s > 0 \end{cases}$$

Existing contracts index price and quantity to the terms outlined in new contracts. Contract prices, \bar{p}_s , prevail in the absence of new contracts, and the firm chooses quantities subject to a prorating constraint. Contract prices can be contingent on output and some subset of Ω_t .⁴

When $x_s = 0$, this scheme succeeds only to the extent that contract prices track marginal cost. To see this, let $\Gamma_s(q_s, \Omega_s) = q_s \bar{p}_s(q_s, \Omega_s)$ be the payment to each producer under the terms of these contract prices. The firm chooses output at time s such that

$$\frac{\partial R_s(Q_s, \omega_s)}{\partial Q_s} = \frac{\partial \Gamma_s(q_s, \Omega_s)}{\partial q_s} = \bar{p}_s + q_s \left(\frac{\partial \bar{p}_s}{\partial q_s} \right)$$

Joint profits of the firm and its suppliers would be maximized if instead

$$\frac{\partial R_s(Q_s, \omega_s)}{\partial Q_s} = \frac{\partial C_s(q_s)}{\partial q_s}$$

When payments on the margin do not reflect costs, two types of distortions arise. First, if \bar{p}_s is set too low (high), the firm raises (lowers) the output of incumbent suppliers beyond the joint profit-maximizing level. Second, the firm's choice of new suppliers is affected. If \bar{p}_s is too low (high), the firm finds it relatively less (more) expensive to expand the output of incumbent suppliers than to contract with new suppliers. In addition, the firm is reluctant (eager) to sign even one new contract, since doing so triggers price changes in all incumbents' contracts.

When $x_s > 0$, none of these distortions arise. Once the firm signs one new contract, p_t^I becomes the relevant price. Since p_t^I reflects both the marginal cost of raising incumbents' output and the incremental cost of adding a new supplier, output and contracting decisions are efficient.

Most-favored-treatment provisions have one additional drawback: they limit recontracting. To illustrate, suppose \bar{p}_s exceeds marginal cost. Any individual producer would be willing to accept a lower price for marginal units in return for higher output, but the firm cannot increase output for one producer without doing so for all. Unless it recontracts simultaneously with all suppliers, renegotiation is precluded. Yet each individual supplier is guaranteed the same output as others even if it refuses to accept a lower price.

The firm can address this problem by constructing supply contracts to make collective bargaining agreements binding. One supplier represents all others in (re)negotiations with the firm. Since suppliers are homogeneous, all prefer any changes negotiated by this representative to the status quo.

Because of the distortions they create, supply contracts may drop explicit contract prices altogether when a supplier representative bargains directly with the firm. The representative could meet with the firm at the beginning of each period to negotiate price and quantity. If the parties do not reach an agreement, suppliers could threaten to withhold production. This raises prospects for opportunistic behavior by either the firm or its suppliers. Nonetheless, it prevents the firm from holding up individual suppliers and also presents it with a credible commitment not to be held up by any individual supplier.

5. SUPPLIER HETEROGENEITY, RISK AVERSION, AND DOWNSTREAM COMPETITION

This section relaxes several of the model's restrictive assumptions. In many cases, most-favored-treatment provisions become less attractive. Keep in mind, however, that the alternatives to these provisions may also become less attractive.

■ **Heterogeneous costs.** Most-favored-treatment provisions can compensate for some basic heterogeneity among suppliers. For example, costs can differ by a lump sum or a constant per unit amount (perhaps due to transportation costs). The provisions can also adjust for quantity differences when the production technology exhibits constant returns to scale. Natural gas contracts acknowledge differences between the deliverability (capacity) of various wells by adopting "rateable take" provisions: if the pipeline purchases 400,000 metric cubic feet (MCF) from a well capable of producing at a rate of 500,000 MCF per day, then it must take 40,000 MCF from any well with a deliverability of 50,000 MCF.

As cost differences become more complex, these adjustments become more costly to construct and enforce, and most-favored-treatment provisions become less attractive.

■ **Heterogeneous output/tasks.** All suppliers in the model produce a homogeneous good. If instead the good is heterogeneous, contracts can discriminate by stipulating higher quality, longer warranties, or better service from some suppliers but not others. Most-favored-treatment provisions can guarantee nondiscrimination along all economically relevant dimensions of the supply contract, but such guarantees may be difficult to employ. Furthermore, the firm may not want a homogeneous product. Once again, heterogeneity raises the cost of most-favored-treatment provisions.

■ **Heterogeneous time horizons.** In the model, all suppliers produce until time T regardless of their vintage. Once they invest in specific capital, new suppliers are identical to their predecessors. If instead suppliers operate for k periods, where $k < T$, then a pattern of overlapping contracts emerges, and drives a wedge between the interests of "young" and "old" suppliers. For example, young suppliers may be willing to accept low returns on their capital in current periods in exchange for high returns in the future. This arrangement may be unacceptable to older suppliers who would not share in such future rewards.

■ **Heterogeneous investments in specific capital.** If the model is modified so that suppliers accumulate specific capital over time, then older suppliers may demand higher prices, a disproportionate share of output, and perhaps greater commitment (e.g., seniority) to compensate for their more substantial investments. This complicates, but does not necessarily preclude, most-favored-treatment provisions. At the least, seniority provisions should be coupled with guarantees that the firm will not discriminate between suppliers with comparable specific investments.

■ **Supplier risk aversion.** The introduction of supplier risk aversion should not alter the basic conclusions of the model. Since all suppliers are prorated and receive the same price, the outcome is consistent with "worksharing" contracts which often arise (at least theoretically) when workers are risk averse (see Rosen, 1985).

■ **Competition in output markets.** Both the example and the model assume that the firm wields monopoly power in its output market. This implies less than perfectly elastic factor demand which leads to rivalry among incumbent

suppliers. Yet rivalry need not stem from such market power. For example, suppose suppliers provide an input into a fixed-coefficients production process exhibiting decreasing returns to scale. Then factor demand is less than perfectly elastic even if output markets are competitive. In short, downstream monopoly power is not crucial to any of the results derived here.

■ **Summary and evaluation.** Heterogeneity can arise from a variety of sources, and invariably complicates most-favored-treatment and nondiscrimination guarantees. Such heterogeneity may also complicate other contractual tools, so the relative merits of these provisions remain ambiguous even with substantial heterogeneity. Nonetheless, heterogeneity detracts from their effectiveness, and explains why they are not used under all circumstances.

Most-favored-treatment provisions have been standard features of international commodity agreements for over 350 years, and appear in most long-term contracts between natural gas producers and pipelines. Nondiscrimination terms appear explicitly or implicitly in many financial contracts.

Union contracts also resemble those modeled here, and for reasons similar in spirit to those given by Williamson, Wachter, and Harris (1975). Union job classifications promote standardization, and nondiscrimination provisions accommodate such complications as heterogenous tasks (e.g., premia for holidays and late-night shifts) and differences in accumulated specific capital (higher pay and greater seniority for older workers). Union agreements are binding on members (and often on nonmembers), and different time horizons sometimes do lead to frictions between young and old workers. Finally, union membership typically does not extend to managerial ranks where the consequences of unobservable heterogeneity become more serious.

6. CONCLUSIONS

Most-favored-treatment and nondiscrimination provisions commit the firm not to pit suppliers against one another once they invest in specific capital. This commitment obviates the need for other price and quantity commitments, and offers the firm greater flexibility to respond to changing market conditions.

The model also illustrates how suppliers may be interconnected even though each works independently. With incomplete contracts, supplier relations with the firm have multilateral implications because the value of each supplier's physical product is closely linked to the actions taken by others. The provisions modeled here explicitly acknowledge this interconnection and force the firm to deal with suppliers collectively -- as a team.

Although this model assigns new suppliers the responsibility for negotiating prices and quantities, it also proposes collective bargaining arrangements whenever new supply contracts are not forthcoming. Yet if such arrangements are valuable, why do firms often oppose them? Two possibilities warrant further investigation. First, suppliers do not always invest in specific capital. In these instances, nondiscrimination and collective bargaining provisions are unnecessary, and serve only to consolidate suppliers into a more effective bargaining unit. Second, suppliers may be heterogeneous. The firm may find it profitable in such cases to discriminate between various supplier types. As long as it could employ other means of commitment, it would therefore prefer to avoid collective bargaining.

With some appropriate modifications, this model could be applied to other settings. For example, all specific capital in this model is purchased up front. If instead suppliers accumulate specific capital over time, then a pattern of seniority might emerge.

Or suppose the firm licenses suppliers to sell the good directly to consumers. The value of such licenses depends on the extent to which suppliers compete with one another in the output market. The firm could limit rivalry among its "franchisees," and thereby increase its license fees, by retaining the right to set output price. Yet no supplier would be willing to have its own output price set unless the firm commits to limit the prices of others. In other words, the firm must commit not to allow rival suppliers to sell the product at a lower price. A practice of resale price maintenance could emerge in such circumstances.

Critics have long objected to discriminatory treatment of workers and shareholders on purely moral grounds. This paper provides an economic basis for such objections: in addition to being morally offensive, discrimination may be inefficient, at least when specific capital and homogeneous agents are involved, and could violate either explicit or implicit contracts.

Perhaps the highest research priority, however, should be extended to empirical work in this area. There are many hypotheses for most-favored-treatment other than the one presented here. One factor complicating this work is that these explanations are not mutually exclusive. Even where nondiscrimination represents the primary motive for most-favored-treatment provisions, their effectiveness could be altered by information asymmetries, risk preferences, or collusive possibilities. Furthermore, a single motive does not likely explain these provisions in all circumstances. Nonetheless, empirical work should help to establish the importance of nondiscrimination as one explanation for these provisions.

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APPENDIX

Proof of Proposition 1: (By contradiction.) The intuition is straightforward: without equal production, output can be redistributed more cost-effectively, and prices can be adjusted to leave producers no worse off.

Suppose $q_t^{r*}(\Omega_t) \neq q_t^{s*}(\Omega_t)$. Define

$$(A1) \quad q'_t = \left(\frac{1}{2}\right) [q_t^{r*} + q_t^{s*}]$$

$$(A2) \quad p_t^{r'} = \left(\frac{1}{q'_t}\right) [p_t^{r*} q_t^{r*} - C_t(q_t^{r*}) + C_t(q'_t)]$$

$$(A3) \quad p_t^{s'} = \left(\frac{1}{q'_t}\right) [p_t^{s*} q_t^{s*} - C_t(q_t^{s*}) + C_t(q'_t)]$$

Suppose each supplier produces q'_t . By (A1), output is unchanged. Suppose further that each supplier receives $p_t^{r'}$ and $p_t^{s'}$ instead of p_t^{r*} and p_t^{s*} . By (A2) and (A3), their net return is unchanged. This is made clear by rearranging these terms as follows:

$$(A2') \quad p_t^{r'} q'_t - C_t(q'_t) = p_t^{r*} q_t^{r*} - C_t(q_t^{r*})$$

$$(A3') \quad p_t^{s'} q'_t - C_t(q'_t) = p_t^{s*} q_t^{s*} - C_t(q_t^{s*})$$

These changes affect the firm's total costs. Instead of paying out $[p_t^{r*} q_t^{r*} + p_t^{s*} q_t^{s*}]$, the firm now pays these suppliers $[p_t^{r'} q'_t + p_t^{s'} q'_t]$. By equations (A1), (A2'), and (A3'), and the convexity of costs,

$$(A4) \quad [p_t^{r'} q'_t + p_t^{s'} q'_t] - [p_t^{r*} q_t^{r*} + p_t^{s*} q_t^{s*}] \\ = 2C_t(q'_t) - [C_t(q_t^{r*}) + C_t(q_t^{s*})] < 0.$$

These changes lower the firm's costs without affecting total output or total revenue. This is a contradiction, since profits were maximized before these changes were made. Q.E.D.

Proof of Proposition 2: (In part by contradiction)

(t-1). By Proposition 1, first-best contracts involve prorationing. Taking account of this result, equation (5) can be substituted into equation (6) to yield the firm's unconstrained objective function:

$$(A5) \quad \Pi_t = \left\{ R_t - \sum_{k=1}^{t-1} x_k p_t^k q_t - x_t C_t(q_t) - x_t K_t \right\} \\ + E_t \sum_{s=t+1}^T \beta^{(s-t)} \left\{ R_s - \sum_{k=1}^{t-1} x_k p_s^k q_s - (y_s - y_{t-1}) C_s(q_s) - x_s K_s \right\}$$

In particular,

$$(A6) \quad \Pi_1 = (R_1 - x_1 C_1(q_1) - x_1 K_1) + E_1 \sum_{s=2}^T \beta^{(s-1)} (R_s - y_s C_s(q_s) - x_s K_s)$$

By definition, $\Pi_1 = \Pi_1^*$ when the firm adopts a contingent plan setting $q_t = q_t^*(\Omega_t)$ and $x_t = x_t^*(\Omega_t)$ for all t . No other plan yields higher profits. If the firm sets $p_t^s = p_t^I$ for all s and t , and promises most-favored-treatment to all suppliers, its expected discounted profits are also given by (A6). Hence, these profits are also maximized by setting $q_t = q_t^*(\Omega_t)$ and $x_t = x_t^*(\Omega_t)$.

(t=t'). The original plan setting $x_t = x_t^*$ and $q_t = q_t^*$ maximizes expected discounted profits, but is time consistent only if the firm would choose to continue it when given the opportunity to reoptimize at time t' .

Suppose the firm employs most-favored-treatment in all supply contracts through time $t'-1$. Because of these most-favored-treatment obligations and the nature of costs, the firm minimizes expected costs at time t' only if

it sets $p_t^k = p_t^I$ for all $k \geq t'$. Similarly, cost-minimization implies equal output for all new suppliers (incumbent suppliers are guaranteed equal output). These conclusions, together with equations (9) and (A5), imply that

$$\begin{aligned}
 (A7) \quad \Pi_{t'} &= (R_{t'} - y_{t'-1} [C_{t'}(q_{t'}) + (K_{t'} - \beta K_{t'+1})] - x_{t'} C_{t'}(q_{t'}) - x_{t'} K_{t'}) \\
 &+ E_{t'} \sum_{s=t'+1}^T \beta^{(s-t')} \{ R_s - y_{t'-1} [C_s(q_s) + (K_s - \beta K_{s+1})] - (y_s - y_{t'-1}) C_s(q_s) - x_s K_s \} \\
 &= y_{t'-1} K_{t'} + (R_{t'} - y_{t'} C_{t'}(q_{t'}) - x_{t'} K_{t'}) \\
 &+ E_{t'} \sum_{s=t'+1}^T \beta^{(s-t')} \{ R_s - y_s C_s(q_s) - x_s K_s \}
 \end{aligned}$$

By equations (A6) and (A7),

$$\begin{aligned}
 (A8) \quad \Pi_1^* &= (R_1 - x_1^* C_1(q_1^*) - x_1^* K_1) + E_1 \sum_{s=2}^{t'-1} \beta^{(s-1)} \{ R_s - y_s^* C_s(q_s^*) - x_s^* K_s \} \\
 &+ E_1 \Pi_{t'}^* - E_{t'} y_{t+1}^* K_{t'}
 \end{aligned}$$

Suppose the firm at time t adopts the plan setting $x_t = x_t'(\Omega_t)$ and $q_t^s = q_t'(\Omega_t)$ for all $t \geq t'$. Let $\Pi_{t'}'$ be expected discounted profits under this plan, and suppose $\Pi_{t'}' > \Pi_{t'}^*$. Then by (A8) the firm could not have maximized profits at time 1, since these profits would have been greater if it had planned to switch to $x_t = x_t'(\Omega_t)$ and $q_t = q_t'(\Omega_t)$ after time $t'-1$. Since $x_t = x_t^*$ and $q_t = q_t^*$ maximize Π_1 by definition, this is a contradiction. Q.E.D.

Proof of Proposition 4:

(t-1). From the proof of Proposition 2, we know that most-favored-treatment provisions, together with a policy of setting $p_t^s = p_t^I$, results in supply agreements which perfectly replicate contingent-claims contracts. By precisely the same logic, expected discounted profits (Π_1) can be maximized by following this policy through time $t'-1$ and then switching to contingent-claims contracts at time t' . These time- t' contracts set $q_t^s = q_t^*$ for all $t \geq t'$ and set $p_t^s = p_t^I$, thus assuring that equation (5) is satisfied and that $\Pi_1 = \Pi_1^*$

(t=t'). This original plan is time consistent only if the firm would choose to continue it if given the opportunity to reoptimize. By the reasoning developed in the proof of Proposition 2, the firm has no incentive to discontinue this plan at any time $s < t'$. It remains only to be shown that the contingent-claims contracts adopted at time t' also set $x_t = x_t^*(\Omega_t)$ and $q_t^s = q_t^*(\Omega_t)$ for all $t \geq t'$.

Since most-favored-treatment provisions are employed through time $t'-1$, contingent contracts at time t' minimize expected costs only if they prorate all suppliers in all subsequent periods and set $p_t^s = p_t^I$. Expected discounted profits from time t' onward are given by equation (A9). By the same reasoning used in the proof of the second proposition, there cannot be a different plan $x_t = x_t'(\Omega_t)$ and $q_t^s = q_t'(\Omega_t)$ which yields higher expected profits than the plan originally chosen, since this plan would yield profits exceeding Π_1^* if adopted from the outset. Q.E.D.

ENDNOTES

¹These hypotheses are reviewed in greater detail in Butz (1988).

²Best-price provisions eliminate the risk that a customer will miss out on a sale. They therefore lock in the current rental price. At the same time, however, they create uncertainty in the ownership price of the good.

³For this price to make sense at time T, assume that $K_{T+1} = 0$.

⁴While minimum prices could be made contingent on all of Ω_t , the primary advantage of most-favored-treatment provisions is that they are simpler than complete contingent-claims contracts.