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MITIGATING CONTRACTUAL HAZARDS: UNILATERAL OPTIONS AND CONTRACT LENGTH

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Abstract

In this paper, we consider the ways in which the desire for efficient, low-cost adaptation to change influences the tradeoff between the design and duration of long-term contractual relationships. Relying on distortions in contract terms occasioned by nonprice competition for natural gas in the presence of well-head price regulation, we find that deviations from optimal contract incentives significantly raise the cost of being bound to long-term agreements and shorten the the duration of contracts. The approach adopted in this paper suggests a method for assessing empirically the efficiency of alternative contracting practices and legal standards.

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1. Introduction

The inability to stipulate complete contingent claims contracts is often cited as a source of market failure and has been used to explain everything from vertical integration to macroeconomic instability as well as to justify government intervention in the marketplace.[1] Yet despite the central, and arguably fundamental, role of contracting in market economies and the large body of research on contracts in both law and economics, relatively little is known about the costs and limitations of long-term contracting and how these affect the design and duration of contractual agreements.

This dearth of information has not been for lack of attention, however. On the contrary, the importance of contractual hazards in determining the form of market transactions and the design of contracts has become increasingly apparent (see Klein and Leffler, 1981; Goldberg and Erickson, 1982; Williamson, 1984; Joskow, 1985a; and Masten and Crocker, 1985). But research has been hampered on a practical level by the difficulty of observing and measuring contracting costs. Not only are these and other transaction-related costs often difficult to quantify, but many of the liabilities associated with incomplete contracts, such as maladaption to change or the need to litigate performance, remain latent absent some unfortunate turn of events. As a result, research in this area has been limited primarily to case studies, offering plausible explanations for observed contractual provisions.[2]

In this paper we combine the approach of these studies with more systematic tests of the ways in which the desire for efficient, low cost governance influences the design of contracts and the willingness of parties to commit to long-term contractual relationships. We argue first that, due to the ease with which they can be implemented, unilateral contract options may sometimes be superior to either contingent claims or judicial remedies for contractual failure and, to the extent such terms can be designed to promote efficient adaptation during execution of a contract, reduce the hazards of being bound to extended agreements. We then employ a unique data set to examine how deviations from efficient performance incentives affect the cost and duration of long-term contracts. Inasmuch as price regulation induces nonprice competition in contract terms (see Masten and Crocker, 1985), performance incentives may be distorted, raising the cost of contractual exchange. By estimating the size of these distortions, we are able to assess empirically the effects of contract design on the length of contractual agreements and the implicit costs of contractual rigidities. Hence, this paper represents a rare opportunity to test some of the received theory regarding the importance of contract incentives to contracting parties.

In the next section, we discuss in general terms the hazards of long-term contracting and their implications for design of contractual relationships. In section 3 we derive structural equations and estimate the effect of contract design on contract length using data on long term contracts in the natural gas industry. Concluding remarks appear in a final section.

2. The Hazards of Incomplete Contracting

That complete contingent claims contracting is costly, if not altogether impossible, has long been recognized. Roy Radner (1969), for instance, questioned the applicability of the Arrow-Debreu model on the basis of the computational limitations that prevent agents from writing comprehensive contracts, and Oliver Williamson has stressed the sources and implications of incomplete contracting in a number of settings (see, especially, 1975, 1976 and 1979). An even earlier exponent of the importance of contractual frictions, Ronald Coase cited almost fifty years ago the "costs of negotiating and concluding" contracts as a motive to supplant the market with organization inside the firm (1952, p. 336). More recently, Oliver Hart and Bengt Holmstrom (1985) have emphasized how important, if elusive, the notion of contracting costs is in devising a theory of contracts. In this section, we review the factors affecting the incidence of these costs and the ways in which private orderings such as unilateral options can mitigate contractual hazards.

2.a. The Costs and Limitations of Long-Term Contracts

There are two dimensions in which contracts may be deficient. First, they may be horizontally incomplete, that is, the full distribution of contingencies at a point in time may not be accounted for in the document; and second, they may be vertically incomplete, or written to cover a specified number of periods short of the relevant horizon. Among the most commonly cited barriers to forging complete contracts are the costs of exploring contingencies and devising optimal responses, of formally composing agreements, and of monitoring and enforcing execution of contract terms. Familiarity with the contracting process suggests that the first of these is likely to be especially constraining: "It is one thing ... to perceive a risk in a manner sufficient to allocate its consequences to one party or the other; it is quite another to work out difinitively the optimal responses to all future contingencies" (Goetz and Scott, 1983, p. 972). Specification and enforcement costs have also been shown to limit the scope of contractual agreements. Townsend (1979) and Shavell (1984), for example, have demonstrated that verification or stipulation costs make it efficient to contract over only a subset of all possible contingencies. Moreover, the cost of court verification of contingent performance is likely to rise with the number of contingencies included; complex arrangements invite both honest mistakes and intentional abuse by opportunistic agents. The increased likelihood that elaborate deals will occasion costly litigation thus further encourages concise agreements.

The principal hazard of failing to write horizontally complete agreements is the potential for maladaptation as events unfold. Because contracts contain only a limited number of provisions, mutually advantageous revisions to the original agreement may arise over time. But contractual guarantees are typically sought in the first place as a means of preventing costly ex post haggling over the terms of trade from dissipating trade surpluses in transaction-specific relationships (Klein, et al., 1978, Williamson, 1979). In the process of restraining wasteful modifications, productive adaptations may also be discouraged, making contracting an inflexible means of governing exchange (Williamson, ibid., p. 242).

Contractual rigidities are apt to become particularly acute over long horizons. As Coase remarked, again anticipating current thought, "owing to the difficulty of forecasting, the longer the period of the contract is for the supply of the commodity or service, the less possible, and indeed, the less desirable it is for the person purchasing to specify what the other contracting party is expected to do" (1952, p. 337). This growing reluctance to commit to a particular course of action as the date of performance becomes more remote can be attributed to a combination of factors. First, the costs and hazards of contracting are likely to rise with the uncertainty and complexity of the transaction. Very complicated or uncertain transactions must contain either an additional layer of contingencies or a greater potential for regret.[3] In either event, the potential cost of contractual exchange rises. Second, uncertainty grows with the distance of the relevant horizon. What were parameters in the short run become variables in the long, increasing the dispersion of possible states of the world. Given the greater probability of being contractually locked into an unprofitable undertaking, an agent who may be willing to commit himself to a particular course of action at a proximate date may not be inclined to do so for a more distant one.[4]

In sum, the willingness of parties to enter long term agreements--hence, the vertical (or temporal) span of a contract--is affected by the degree to which the agreement's horizontal scope permits efficient, low cost adaptation to increasingly uncertain environments. To the extent that contracts and supporting institutions can be designed to accomodate these often competing goals, the efficiency of contractual exchange is enhanced.

2.b. Unilateral Options and Private Ordering

The desire to provide for adaptation while avoiding the liabilities of contingent contracts has been used to explain the evolution of common law doctrines such as force majeure and remedies for breach of contract (see, e.g., Shavell, 1984). Legal standards, it is suggested, may substitute for contingent performance by approximating the incentives that contracting parties would themselves choose if contingent contracting were costless.

Although generally persuasive, this interpretation should not mislead one to conclude that reliance on the doctrines of contract law is a panacea for contractual hazards. On the contrary, Oliver Williamson has argued that the limitations of the legal system, particularly violation of "the assumption, common to both law and economics, that the legal system enforces promises in a knowledgeable, sophisticated and low-cost way" (1983, p. 519), often induce parties to "'contract out of or away from' the governance structures of the state by devising private orderings" (p. 520). Hence, while common law provides a foundation upon which to build contractual agreements, the structure of those agreements is often modified to reflect the specifics of the transaction.

The private orderings discussed by Williamson may be strictly bilateral in nature, such as the use of economic hostages (see ibid, pp. 530-7), or may seek to reduce the need for costly court intervention within the context of a formal contract through the design of the agreement. The use of unilateral options in place of contingent performance is one way to accomplish the latter. Because they mitigate the need for costly court verification of exogenous events, contract options are much easier for courts to enforce and therefore reduce the uncertainty (ergo, the expense) of a court challenge. Whereas contingent clauses require both the parties and the courts to establish the state that has actually transpired, properly authorized orders and receipts may be all that is necessary to verify that an option has been invoked and its terms fulfilled.

Examples of provisions conferring on one contracting party a right to make unilateral adaptations include quantity options (Masten, 1984)[5] and take-or-pay or minimum bill provisions (Masten and Crocker, 1985), as well as other variable-quantity pricing schedules (Goldberg and Erickson, 1982; see, also, Williamson, 1983, p. 530). Perhaps the simplest and most direct instance of recourse to private ordering in a contractual setting is the use of stipulated damages to supersede court determined penalties for breach of contract. To illustrate, consider a situation in which a buyer contracts with a seller to supply a specialized input, the value of which, ν, to the buyer is uncertain at the time the contract is written. The buyer agrees to pay the seller an amount y at the time of delivery, but at that time discovers that demand for his output is lower than expected so that $\nu < y$ and the buyer wishes to breach the agreement. Courts will generally impose a damage penalty on the breaching party in such instances equal to the difference between the contracted price and the value of the seller's assets in their next best use, or $\delta = y - s(\alpha)$, where $s(\alpha)$ is the alternative value of assets with attributes α.[6] It is straightforward to show that the imposition of δ induces efficient performance by the buyer. The latter would be better off breaching his agreement with the seller if $\nu - y < - \delta = -(y-s(\alpha))$; or $\nu < s(\alpha)$. Breach is efficient, however, exactly in those circumstances in which the assets have a higher value in their alternative than intended application.

Shavell argues that the use of common law damage penalties for breach of contract reduces contracting costs by making contingent provision for nonperformance by the parties unnecessary. This presumes, of course, that the courts can accurately and cheaply assess the opportunity costs of the transactors, in this case, $s(\alpha)$.[7] But as already noted, this presumption poorly characterizes the workings of the legal system in practice. First, there are reasons to believe that courts may systematically deviate from efficient awards. Claims for damages, for example, are subject to a requirement of "proof with reasonable certainty." In cases where lost profits cannot be adequately established, parties may be able to recover only the cost of their investments rather than foregone profits, implying lower than optimal awards on average.[8] And second, even if court determined damages were not systematically biased, the cost of adjudicating damage awards would induce contracting parties to perform contracts too often relative to the optimum at an expected cost--over and above the direct costs of litigation--of $s(\alpha) - \nu$, the foregone gains from not reallocating assets to their highest valued use, times the probability of inefficient performance.[9]

Although asset or expectation valuations may be difficult for courts to carry out, the parties themselves may have a reasonably good idea of those values at the time the contract is written. If so, the costs of litigation and inefficient exchange may be moderated by stipulating damages for nonperformance at the outset of the relationship. As long as courts uphold such terms[10], stipulated damages are likely to result in more accurate awards and also obviate the time and effort required to establish court-determined penalties: "The advantages of stipulating in advance a sum payable as damages are manifold. For both parties, it may facilitate the calculation of risks and reduce the cost of proof. For the injured party, it may afford the only possibility of compensation for loss that is not susceptible of proof with sufficient certainty. For society as a whole, it may save the time of judges, juries, and witnesses, as well as the parties, and may cut the expense of litigation" (Farnsworth, 1982, p. 896). Indeed, given the relative ease of implementing stipulated damage clauses, an agent may choose not to contest the award and simply pay the agreed-to sum, making breach effectively an option invoked unilaterally by that party.

The reason stipulated damages are not ubiquitous is that their use requires that most of the uncertainty associated with performance be on only one side of the transaction. If, in our previous illustration, $s(\alpha)$ were also uncertain when the contract was written, the optimal penalty would depend on the realized value of $s(\alpha)$ at the time the agreement was to be executed. Stipulating a penalty ex ante could therefore easily lead to inappropriate performance incentives ex post and make court-determined damages more desirable. The point is that private orderings may in certain circumstances reduce the hazards of contractual exchange, their relevance and design turning ultimately on characteristics of the transaction.

3. Regulation, Contract Length and the Value of Unilateral Options

To the extent that parties can design contracts that accommodate change in a low cost fashion, the liability of being bound to a long-term agreement is reduced. Hence, we would expect that contracts that promote efficient adaptation would positively influence the duration of a contract, or, alternatively, that poorly designed contract incentives would inhibit the use of extended contractual agreements. As a rule, however, it is difficult to guage whether the terms of a particular agreement are "appropriate": Ex ante, the choice of contract terms depends on the subjective beliefs of the actors. And, inasmuch as special contractual provisions often come into play only in the event of relatively low probability events, potential frictions due to inapt provisions may remain latent to the transaction ex post. Even observed contractual failures may be consistent with expected profit-maximization and tell us little about the sensibility of the contract's terms at the time the contract was written.

External interference in contractual relationships, however, may directly or indirectly influence the contents of contracts. Courts or regulators, for instance, may prohibit or restrict the use of certain provisions. In addition, price regulation may induce nonprice competition in contract terms as a means of attracting scarce resources (see Masten and Crocker, 1985). The resulting distortions in performance incentives can raise the potential hazards of contractual exchange, inducing parties to adopt shorter term agreements.

In this section, we investigate how the design of contracts affect the cost and duration of contractural relationships by examining the effects of regulatory induced distortions in contract terms. We begin by deriving structural equations for this problem in section 3.a. Discussion of the data, methodology and results appear in section 3.b.

3.a. The Design and Duration of Contractual Agreements

A central element of the arguments presented above is that large, durable transaction-specific investments invite costly haggling over the division of surpluses in subsequent exchange. Formal contracts alleviate the need for repetitive bargaining in a condition of bilateral monopoly by securing a distribution of gains for the duration of the agreement. To model this, we assume that the seller must undertake an irreversible, transaction-specific investment, r, prior to exchange taking place.[11] In the absence of a contract, the buyer and seller must negotiate a payment, y_t, on a day-to-day basis and, in the process, incur bargaining costs, a_t and b_t, respectively.[12] The parties can avoid these costs, however, by establishing the terms of trade in a contract prior to the seller's investment, where, for our purposes, a contract is assumed to contain a payment schedule, y, a penalty for nonperformance, δ, and the length of the agreement, τ.

Contracts written to cover extended periods of time are rife with uncertainty. Moreover, as noted above, uncertainty tends to increase with the distance of the relevant horizon. Because the spatial and temporal interrelationships that generate this process of change are much too rich to model directly (see Nelson and Winter, 1980, pp. 190-91), models of contract length typically seek to capture this feature of the economic environment by assuming the stochastic dependence of variables over time (see Gray (1978) and Dye (1985b)). The effect of this assumption is to increase the probability that the behavior stipulated in the agreement will be inefficient at later dates, thereby generating increasing costs for contracts of longer duration. Rather than follow this approach directly, we incorporate their basic result by simply assuming that c(t) represents the expected cost of a contract in period t as perceived from period 0, where the total cost of a contract of length τ (if δ is chosen optimally) equals $\int_0^\tau c(t)dt$ and $c'>0$.[13] This assumption helps to keep the model tractable and permits us to focus on the effects of contract design on a single dimension of uncertainty represented by the buyer's derived demand for the seller's output, ν, which is assumed to be continuously distributed according to the density function $f(\nu)$.

Given these assumptions, the profits of the buyer and seller (gross of contracting and investment costs) in each period under the contract (y,δ,τ) would be, respectively,

$$\pi_B^\tau = \int_{\hat{\nu}}^{\infty} (\nu-y)f(\nu)d\nu - \int_{-\infty}^{\hat{\nu}} \delta f(\nu)d\nu$$

$$\pi_S^\tau = \int_{\hat{\nu}}^{\infty} yf(\nu)d\nu + \int_{-\infty}^{\hat{\nu}} (s(\alpha) + \delta)f(\nu)d\nu.$$

Since the buyer will choose to perform the contract only if $\nu - y > -\delta$, $\hat{\nu} = y - \delta$.[14]

After expiration of the contract, the parties negotiate whether or not and the terms under which subsequent trade will take place. Noting that the buyer will agree to trade only if $\nu - y_t \geq 0$, and the seller if $y_t \geq s(\alpha)$, profits in each period not covered by a contract would be

$$\pi_B^t = \int_{-\infty}^{\infty} [\max(\nu - y_t, 0) - a_t] f(\nu) d\nu$$

$$\pi_S^t = \int_{-\infty}^{\infty} [\max(y_t, s(\alpha)) - b_t] f(\nu) d\nu.$$

For exchange between the buyer and the seller to take place in this context, it must be true that $\nu \geq s(\alpha)$, that is, the gains from trade must be positive and hence exchange efficient. Accordingly, let $\nu^* = s(\alpha)$ be the value of the seller's output at which the buyer is just indifferent between trading and not trading with the seller in a simple exchange.

Assuming that contracting costs accrue to the buyer, the expected profits of the buyer and seller over the entire life of the investment, T, would be

$$E(\pi_B) = \int_0^{\tau} (\pi_B^{\tau} - c(t)) e^{-\rho t} dt + \int_{\tau}^{T} \pi_B^t \, e^{-\rho t} dt$$

$$E(\pi_S) = \int_0^{\tau} \pi_S^{\tau} e^{-\rho t} dt + \int_{\tau}^{T} \pi_S^t e^{-\rho t} dt - r$$

where ρ is the discount rate.

The expected joint profit maximizing choices of y, δ and τ can be found by maximizing $E(\pi_B)$ subject to the constraint that $E(\pi_S)$ be at least as great as k, the gains from trade accruing to the seller. To examine the effects of distortions in contract terms on contract length, however, we consider a situation in which the transaction is subject to price regulation. This adds to the problem the additional constraint that y be less than or equal to $\bar{y}$, where $\bar{y}$ is the regulated price ceiling.[15] Hence, the choice of contract terms can be found by solving the Lagrangian

$$\max_{y,\delta,\tau} \quad L = E(\pi_B) + \lambda\{E(\pi_S)-k\} + \mu\{\bar{y} - y\},$$

where λ and μ are the respective multipliers.

The first order conditions for an interior solution to this problem are

$$\frac{\partial L}{\partial y} = -(1 - F(\hat{v})) + \lambda\{(1 - F(\hat{v})) + (s(\alpha) + \delta - y)f(\hat{v})\frac{\partial \hat{v}}{\partial y}\} - \mu = 0$$

$$\frac{\partial L}{\partial \delta} = -F(\hat{v}) + \lambda\{F(\hat{v}) + (s(\alpha) + \delta - y)f(\hat{v})\frac{\partial \hat{v}}{\partial \delta}\} = 0$$

$$\frac{\partial L}{\partial \tau} = \pi_B^\tau - \pi_B^t\Big|_\tau - c(\tau) + \lambda\{\pi_S^\tau - \pi_S^t\Big|_\tau\} = 0$$

Solving these three equations simultaneously yields

(1) $\lambda = 1 + \mu$

(2) $\delta = y - s(\alpha) + \dfrac{(\lambda-1)}{\lambda}\dfrac{F(\hat{v})}{f(\hat{v})}$

(3) $c(\tau) + \int_{\hat{v}}^{v^*}(s(\alpha)-v)dF(v) = \int_{-\infty}^{\infty}(a_\tau + b_\tau)dF(v) + \mu\{\pi_S^\tau - \pi_S^t\Big|_\tau\}.$

It is straightforward to show that in the absence of regulation or if the price ceiling is not binding, $\lambda^* = 1$, $\delta^* = y - s(\alpha)$ and τ^* is the solution to

(3') $c(\tau) = \int_{-\infty}^{\infty}(a_\tau + b_\tau)dF(v).$

The expected joint-profit maximizing choices of y, δ and τ are such that y^* guarantees the seller receives k, δ^* induces efficient adaptation, and τ^* equates the marginal costs and benefits of contracting. The latter are depicted by the solid lines in figure 1. The marginal benefit of contracting is the bargaining costs avoided by extending the contract an additional period.

Since the parties respond efficiently to changes in ν, the marginal cost of contracting when the price ceiling is not binding is just $c(\tau)$.[16] A point worth noting is that absent external constraints on contract terms, distributional considerations do not affect the optimal contract length between risk neutral agents. In particular, since any desired distribution can be effected by transfers between the parties at the outset of the relationship, the motivation to write long-term contracts derives not from a desire to control the distribution of quasi-rents per se, but rather because of the real costs incurred negotiating the terms of trade at contract renewal time.

When the price constraint is binding ($\mu > 0$), two additional factors affect the choice of contract length, as is seen by comparison of (3) with (3'). The term $[\pi_S^\tau - \pi_S^t|_\tau]$ is the difference between what the seller would receive under the contract in period τ and his expected profits from a simple exchange in that period. This term reflects direct nonprice competition in contract length. The direction of this effect depends on whether the seller expects to do better or worse at contract renewal time than under the original contract: If he expects contract price to exceed the (net) renegotiated price (perhaps because of a poor bargaining position ex post), then the seller could recoup some of the gains forfeited due to price constraints by a longer agreement. On the other hand, if future terms are expected to be more favorable to the seller than current prices (due perhaps to anticipated deregulation of the industry), a shorter contract would be in the seller's interest.

By the same token, however, regulation may induce nonprice competition in other contract terms. As indicated by equation (2), when the price constraint is binding ($\mu > 0$), $\hat{\delta}$ exceeds δ^*, causing the buyer to trade with the seller too often under the contract. Noting that $\nu < s(\alpha)$ for $\nu \varepsilon [\hat{\nu}, \nu^*]$, equation (3) implies an increase in the marginal cost of contracting, as depicted by the dashed line in figure 1. Specifically, the term $\int_{\hat{\nu}}^{\nu^*}(s(\alpha)-\nu)dF(\nu)$ represents the expected gains from trade foregone due to overperformance of the contract, which, by a change in variables, is equal to

$$(4)\quad \int_{\delta^*}^{\hat{\delta}}(s(\alpha)+\delta-y)f(y-\delta)d\delta.$$

Assuming a linear approximation to the distribution function, $F(\nu)$, this expression reduces to $f(y-\delta)(\hat{\delta}-\delta^*)$, the size of the distortion itself times the marginal probability of breach for a change in δ. In general, factors that induce distortions in contract incentives will be more costly the larger the distortion and the more sensitive is behavior to changes in those incentives. Hence, while the overall effect of regulation on contract duration depends on the direction and magnitude of direct nonprice competition in contract length as discussed above, distortions in the performance incentives in force during execution of a contract unambiguously raise the expected cost of contracting and shorten contract length.

3.b. Empirical Results

In this section, we employ the data set on natural gas contracts from our previous article (Masten and Crocker, 1985) to estimate the relationships characterized by equation (3). In order to do so, we wish to relate the incidence of contracting and bargaining costs to characteristics of the transaction. Recalling our earlier discussion, contracting costs, $c(\tau)$, are hypothesized to be an increasing function of both contract length and uncertainty. Renegotiation costs, a_t and b_t, on the other hand, have been argued to increase with the amount of quasirents at stake (Klein, Crawford and Alchian, 1978; Williamson, 1979). Letting ω represent the degree of uncertainty associated with the transaction and Q the level of appropriable quasi-rents, we linearize equation (3) to get the following specification of the contract length equation:

$$(3'')\ c_0 \cdot \tau + c_1 \cdot \omega + c_2 \cdot (\hat{\delta} - \delta^*) = \beta_0 + \beta_1 \cdot Q + \mu \cdot (\pi_S^\tau - \pi_S^t \big|_\tau),$$

where c_0, c_1, c_2, β_0, and β_1 are coefficients, and other variables are defined as before. Given the preceding discussion, c_0, c_1, β_0 and β_1 are all expected to be positive. The third term in (3") represents the efficiency loss from overperformance, where $c_2 = f(y-\delta) > 0$. Finally, $(\pi_S^\tau - \pi_S^t \big|_\tau)$, the difference in expected profits during and after expiration of the contract, measures the direct effect of nonprice competition on contract length when the price constraint is binding ($\mu > 0$). The larger are profits under the contract relative to anticipated follow-on profits, the greater the benefits on the margin of extending the contract an additional year.

Rewriting (3") in terms of τ, we get

$$(3''')\ \tau = \hat{\beta}_0 + \hat{\beta}_1 Q + \hat{\beta}_2 \mu (\pi_S^\tau - \pi_S^t \big|_\tau) + \hat{\beta}_3 \omega + \hat{\beta}_4 (\hat{\delta} - \delta^*).$$

The hypothesized coefficients become

$$\hat{\beta}_0 = \frac{\beta_0}{c_0} > 0;\ \hat{\beta}_1 = \frac{\beta_1}{c_0} > 0\ ;\ \hat{\beta}_2 = \frac{1}{c_0} > 0\ ;\ \hat{\beta}_3 = -\frac{c_1}{c_0} < 0\ ;\ \hat{\beta}_4 = -\frac{c_2}{c_0} < 0\ .$$

Intuitively, larger quasi-rents and higher expected profits during relative to after expiration of the contract should lead to longer agreements, while more uncertainty and a larger distortion in incentive provisions should lead to shorter term arrangements.

The variables employed in the estimations are defined in Table 1. The level of appropriable quasi-rents remaining at contract renewal time is a function of the availability of alternative customers and suppliers; more buyers and sellers reduce the potential for hold-up problems during contract renewal. Accordingly, we expect quasi-rents, Q, to be largest in bilateral trading relationships and generally to be negatively related to the total number of independent buyers and sellers operating in a field. Uncertainty regarding the demand for gas is tied to conditions in energy markets in general. To measure changes in the degree of uncertainty over time, ω, we use a measure of the volatility in real oil prices and a dummy variable reflecting the shift in expectations following the oil crisis in 1973. Similarly, we expect the seller's anticipated profits from future gas sales, $\pi_S^t|_\tau$, to rise after passage of the Natural Gas Policy Act of 1978 (NGPA) which effectively deregulated most gas categories as of 1985. Hence, we expect contracts written during this period to be shorter, reflecting the potential for higher gas prices in the future. As a proxy for expected profits accruing during the contract, π_S^τ, we employ the actual contract price. Note that since there is direct nonprice competition in contract length only if the price constraint is binding, this price is the exogenously set regulated price whenever $\mu > 0$. Whether or not this last condition holds for a given well, however, depends on characteristics of the transaction. We therefore predict the value of this constraint by estimating the difference between the constrained and unconstrained prices. Specifically, we construct a proxy, D, for μ such that $D_i = y_i^* - \bar{y}_i$ when the price constraint is binding ($\mu > 0$) and 0 otherwise, where y_i^* is the price that would have obtained in the absence of price ceilings. Since the unregulated price of gas is not observed for those prices above the ceiling, we estimate this price using instrumental variables in a Tobit model.[17]

Contract distortions. Although natural gas contracts typically do not contain explicit damage provisions, we argued in an earlier paper (Masten and Crocker, 1985) that take-or-pay provisions simulate the incentives of stipulated damages: By requiring purchasers to pay for a contractually specified minimum quantity of output, even if delivery is not taken, take obligations effectively impose a penalty for refusing deliveries. Because these provisions are typically written as a percentage of the value of the contract, we divide equation (2) by y to get

$$(2') \quad \gamma = 1 - \frac{s(\alpha)}{y} + \frac{(\lambda-1)}{\lambda} \frac{F(\hat{v})}{f(\hat{v})y} .$$

This expression can be used to construct estimates of $(\hat{\delta} - \delta^*)$. Noting that $(\lambda-1)F(\hat{v})/\lambda f(\hat{v})$ is positive only for $\mu > 0$, and letting D again proxy for the shadow value of the price constraint so that $\hat{\delta} = y - s(\alpha) + \xi D$, the distortion in δ caused by nonprice competition, ξD, can be constructed using the estimated coefficient ξ from $\gamma = 1 - s(\alpha)/y + \xi D/y$.

Nonlinear two stage least squares estimates of γ are reported in table 1. The results indicate that price constraints significantly raise the size of take percentages stipulated in natural gas contracts. In addition, the results support the hypotheses that the availability of alternative purchasers (more buyers) increases the alternative value of a well to producers, and that more sellers, by increasing drainage of gas by other wells, reduces the alternative value of gas not taken by the intended buyer.[18]

Contract duration. Because the data were collected from a survey of existing contracts in 1981, contracts with lengths shorter than the period between 1981 and the date the agreement was signed are not observed. Specifically, contracts were sampled only if $\tau > 1981 -$ CONTYEAR. This truncation of the dependent variable may cause biases in ordinary least squares estimates (see Maddala, 1983, pp. 166-7). To correct for this bias we estimate equation (3''') using maximum likelihood techniques. The likelihood function for this model is $\Lambda = \Pi_i h(\tau_i)$, where

$$h(\tau_i) = \frac{(1/\sigma)\cdot g[\tau_i - \hat{\beta}'X_i)/\sigma]}{1-G[(L_i - \hat{\beta}'X_i)/\sigma]}, \text{ if } \tau_i \geq L_i,$$

$$h(\tau_i) = 0, \text{ otherwise,}$$

and $h(\tau_i)$ is the density function of τ_i, L_i = 1981 - CONTYEAR, and $g(\cdot)$ an $G(\cdot)$ are the standard normal density and distribution functions respectively.

Ordinary least squares (OLS) and maximum likelihood estimates (MLE) of contract length are reported in table 2.[19] Note that the variables y and LEGIS have been multiplied by D, our proxy for the value of the multiplier, μ, as implied by equation (3'''). The coefficients on $(\hat{\delta} - \delta^*)$, D$\cdot$y and D$\cdot$LEGIS all have the predicted signs and are significant beyond the .05 level in both equations. The coefficients on OILVAR and CRISIS also have the expected signs in each case, although only CRISIS is significant at conventional levels. Interestingly, even though the coefficient on BILAT is negative using OLS, it is positive and significant at the .10 level in the MLE equation. This appears to reflect the fact that most of the fields in which there is only a single buyer and seller are in relatively remote areas that only became profitable to exploit during the severe gas shortages that occured during the later years of the sample. Apparently, the negative correlation between BILAT and contract length in the OLS regression reflects the increasing truncation of the dependent variable at earlier dates. Once this truncation is controlled for, the results indicate that the transactions involving relatively isolated wells actually, as anticipated, induce longer term agreements, in this case by an average of more than three years, <u>ceteris paribus</u>. Finally, the coefficient on PARTIES, which was expected to be negative, is insignificant in both equations.[20]

Overall, the evidence supports both the main transaction-cost arguments and the principal hypotheses regarding the effects of contract distortions on contract length. In particular, there appears to be a tradeoff between the costs of renegotiation in the presence of transaction-specific assets and the hazards of being bound to a long-term agreement. Moreover, distortions in performance incentives appear to raise substantially the hazards of long-term contracting and shorten the duration of contracts. Note that if take-or-pay provisions served primarily to distribute the gains from trade between transacting parting, as others have argued (see Hubbard and Weiner, 1986), then the analysis of the preceding sections would imply that higher take percentages, by raising the value of a contract to a seller, should lead to longer term agreements. If, on the other hand, such clauses serve efficiency purposes, as we have hypothesized, "excessive" take obligations should lead to higher costs of contracting and a negative effect on contract length. In fact, our results indicate that distortions in performance incentives caused by nonprice competition in take-or-pay obligations reduced the average length of natural gas contracts in 1981 by approximately 8 years.[21]

Finally, the direct effect of nonprice competition on contract length seems, as predicted, to depend on the position of the seller expected to prevail during relative to after the current contract: lower prices during the contract and the expectation of deregulation by the time the current contract expires also favor shorter term agreements. The evidence suggests that the prospect of deregulation following passage of the Natural Gas Policy Act of 1978 reduced average contract length by an additional 3 years.

5. Conclusion

The willingness of parties to enter long-term contracts is limited by the hazards inherent to contractual exchange. Because of the expense of writing and enforcing contingent clauses, only a limited number of contingencies at best are ever included in contractual agreements. Failure to accomodate changing economic conditions, however, opens the potential for either maladaption or costly renegotiation of the terms of trade.

Reliance on common law remedies may substitute for contingent performance in allowing for change in certain circumstances, but the use of the court system can be costly in its own right and is likely to be invoked as a mechanism for adaptation only as a last resort. To minimize the need for costly adjudication while maintaining incentives for appropriate adaptation, parties will therefore often seek to accomodate change through the use of unilateral options. Such provisions promote flexibility without requiring costly court verification of exogenous events. The problem, of course, is to design such options in ways that induce joint-profit maximizing responses to new economic conditions. To the extent this can be accomplished, however, the hazards of contractual exchange are reduced. This, in turn, can be expected to increase both the adoption and duration of contractual agreements.

In this paper, we attempted to gauge the importance of contract design to contracting parties by analyzing the effects of distortions in contract terms on the duration of long-term contracts and found that the prospect of inefficient adaptation during execution of a contract significantly reduces the willingness of parties to engage in long-term contracting. The evidence suggests that the enormous amount of theoretical research on contract incentives may be justified, given the observed sensitivity of agents to small distortions in contract terms, and demonstrates the possibility of formally testing transaction-cost theories of economic organization.

Finally, the arguments of this paper regarding the effects of contract design on the hazards of contracting apply whether distortions in performance incentives are the indirect result of regulatory induced nonprice competition or the direct outcome of systematic judicial error or misguided legal precedent. Hence, in addition to its direct policy implications for the regulation of industry, the evidence also suggests that even small errors on the part of the courts to assess accurately optimal penalties for nonperformance can significantly raise the cost of contractual exchange and thereby reduce its desirability relative to other forms of organization. The methods for inferring the magnitude of contracting and other transaction-related costs outlined in this paper should suggest ways of evaluating alternative legal standards by observing cross-jurisdictional differences in contracting behavior.

Footnotes

[1]Models of vertical integration which emphasize the infeasibility of complete contingent claims contracts include Williamson (1975, 1979); Klein, Crawford and Alchian (1978); and Crocker (1983). On the role and implications of incomplete contracts in macroeconomic theory see, for example, Barro (1977) and Hall and Lillian (1979). Contractual failures are implicit in all of the market failure literature; for an explicit statement, see Williamson (1976).

[2]The work of Gary Libecap and Steven Wiggins is a notable exception. See Wiggins and Libecap (1984, 1985) and Libecap and Wiggins (1985). Also see Masten and Crocker (1985). Since completing this paper we have also received an empirical examination of contract length by Paul Joskow (1985b).

[3]Charles Goetz and Robert Scott (1980) use the term "regret contingency" to "denote the future occurrence of a condition that would motivate breach if breach were a costless option for the promisor. Assuming any reliance, the occurrence of a regret contingency necessarily implies that either the promisor or promisee must bear a cost" (p. 1273).

[4]For example, the larger the variance in marginal benefits or costs, the greater the probability (assuming the former are not perfectly correlated) that the contract and optimal quantities will not coincide, hence, the greater the expected cost of being bound to a particular course of action.

[5]Government procurement regulations allow explicitly for the use of quantity and renewal options, which they define as "a unilateral right in a contract by which, for a specified time, the Government may elect to purchase additional quantities of the supplies or services called for by the contract, or may elect to extend the period of performance of the contract" (Defense Aquisition Regulations, paragraph 32,422 and seriatim.)

[6]Known as "expectation damages," this penalty is commonly applied by the courts (see, e.g., Barton, 1972, "the goal of expectation protection ... is the one usually expressed by common law courts" (p. 278)).

[7]Shavell (1984) recognizes the difficulty courts sometimes face in determining expectation damages and explicitly considers the implications of judical error for the choice of damage penalty.

[8]See Farnsworth, pp. 881-890.

[9]To illustrate, suppose that the buyer and seller occur litigation expenses, ℓ_B and ℓ_S, attempting to influence the size of the award, δ, by convincing the judge that $s(\alpha)$ is either very large or very small. Given the cost of adjudication, the buyer would seek to breach the contract only if the gain from doing so exceeded the penalty plus his cost of litigation, or $\nu - y < -(\delta + \ell_B)$, thus leading to overperformance by the buyer.

[10]"The most important restriction [on the ability of parties to use stipulated damage clauses] is the one denying them the power to stipulate in their contract a sum of money payable as damages that is so large as to be characterized as a 'penalty' (Farnsworth, p. 896). Specifically, "'the amount stimpulated must be a reasonable one, that is to say, not greatly disproportionate to the presumable loss or injury'" (p. 898).

[11]Although fixed in this model, the level of investment undertaken could be determined endogenously and would be affected by the parties expectations regarding the efficiency of subsequent exchange (cf. Shavell, 1980, and Masten, 1986).

[12]We assume that bargaining takes place before each party knows the reservation price of the other. Hence, a_t and b_t are incurred before and whether or not exchange takes place. (the subscripts allow the possibility that bargaining expenses depend on the realization of ν.) Also, we assume for simplicity that, rather than negotiate a new contract, the parties bargain over exchange on a period-by-period basis. The qualitative results of the model are unaffected by these assumptions.

[13]The increasing costs of contracting over time is a central element of all contract length models (see Dye, 1985b).

[14]Note that in this model the future status of the contract is not undermined by current failure. In practice, breach of an agreement would typically result in the termination of the relationship. Instead of the single period expectation, the optimal damage penalty would be the discounted value of expected lost profits over the remaining life of the contract. In that case, the buyer would breach only if the discounted value of continued performance fell below the discounted value of lost profits to the seller. In expected terms, breach would still occur only when efficient. Again, the qualitative results of the model are unaffected.

[15]Note that for price regulation to be meaningful, side payments must also be precluded. Hence, it is the case with natural gas regulation as well as rent controls that lump sum payments by the buyer to the seller are legally prohibited.

[16]Note that this analysis assumes an interior solution. Optimal contract length is bounded above by the life of the asset.

[17]See Masten and Crocker (1985) for a more complete description. The addititional exogenous variables used in that estimation were the depth of the well, GNP in the year the contract was written, a Herfindahl measure of the concentration of pipelines in the region, and a dummy variable reflecting direct sales of gas to nonpipeline customers. A likelihood ratio test of the contribution of these variables to the prediction of y^* indicates significance beyond the .001 level.

[18]See Masten and Crocker (1985) for a more complete discussion. The two stage estimates reported here are consistent with previous OLS estimates of take percentages by Masten and Crocker (1985) and Mulherin (1986).

[19]T-ratios appear in parentheses. Asymptotic t-ratios for the maximum likelihood estimates were computed using analytic second derivatives of the log likelihood function. Note that each of the right-hand side variables in the contract length estimations are either exogenous or predicted values. The truncation of the dependent variable appears to produce biased OLS estimates, with the coefficients on each of the continuous variables biased toward zero. The bias on the coefficients for the dummy variables, BILAT and CRISIS, is even stronger but in the opposite direction.

[20]A new paper by Paul Joskow (1985b) uses a number of measures of the degree of transaction specifity not available in our data to examine the determinants of contract length in coal transactions. His results indicate a strong positive relationship between these variables. The disappointing results regarding the effects of PARTIES on contract length in our study may reflect the fact that large fields both take longer to deplete and tend to be served by more producers and pipelines. Hence, the number of parties in a field may also measure in part the anticipated life of a well, which both directly (see footnote 16) and indirectly (by affecting the level of quasi-rents remaining at contract renewal time) limits contract length.

[21]Using this methodology, it would be possible in principle to estimate the dollar costs of contract distortions as well as those of bargaining and contracting as a function of characteristics of the transaction. In essence, maximum likelihood estimation reveals by inference the structure of goverance costs that most likely generated the observed institutional arrangements (see, e.g., Masten, 1984). As in this earlier study, however, the present estimates provide only ordinal measures of these costs. Because the variance of the estimate must also be estimated in the maximum likelihood procedure, equation (3") involves n variables and n+1 unknowns. The transformation to dollars could be accomplished if a dollar value for one of the arguments of the structural equation were available. Recalling, for example, that the cost of a distortion in δ is approximately equal to $f(y-\delta)(\hat{\delta}-\delta^*)$, and noting that the probability that a contract will be performed equals $Pr(\mu < y-\delta) = 1 - F(y-\delta)$, estimates of $f(y-\delta)$, and thus the expected dollar cost of contract distortions, could be derived from information on actual performance. In the case of natural gas contracts, $1 - F(y-\delta)$ would equal the expected percent of gas actually taken in a specific contract. Once this relationship has been identified, dollar estimates of each of the various costs underlying the contract length decisions could be calculated by substituting $f(y-\delta)$ for c_2 in equation (3''') and solving for the remaining structural coefficients. Unfortunately, information on the fulfillment of individual contracts is not available from public sources.

Table 1

TAU_i = the duration of contract i;

$CONTYEAR_i$ = the year in which the contract was written;

$BUYERS_i$ = the number of independent pipelines serving the field corresponding to contract i;

$SELLERS_i$ = the number of independent producers operating in the corresponding field

$BILAT_i$ = 1, if $BUYERS_i$ = 1 and $SELLERS_i$ = 1, i.e., if only a single buyer and seller are operating in the corresponding field,
= 0, otherwise

$PARTIES_i$ = ($BUYERS_i$ + $SELLERS_i$), i.e., the total number of agents operating in the field corresponding to contract i;

$OILVAR_i$ = the standard error of real oil prices over the six quarters preceding the year in which the contract was written;

$CRISIS_i$ = 1, for contracts written during or after 1973,
= 0 otherwise

$(\hat{\delta}_i - \delta_i^*)$ = the predicted distortion in contract terms due to the presence of regulated price ceilings;

y_i = the actual contract price of gas in October 1981;

$\bar{y}_i$ = the applicable price ceiling for this gas in October 1981;

$LEGIS_i$ = 1, for contracts written after the passage of the Natural Gas Policy Act of 1978,
= 0, otherwise;

D_i = a measure of excess demand of gas covered by contract i.

Table 2

Estimation of γ

VARIABLE	COEFFICIENT	T-RATIO	MEAN
Constant	81.703	28.698[a]	1.000
BUYERS/y	-2.1437	-4.0198[a]	2.1475
SELLERS/y	.6558	3.1474[a]	4.0338
D/y	4.2729	1.9048[c]	1.0748

R^2 = .0775

number of observations: 285

[a]Indicates significance beyond the .01 level
[b]Indicates significance beyond the .05 level
[c]Indicates significance beyond the .1 level

Table 3

Estimations of τ

VARIABLE	OLS	MLE	MEAN
Constant	20.258 (20.373)[a]	13.7814 (7.4238)[a]	1.000
BILAT	-2.9724 (-3.2290)[a]	3.5597 (1.7043)[c]	.1176
PARTIES	.0067 (.4879)	.0090 (.5556)	13.773
OILVAR	-1.0787 (-.9028)	-1.5534 (-1.0679)	.2584
CRISIS	-5.8171 (-5.3970)[a]	-2.7798 (-1.7326)[c]	.8039
$(\delta-\delta^*)$	-.5408 (-2.1658)[b]	-.7562 (-2.1488)[b]	11.209
D•y	1.0730 (2.7451)[a]	1.9052 (3.3314)[a]	6.9727
D•LEGIS	-.81098 (-2.0733)[b]	-1.3733 (-2.7745)[a]	2.1394

R^2: .3323

F: 17.560 with 7 and 247 d.f.[a]

Chi-square: 24.189 with 7 d.f.[a]

number of observations: 255

[a]Indicates significance beyond the .01 level
[b]Indicates significance beyond the .05 level
[c]Indicates significance beyond the .1 level

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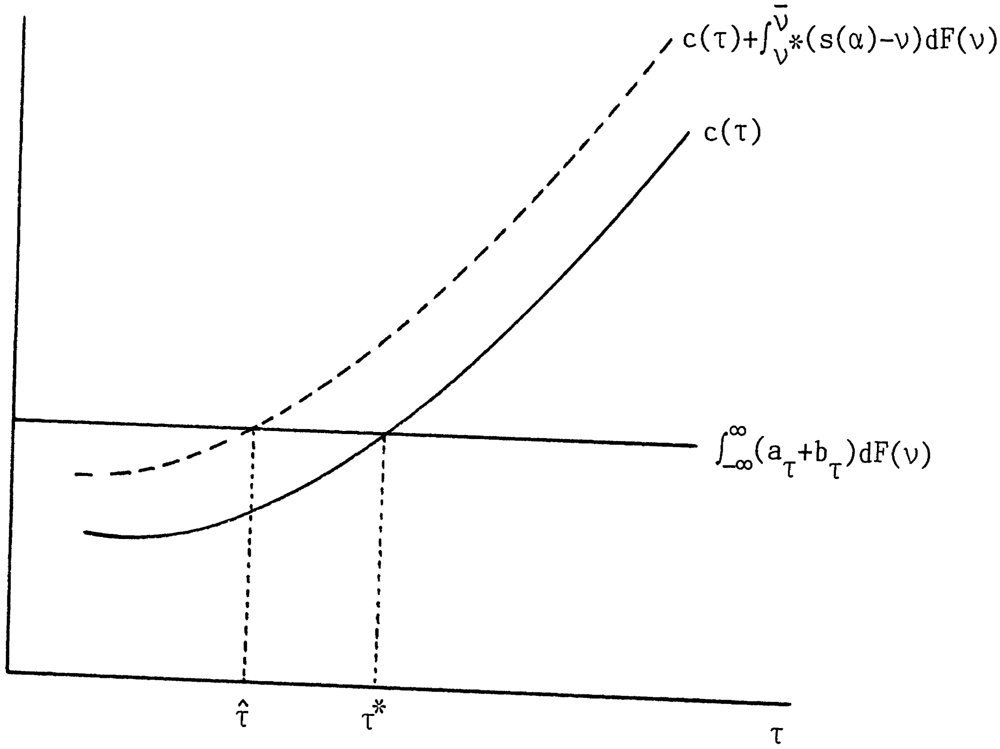

$c(\tau)+\int_{\nu^*}^{\bar{\nu}}(s(\alpha)-\nu)dF(\nu)$
$c(\tau)$
$\int_{-\infty}^{\infty}(a_\tau+b_\tau)dF(\nu)$
$\hat{\tau}$
τ^*
τ

Figure 1