# PRETIA EX MACHINA? PRICES AND PROCESS IN LONG-TERM CONTRACTS*

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## I. INTRODUCTION

AMONG the primary motives for writing contracts identified in both the law and economics literatures is the desire to protect against the hazards inherent to exchange where one or both parties have invested in reliance, or relationship-specific assets, in support of the transaction.[1] Because such investments have a higher value in their intended than in their next best use, parties have an incentive to engage in haggling or other forms of opportunism in hopes of influencing the distribution of the resulting quasi rents. Contracts promote efficiency by securing the distribution of those rents ex ante, thereby avoiding costly repetitive bargaining over the terms of trade and reducing the risk for each party of relying on the performance of the other.

In reality, this description of the role and functioning of contracting is oversimplified. As a number of legal and economic scholars have emphasized, contracts are not the precise, mechanically enforced documents often encountered in economic theory.[2] Indeed, contracts are extremely

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[1] See, for example, Benjamin Klein, Robert G. Crawford, & Armen A. Alchian, Appropriable Rents and the Competitive Contracting Process, 21 J. Law & Econ. 297 (1978); Oliver E. Williamson, Transaction-Cost Economics: The Governance of Contractual Relations, 22 J. Law & Econ. 233 (1979); and Steven Shavell, Damage Measures for Breach of Contract, 11 Bell J. Econ. 466 (1980).

[2] See, for example, Ian R. Macneil, Contracts: Adjustment of Long-Term Economic Relations under Classical, Neoclassical, and Relational Contract Law, 72 Nw. U. L. Rev. 854 (1978); Kenneth W. Clarkson, Roger Leroy Miller, & Timothy J. Muris, Liquidated Damages v. Penalties: Sense or Nonsense? Wis. L. Rev., 1978, at 351; Charles J. Goetz &

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imperfect tools for controlling opportunism. Parties may resort to all sorts of tactics to evade or chisel on performance. In that regard, contracts do not so much define the terms of trade as establish the procedures and alter the threat points from which parties compete over the division of transactional surpluses. An important element in designing contracts then becomes economizing on the costs associated with resolving disputes and governing exchange.

In this article, we examine the processes by which parties adjust prices in long-term contracts from this more relational view of contracting. That contracts often contain provisions for the periodic adjustment of prices is not all that surprising. Both relative prices and the general price level can change substantially over the extended time periods covered by many contracts, making original prices inappropriate to future conditions. What is possibly more surprising is the variety of processes that contracting parties have devised to effect such adjustments. Pricing provisions vary from definite escalators that establish a predefined schedule of prices over the life of the contract to vaguely worded renegotiation provisions. But while there have been a number of recent explanations for why parties might wish to provide for price flexibility[3] and some empirical work on how well contract prices track "market prices,"[4] there has been little systematic analysis of how parties choose among alternative pricing processes.[5] By focusing on the manner in which price adjustments are admin-

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Robert E. Scott, Principles of Relational Contracts, 67 Va. L. Rev. 1089 (1981); Timothy J. Muris, Opportunistic Behavior and the Law of Contracts, 65 Minn. L. Rev. 521 (1981); Victor P. Goldberg, Toward an Expanded Theory of Contract, 10 J. Econ. Issues 45 (1976); Victor P. Goldberg, Price Adjustment in Long-Term Contracts, Wis. L. Rev., 1985, at 527; Williamson, *supra* note 1; Oliver E. Williamson, The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting (1985); Oliver E. Williamson, The Logic of Economic Organization, 4 J. L. Econ. & Org. 65 (1988); and Benjamin Klein, Contract Costs and Administered Prices: An Economic Theory of Rigid Wages, 74 Am. Econ. Rev. 332 (1984).

[3] See A. Mitchell Polinsky, Fixed Price vs. Spot Price Contracts: A Study in Risk Allocation, 3 J. L. Econ. & Org. 27 (1987); Goldberg, Price Adjustment, *supra* note 2; and Victor P. Goldberg & John R. Erickson, Quantity and Price Adjustment in Long-Term Contracts: A Case Study of Petroleum Coke, 31 J. Law & Econ. 369 (1987).

[4] See Dennis W. Carlton, The Rigidity of Prices, 76 Am. Econ. Rev. 637 (1986); and Paul L. Joskow, Price Adjustment in Long-Term Contracts: The Case of Coal, 31 J. Law & Econ. 47 (1988).

[5] One exception is Harold Mulherin's 1986 article, in which he seeks to explain, among other things, the adoption of most-favored-nation clauses in natural gas contracts in existence during the period 1940–54; J. Harold Mulherin, Complexity in Long-Term Contracts: An Analysis of Natural Gas Provisions, 2 J. L. Econ. & Org. 105 (1986). Victor Goldberg and John Erickson's 1987 article (*supra* note 3) also looks at issues similar to those considered here as they apply to price adjustment in petroleum coke contracts. That article, however, relies on case study methods to explain observed contractual provisions, whereas this one employs more formal econometric techniques to evaluate contract design. Although

istered, we hope to provide additional insights into the role of various pricing provisions and the factors affecting contract design more generally.

We begin in the next section with a discussion of the trade-offs involved in designing contracts implied by relational contracting theory. We then discuss in Section III how these arguments relate to the design of processes for the adjustment of prices in long-term relationships. In Section IV, we apply those insights to explain the specific price adjustment processes adopted in a sample of long-term natural gas contracts. Section V contains our conclusions.

## II. Relational Contracting

Most of the economic literature on contracting treats contracts in a mechanistic fashion. Once a contract is entered, the obligations of the parties for the duration of the agreement are fully prescribed. Contractors accommodate future uncertainty by stipulating contingent claims. Issues relating to enforcement are rarely afforded explicit discussion, but the presumption is clear that courts will either direct specific performance or apply appropriately measured damages to assure that the intentions of the parties are fulfilled. Overall, the incentives and the distribution of rents contained in the contract are definitive and immune to efforts to evade performance or to reopen the agreement to further negotiation.

Familiarity with actual contracting reveals that contracts rarely exhibit the precise, unequivocal character suggested by this traditional view. First of all, courts are not the reliable enforcers of contractors' intentions that are often envisioned. The legal system does not costlessly and unerringly assess remedies. On the contrary, there are reasons to believe that courts 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, recovery is likely to be limited to the cost of reliance, implying lower than optimal awards on average. And even if court-determined damages were not systematically biased, the cost of adjudicating damage awards would diminish the attractiveness of litigated enforcement.

Second, and largely as a result of these imperfections in enforcement, parties often engage in conduct designed to escape performance or force

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our approach permits systematic tests on a larger set of contracts, we do miss much of the detail useful in evaluating contract terms that is available only through case studies. Paul Joskow's 1985 and 1988 articles also contain a considerable amount of useful case detail. See Paul L. Joskow, Vertical Integration and Long-Term Contracts: The Case of Coal Burning Electric Generating Plants, 1 J. L. Econ. & Org. 33 (1985); and Joskow, *supra* note 4.

renegotiation of contract terms. A short list of tactics contractors might exploit in attempting to effect a redistribution of the gains from trade includes capitalizing on ambiguous terms, suing for trivial deviations, making false claims of dissatisfaction, withholding relevant information, interfering with or failing to cooperate in the other party's performance, and failing to mitigate damages where a breach has occurred.[6] The success of any of these tactics depends on, among other things, how easily they can be detected and substantiated in court, but the uncertainty associated with litigated outcomes will generally leave some such tactics potentially profitable.

Finally, rather than defining the full set of obligations under the contract at the outset as implied by the standard economic treatment, contracts often leave terms and duties to future determination. Where uncertainty about what will constitute optimal behavior at the time of performance is great, it may be better to leave aspects of that performance open to negotiation rather than to constrain parties to specific but potentially inappropriate actions. Contracts in which parties intentionally defer decisions about price, quantity, or other aspects of the exchange until well into the term of the agreement are in fact quite common.[7]

These factors combine to suggest that contractual relationships, especially long-term ones, are rarely implemented in the mechanical way typically envisioned in economic theory but are characterized instead by an ongoing process of negotiations over the terms of trade. Contracts, from this perspective, become simply a means of structuring those negotiations, and litigation merely a negotiation tactic—a view supported by the small number of cases that go to trial relative to the number of actions filed. In this more relational view of contracting, "formal legal procedures are but a step in a longer process of negotiation. Filing a complaint and pre-trial procedure can be tactics in settlement bargaining."[8]

The problem is to devise a structure that encourages rent-increasing

[6] For more extensive lists and further discussion, see Goetz & Scott, *supra* note 2; Muris, *supra* note 2; Clarkson *et al.*, *supra* note 2; and Robert S. Summers, "Good Faith" in General Contract Law and the Sales Provision of the Uniform Commercial Code, 54 Va. L. Rev. 195 (1968). Such behavior "together with the other party's efforts to counteract them" create what Charles Goetz and Robert Scott refer to as "evasion costs." See Charles J. Goetz & Robert E. Scott, The Mitigation Principle: Toward a General Theory of Contractual Obligation, 69 Va. L. Rev. 967, 977 (1983). The important points are that, although the nature of strategic behavior within a contract will differ, opportunism occurs within as well as outside contractual agreements and that attempts to force a reallocation of contractual surpluses and efforts to counter them, whether through legal channels or less formal means, dissipate part of the rents accruing to exchange.

[7] For specific examples, see Goldberg & Erickson, *supra* note 3; and below.

[8] Stewart Macaulay, An Empirical View of Contract, 1985 Wis. L. Rev. 465, 468 (1985).

adjustments (flexibility) but discourages rent-dissipating efforts to redistribute existing surpluses (opportunism). Although more detailed and precise agreements make evasion more difficult, contingent claims contracting becomes costly very quickly in complex or uncertain environments. Failure to account adequately for uncertainty, however, may leave gains from adaptation unrealized or, if one party is greatly disadvantaged by ensuing developments, induce the types of costly efforts to evade performance or force a renegotiation described above.

The advantage of less precise, "relational" contracts that leave terms to future negotiation is that, because they do not attempt to explore and stipulate responses to every possible event, such agreements are considerably simpler to draft than contingent claims contracts yet at the same time remain flexible in the face of changing circumstances. As Victor Goldberg has argued, in designing relational contracts, emphasis shifts from devising "a detailed specification of the terms of the agreement to a more general statement of the process of adjusting the terms of the agreement over time—the establishment, in effect, of a 'constitution' governing the ongoing relationship."[9] The drawback is that such broad statements often afford the parties considerable latitude for dispute over what constitutes satisfactory performance and therefore introduce the prospect of having to engage in costly bargaining on a regular basis—the avoidance of which presumably motivated the use of long-term contracts in the first place.[10]

In practice, parties attempt to strike a balance between flexibility and opportunism in a variety of ways. To limit the nature and scope of renegotiations in relatively open-ended agreements, parties may restrict either the set of permissible adjustments or the process by which such changes are to be implemented. For example, the contract may permit negotiation over price or quantity requirements only at specified intervals or may designate which party has the right to initiate such renegotiations. Certain types of bargaining tactics may also be excluded, such as strikes or refusals to accept delivery. Delay as a tactic in negotiations is often made less attractive by stipulating that renegotiated terms apply retroactively to all deliveries after renegotiations were initiated. Alternatively, parties may attempt to expand the scope for negotiation and adjustment within rela-

[9] Goldberg, Toward an Expanded Theory, *supra* note 2, at 428.

[10] See Klein *et al.*, *supra* note 1; Williamson, *supra* note 1. For evidence that the size of quasi rents affects the length of contractual agreements, see Paul L. Joskow, Contract Duration and Relationship-specific Investments: Empirical Evidence from Coal Markets, 77 Am. Econ. Rev. 168 (1987); and Keith J. Crocker & Scott E. Masten, Mitigating Contractual Hazards: Unilateral Options and Contract Length, 19 Rand J. Econ. 327 (1988).

tively precise agreements by including provisions such as force majeure or gross inequity clauses.

Ultimately, the degree to which transactors leave the details of performance to future resolution will reflect the nature of the transaction. In the words of Oliver Williamson, "What is needed, evidently, is some way for declaring admissible dimensions for adjustment such that flexibility is provided under terms in which both parties have confidence. This can be accomplished partly by (1) recognizing that the hazards of opportunism vary with the type of adaptation proposed and (2) restricting adjustments to those where the hazards are least."[11]

## III. Price Adjustment Processes in Long-Term Contracts

Here we apply the relational contracting perspective described above to analyze the nature of price adjustment processes. Unlike most earlier studies of price adjustment that emphasize either the reasons parties might want to allow for price flexibility[12] or the correlation between contract and market prices,[13] we focus on the question of *how* parties adjust prices. Thus, our concern is less with what prices actually result than with the processes by which they get determined.[14]

[11] Williamson, *supra* note 1, at 251.

[12] For discussions of alternative theories, see Goldberg, Price Adjustment, *supra* note 2; Goldberg & Erickson, *supra* note 3; Joskow, *supra* note 4; and note 14 *infra*.

[13] See, for example, Carlton, *supra* note 4; and Joskow, *supra* note 4. There are reasons to question whether market prices are the appropriate standard against which to evaluate contract prices. As Goldberg has argued, "[T]he relevant price to each party is its opportunity cost—the net price it could get from the next best trading partner. In a market for a standardized commodity, the list price and these two opportunity costs are roughly the same. However, in a long-term contract in which the parties deliberately isolate themselves from the external market, these three prices are more likely to diverge." See Goldberg, Price Adjustment, *supra* note 2, at 540.

[14] Focusing on process obviously begs the question of what parties are trying to accomplish in adjusting prices. Generally, economists have identified three motives for price adjustment: risk sharing, incentive alignment, and, most recently, transaction-cost based arguments. Risk-sharing arguments see the goal of price adjustment as stabilizing the surplus of the more risk-averse party (see, for example, Polinsky, *supra* note 3). In the incentive explanation, prices in variable quantity contracts are adjusted to provide appropriate price signals to the transactor having discretion over quantity.

The third rationale interprets price adjustment in a more relational manner. According to Goldberg, a goal of price adjustment is to reduce relational frictions or "postagreement jockeying." Changes in market conditions during execution of a fixed-price contract may leave one or the other party in an unfavorable position relative to his outside opportunities. That party then becomes more likely to engage in rent-seeking activities designed to evade performance or force a redistribution of contractual surpluses. "If the probability of wasteful behavior increases as the divergence between contract price and opportunity costs of the aggrieved party widens, price-adjustment rules which narrow the gap become increasingly attractive." See Goldberg, Price Adjustment, *supra* note 2, at 533. Also see Richard E.

### A. *Methods of Price Adjustment*

*Redetermination Provisions.* Price adjustment processes can be divided into two basic categories, redetermination processes and renegotiation processes. Redetermination provisions establish prices by formula. The most extreme, rigid form is a definite escalator that adjusts prices according to an explicit, predefined schedule, increasing prices at a stipulated rate, for example. While the price that applies at a particular date is easily determined by reference to the contract, definite escalators have the obvious disadvantage of failing to make use of information arising over the course of the relationship and thus suffer many of the deficiencies of fixed-price contracts.

Indefinite escalators, in contrast, attempt to relate contract prices to market conditions as they unfold. The process of determination is still formulaic, but the equation now ties price to market data such as a general price index or the price of some important input or substitute product. Implementation thus remains straightforward, while prices become more flexible. But the same factors that prompt the use of long-term contracts limit the practicality of indexing. Specifically, the relationship-specific nature of many of the assets used in producing, transporting, or consuming a product isolates the parties from market alternatives. The more isolated the transaction in question, the more likely is it that indexed prices will fail to track the parties' respective opportunities.

To make use of information more closely related to the transaction at hand, parties have devised adjustment provisions such as most-favored-nation and right-of-first-refusal clauses that tie contract prices to prices obtained in similar transactions or to best alternative offers. Still, even these may miss cost or demand changes specific to a particular transaction and thus adjust prices imperfectly. In addition, the need to seek out and validate outside prices makes these provisions more costly to implement than index formulae and, being less definite, introduce a somewhat greater prospect of strategic behavior.

*Renegotiation Provisions.* Each of the indefinite pricing processes described above, while leaving price indeterminate at the time the contract

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Speidel, Court Imposed Price Adjustments under Long-Term Supply Contracts, 76 Nw. U. L. Rev. 369, 373 (1981). An implication of this argument is that parties will wish to set prices so that ex post distributions of rents are divided equitably (see Scott E. Masten, Equity, Opportunism, and the Design of Contractual Relations, 144 J. Theoretical & Institutional Econ. 493 (1986)) to effect what Oliver Williamson has called "hazard equilibration" (for example, Williamson, *supra* note 2, at 34). We have implicitly adopted this relational explanation as our maintained hypothesis. Although we do not attempt to test the latter against alternative theories of price adjustment directly, evidence in support of one or the other is occasionally noted.

is written, is still definite in the sense that the price at which the parties will trade is determined definitively by the contract once the state of the world has been verified. Under renegotiation provisions, however, the distribution of rents under the contract is indeterminate up to the point at which the parties reach agreement on price. The ability to take into account the full range of relevant information before settling on price affords the transaction a considerable degree of flexibility.

This is not to say that such negotiations are totally unconstrained. Parties may structure the negotiation process by, for example, defining in the contract the sequence of offers and acceptances or specifying the defaults if agreement cannot be reached. Even contracts that place no express restrictions on the strategies of the parties provide more structure than no contract at all. As long as agreements are sufficiently definite to be considered valid contracts,[15] the law imposes a duty of good faith in execution of ambiguous terms.[16] Circumstances in which a duty to deal in good faith might come to bear include situations where a contract leaves the power to specify price or quantity to either or both parties. "Contract cases condemn the abuse of these powers as a form of bad faith in performance, even when the objectionable conduct is within the letter of the contract or when the contract says nothing at all about how the powers are to be exercised."[17] Thus, the law generally requires that quantity decisions in variable quantity contracts be made in good faith and seeks to deter variations whose purpose is to extort concessions from the other party.[18] More important for the issue at hand, "good faith prohibits a party from setting unreasonably high (or low) prices under an 'open price' provision."[19]

The advantage of renegotiation provisions is that they permit the parties to take full advantage of current information in adjusting prices.

[15] Although contracts that are too vague may be found void for want of definiteness, the Uniform Commercial Code states explicitly, "An agreement for sale which is otherwise sufficiently definite . . . to be a contract is not made invalid by the fact that it leaves particulars of performance to be specified by one of the parties. Any such specification must be made in good faith and within the limits set by commercial reasonableness" (U.C.C. § 2-311(1)).

[16] Generally, "[e]very contract [covered by the Uniform Commercial Code] imposes an obligation of good faith in its performance and enforcement" (U.C.C. § 1-203). The duty to deal in good faith, moreover, applies only to the *execution* and not the *negotiation and formation* of a contract. See Summers, *supra* note 6, at 220. Summers refers to good faith as "a phrase which has no general meaning or meanings of its own, but which serves to exclude many heterogeneous forms of bad faith" (*id.* at 201) and provides an extensive discussion of various practices constituting bad faith.

[17] Summers, *supra* note 6, at 239.

[18] See, generally, Muris, *supra* note 2, at 556–64, and cities therein.

[19] Summers, *supra* note 6, at 239–40.

Hence, they provide a high degree of flexibility. But they also expose the parties to the costs of having to negotiate mutually acceptable terms. Although the good faith requirement places restrictions on the use of the most flagrant negotiating tactics, considerable scope may remain for exercising more subtle, though still costly, bargaining strategies.

### *B. The Choice of Adjustment Process*

The choice between redetermination and renegotiation provisions will reflect the relative costs of governing relationships under the respective arrangements. On the one hand, renegotiation provisions generally offer wider latitude to respond to changing conditions but subject the parties to the need to negotiate prices on a regular basis. Redetermination provisions, on the other hand, avoid the expense of negotiations but are less sensitive to relationship-specific events and are therefore more likely to generate acute hazards in extreme situations.[20] By relating the magnitude of these costs to characteristics of a transaction, it should be possible to predict the adjustment process most likely to be adopted to govern a particular relationship.

The literature on relational contracting suggests several factors that are likely to influence the degree to which contracts leave performance to future discretion. The most prominent consideration is the extent to which the environment associated with the transaction is complex or uncertain.[21] According to Charles Goetz and Robert Scott, for example, contracts will tend to be more relational in character where[22] "the parties are incapable of reducing important terms of the arrangement to well-defined obligations. Such definitive obligations may be impractical because of the inability to identify uncertain future conditions or because of inability to characterize complex adaptations adequately even when the contingencies themselves can be identified in advance."

Applied to pricing provisions, this suggests that the hazards of relying on relatively mechanical price adjustment processes will be smaller when the parties are fairly confident about future conditions or the variables of concern are easily quantifiable. Devising a satisfactory index may prove difficult, however, when the relevant information is costly to obtain or

[20] Witness, for example, *Aluminum Co. of America v. Essex Group, Inc.*, 499 F.Supp. 53 (W.D.Pa. 1980) (discussed in Goldberg, Price Adjustment, *supra* note 2) or the well-known experience of Westinghouse with its uranium supply contracts in the 1970s (see, for example, Paul L. Joskow, Commercial Impossibility, the Uranium Market, and the Westinghouse Case, 6 J. Legal Stud. 119 (1977)).

[21] See, for example, Macneil, *supra* note 2, at 901; and Williamson, *supra* note 1, at 238.

[22] Goetz & Scott, *supra* note 2, at 1091.

certify in court. The more uncertain the environment in these dimensions, the higher the likelihood that prices determined by formula will be severely disadvantageous to one of the parties. In such settings, renegotiation provisions, which institutionalize the ability to adapt to extreme conditions, reduce the incentive to employ the most costly evasion tactics. But they do so at a greater cost of arriving at prices on a day-to-day basis.

The greater uncertainty associated with distant horizons makes inflexible pricing particularly hazardous in longer-term agreements.[23] What were parameters in the short run become variables in the long run, increasing the dispersion of possible states of the world. The probability of being locked into an unprofitable undertaking and, hence, of efforts to subvert the agreement, will therefore be larger the more time separating acceptance and performance. We would thus expect renegotiation provisions to become more common as the duration of the contract increases.

The use of relational contracts is also often associated with the degree to which transactors need to invest in relationship-specific assets. Oliver Williamson, for example, generally posits a direct correlation between relational contracting and relationship-specific investments.[24] One reason for the latter is that the existence of appropriable quasi rents often motivates long-term affiliations, which, as just noted, favor the use of flexible arrangements. The effect of asset specificities on the incentive to write more relational contracts holding contract duration constant is less clear, however. On the one hand, increases in the size of appropriable quasi rents might be expected to increase the amount of resources transactors would be willing to expend attempting to negotiate a favorable distribution of those rents, making recurring negotiations unattractive.[25] On the other hand, investments in relationship-specific assets would inhibit the design and implementation of formulaic adjustment processes by insulating traders from similar transactions, thereby raising the costs associated

[23] See, for example, Williamson, *supra* note 1, at 238; Macneil, *supra* note 2, at 901; and Goetz & Scott, *supra* note 2, at 1091.

[24] Williamson, *supra* note 1.

[25] In explaining the relative infrequency of renegotiation provisions in contracts between petroleum coke refiners and aluminum producers, for instance, Goldberg and Erickson reason, "The aluminum contracts generally entailed greater insulation from current market conditions. Reopening a contract would mean that the parties would haggle over how to share the pie. The more parties are isolated from alternative trading partners, the larger the size of the pie. The larger the pie, the more resources the parties would devote to pursuing it. That is, the higher reliance interest in the aluminum contract would result in higher renegotiation costs, making frequent renegotiation relatively less attractive." See Goldberg & Erickson, *supra* note 3, at 391. The comparison is to upstream contracts between the coke refiners and suppliers of unrefined coke.

with redetermination as well.[26] Thus, although larger quasi rents are likely to lead to longer-term agreements, the differential effect of quasi rents on the costs of redetermination and renegotiation provisions, holding contract duration constant, appears to be ambiguous.

Finally, the choice of price adjustment processes is likely to interact with nonprice dimensions of the contract such as quantity, timing, and product specifications. At a superficial level, flexibility in price and in these other dimensions can be thought to act as substitutes: the more flexibility allowed in quantity, for instance, the less need there will be for flexibility in price. But the relational contracting approach also provides a more substantive rationale for expecting such a trade-off.

In fixed-quantity contracts, price adjustments are zero sum in nature.[27] As a result, reaching agreement on adjustments to a contractually established, but inequitable, price is likely to be difficult. However, unlike renegotiation provisions that provide expressly for such modifications and limit the tactics that can be employed in arriving at a settlement, redetermination provisions give much greater support to the status quo and actually provide an arsenal of legal tactics to protect the existing distribution of rents. The prospect of having to resort to litigation, delay, and similar tactics to affect adjustments makes inflexible pricing extremely hazardous where quantity variations are contractually restricted.

The relative disadvantage of redetermination provisions decreases, however, when quantity is variable. First, in response to an unfavorable price, the party with discretion over quantity may temper his losses by adjusting output or purchases, generally without exposing himself to the threat of costly litigation.[28] Second, and more important, where contracts permit variation in quantity, there is a greater chance of finding modifications to price *and* quantity that will be mutually beneficial. The result is that disputes are more likely to be settled with minimum disruption to

[26] Higher quasi rents might also increase the frequency and expense of evasion efforts. Moreover, the duty to deal in good faith that the law imposes on transactors during contract performance should constrain the most blatant manifestations of opportunism and thus temper the effect of quasi rents on the costs of renegotiation. Again, the fact that good faith requirements apply only to performance and not formation of a contract distinguishes negotiations during the term of the contract from those at contract renewal intervals. See text around notes 15–19 *supra*.

[27] Compare Williamson: "[P]rice adjustments have an unfortunate zero-sum quality, whereas proposals to increase, decrease, or delay delivery do not." See Williamson, *supra* note 1, at 251. See also, Michael L. Wachter & Oliver E. Williamson, Obligational Markets and the Mechanics of Inflation, 9 Bell J. Econ. 549 (1978).

[28] Quantity variations also may be held to good faith requirements. In particular, the courts seek to deter variations made for strategic purposes. See Muris, *supra* note 2, at 556–64, and cites therein.

the relationship where mechanically determined prices are accompanied by flexibility in other substantive dimensions of the agreement.

## IV. Price Adjustment in Natural Gas Contracts

From the inception of the industry, sales of natural gas between producers and pipelines have been governed by contracts averaging ten to fifteen years in duration. The use of price-adjustment provisions in those contracts was common prior to the introduction of wellhead price regulation. The most frequently used provisions were two-party most-favored-nation (MFN) clauses that indexed contract price to the price paid by the purchaser to other suppliers in a stipulated area and renegotiation provisions, typically calling for open-ended price discussions every four or five years.[29]

Following the *Phillips* decision in 1954,[30] however, the Federal Power Commission began the process of regulating wellhead prices that culminated in 1960 in the introduction of area rate price ceilings for interstate gas sales. As part of that regulation, the commission also introduced restrictions on the types of price escalators parties could adopt and the frequency with which prices could be adjusted in contracts for gas sold below ceiling prices. The commission's objection to indefinite escalators was based on the belief that such provisions permitted price increases based on events having no relation to the economics of a particular sale.[31] Nevertheless, in a decision to ease those restrictions soon thereafter, the commission indicated a grudging appreciation of the role of price flexibility in facilitating long-term contractual relationships:[32]

> We reaffirm our earlier findings that the use of long-term contracts for the sale of natural gas by producers to pipelines or to others is desirable and appropriate in the public interest but that indefinite escalation provisions are, in general, contrary to the public interest. However, it also appears that elimination of all indefinite escalation provisions would be too restrictive to enable the industry adequately to cope with possible changing economic conditions over the span of long term contracts. Therefore, *to permit pricing flexibility and to provide an incentive for long term contracts,* we should permit future contracts to contain limited price-redetermination provisions.

[29] See Edward J. Neuner, The Natural Gas Industry (1960); Mulherin, *supra* note 5; and J. Harold Mulherin, Specialized Assets, Governmental Regulation, and Organizational Structure in the Natural Gas Industry, 142 J. Theoretical & Institutional Econ. 528 (1986).

[30] Phillips Petroleum Company v. Wisconsin, 347 U.S. 672 (1954).

[31] See U.S. General Accounting Office, Comptroller General, Information on Contracts between Natural Gas Producers and Pipeline Companies, 14 (February 22, 1983).

[32] *Id.* at 26, emphasis added.

Although the Federal Power Commission, and its successor, the Federal Energy Regulatory Commission (FERC), continued to limit the nature and frequency with which prices could be adjusted during the period of gas regulation, regulators did permit parties to adopt contract provisions that stipulated how gas prices were to be determined *in the event that gas sales were deregulated.*[33] As the prospect of deregulation increased prior to and following the passage of the Natural Gas Policy Act (NGPA) of 1978, the significance of such deregulation provisions increased. Below, we examine evidence regarding the relation between adjustment processes contained in these deregulation provisions and the characteristics of gas transactions in light of the discussion in the preceding section, using data collected when many categories of gas were either already deregulated or scheduled to be so in the near future.

### *A. Deregulation Provisions*

Our information on contract terms was obtained from a 1982 survey (EIA-758) conducted by the Energy Information Administration (EIA) covering wells that qualified for incentive pricing under sections 102, 103, 107, and 108 of the Natural Gas Policy Act.[34] Through this survey, the EIA compiled detailed data on 659 contracts governing the sale of natural gas from 615 wells located in and off the coast of the lower forty-eight states. We then independently augmented this data with information on well characteristics from public records at the Department of Energy. Missing observations in the sample and limits on our ability to identify attributes of wells reduced the sample to 234 contracts governing onshore gas sales under NGPA sections 102 (''new'' natural gas), 103 (''new'' onshore production wells), and 107 (''high-cost'' gas from deep wells, tight sands, Devonian shales, or geopressurized brine).[35]

[33] *Id.* at 28. Permissible pricing provisions were limited to (1) definite escalator clauses, (2) tax reimbursal provisions, and (3) limited indefinite escalators that adjusted price no more frequently than every five years. Later (1966), provisions that raised the price to the highest allowed regulatory rate were also permitted (18 C.F.R. 154.93).

[34] U.S. Department of Energy, Energy Information Administration, Natural Gas Producer/Purchaser Contracts and Their Impacts on the Natural Gas Market, Publication No. 0330 (1982). The NGPA established a time schedule for deregulation by gas category with high-cost section 107 gas deregulated as of November 1979, and sections 102 and 103 gas deregulated between January 1985 and July 1987, depending on the depth of the well.

[35] The EIA-758 survey data on contract terms was obtained under a confidentiality agreement with the Energy Information Administration. Over a third (233) of the contracts in the original data set covered offshore wells for which well characteristics data were unavailable. Correlation of the remaining observations with information obtained from FERC-121 filings (Application for Determination of the Maximum Lawful Price under the Natural Gas Policy Act) yielded basic well and field characteristics data on 392 contracts

TABLE 1

PRICE ADJUSTMENT PROVISIONS

| | ADJUSTMENT PROCESS | | | |
|---|---|---|---|---|
| | Redetermination | | | Renegotiation |
| | Equal to | Highest of | Selected by Seller | Based on |
| Total contracts | 102 | 67 | 13 | 52 |
| Adjustment factors: | | | | |
| Definite escalator | 10 | 37 | 5 | 2 |
| Fuel index | . . . | 31 | 6 | 1 |
| Other price index | . . . | 1 | 1 | 1 |
| Two-party most-favored nations | 4 | 12 | . . . | . . . |
| Three-party most-favored nations | 87 | 57 | 13 | 15 |
| Market factors | . . . | 13 | 1 | 39 |
| Other | 3 | 27 | 3 | 2 |
| Other provisions: | | | | |
| Market out | 29 | 21 | 7 | 6 |
| Maximum price | 10 | 27 | 2 | 9 |
| Minimum price | 24 | 23 | 1 | 10 |
| Right of first refusal | 19 | 2 | 3 | 6 |
| Price arbitration provision | 40 | 40 | 7 | 34 |

Contract provisions relating to or affecting price can be remarkably complex.[36] Table 1 provides a sense of the diversity of natural gas pricing

representing 235 onshore gas fields. Missing values on one or more variables and exclusion of contracts written prior to the introduction of area rate regulation in 1960, and of section 108 contracts, which were not deregulated under the NGPA, left a sample of 234 contracts containing deregulation provisions. The majority of these (79 percent) were written during or after the year in which the NGPA was passed.

[36] We had access only to the Department of Energy's survey data and not to the original contracts. The following, however, is a sample deregulation clause provided by the Energy Information Administration:

Redetermination may be requested at time of deregulation and at each succeeding January 1 thereafter by seller who will select a redetermined price from one of the following:

(1) Initial price of $6.169 effective December 1, 1981, escalating monthly thereafter based on Section 102 escalation factors;

(2) The price in effect immediately prior to redetermination;

(3) Average of the two highest prices, selected by seller, being paid for substantially comparable gas produced in South Louisiana, onshore and offshore, escalated monthly by the Section 102 escalation factor, including taxes [a most-favored-nation clause]; or

(4) A price equivalent to 80 percent of the price of No. 2 fuel oil. defined as 100 percent of the average price per MMBtu for No. 2. fuel oil as published in *Platt's Oilgram* for "South and East Terminals, New York Harbor District." The average fuel oil price each month will be calculated from the arithmetic average of the daily arithmetic averages of the high and low quotations for each day of the month used. To convert price per gallon to

provisions. The column headings in the table—"equal to," "highest of," "select by seller," and "based on"—indicate the basic processes natural gas contracts employ to guide the establishment of prices, while the row headings list the most common reference prices or "adjustment factors," and the cells indicate the frequency with which each combination of processes and factors appears in the sample. Notice that more than one factor may be referenced in a given contract.

The adjustment processes are listed from least to most relational moving left to right across the table. The most precise process used in natural gas contracts set price either "equal to" or as the "highest of" some combination of the adjustment factors. Once the reference price or prices are established, the corresponding contract price is determined by the formula adopted in the agreement. An alternative that provides more flexibility is to permit one party, in this case, the seller, to select price from among a set of prices determined by the adjustment factors listed in the contract. Giving the seller some discretion over price allows greater opportunity to conform price to unusual circumstances (and to behave opportunistically) than would "equal to" or "highest of" contracts. Finally, renegotiation provisions indicate only that renegotiations should be "based on" or take into consideration specific factors such as prices paid by other pipelines or simply "market factors." Unlike "selected by seller" contracts in which the seller chooses price unilaterally, this adjustment process requires that the parties reach agreement before price is established.

The trade-off between precision and flexibility may be influenced not only by the adjustment process but also the adjustment factors selected. Definite escalators, for example, are extremely precise but inflexible. Fuel indices are also fairly precise but track only general market conditions, whereas most-favored-nation clauses use more well-specific information but must rely on the firm's ability to identify and document prices received by other producers.[37] Other provisions also influence the amount

price per MMBtu, each gallon will be deemed to contain 0.138691 MMBtu [a fuel-tied provision].

Redetermined prices, including tax reimbursement, shall not exceed 110 percent of the price of No. 2 fuel oil as determined above [a maximum price provision].

If buyer, at its sole discretion, determines that the total price being paid for all or a portion of the gas is not economical, buyer may elect not to pay the price and notify seller of the price it is willing to pay. If seller is unwilling to accept such price, it can cancel the contract [a market-out provision].

See U.S. Department of Energy, *supra* note 34, at 9.

[37] Most-favored nation clauses may be either two-party or three-party. Two-party clauses

of flexibility in the contract. Maximum and minimum prices may limit price increases or decreases or may trigger renegotiation, as may "market out" provisions that allow a purchaser to refuse deliveries if gas is "unremarketable" at the current contract price. The nature and scope of renegotiations may, in turn, be structured by arbitration provisions or buyer-right-of-first-refusal clauses that give the purchaser the option of either meeting third-party offers or releasing the seller from the contract. Finally, contracts may differ with regard to how often adjustments can or must take place and how and by whom adjustments are initiated.

Although the diversity of adjustment processes suggests a continuum of contract types, data and statistical limitations prevent estimation of the full variety of contract clauses.[38] Nevertheless, the hypotheses discussed in Section III can be tested by partitioning the data in a variety of ways. We begin by examining the adoption of redetermination versus renegotiation provisions.

### *B. Pricing Processes and the Frequency of Adjustment*

The discussion in Section III*B* suggests that renegotiation provisions are more likely to be adopted the more uncertainty associated with the transaction, the longer the duration of the contract, and the more restrictive the nonprice aspects of the agreement. Information on contract duration and nonprice provisions were provided in the original data.[39] Given that natural gas is a fairly homogeneous product, the main dimension other than price over which the parties have control is quantity. The amount of quantity flexibility permitted in the contract is governed by take-or-pay provisions, which require purchasers to pay for a contractually specified minimum quantity of output even if delivery is not taken.[40]

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tie price to the prices paid by the buyer to other sellers, while three-party MFNs tie price to prices paid by *any* buyer in a specified region. A number of papers have interpreted such MFNs as devices to facilitate collusion; see, for instance, Charles A. Holt & David T. Scheffman, Facilitating Practices: The Effects of Advance Notice and Best-Price Provisions, 18 Rand J. Econ. 187 (1987), and cites therein. For alternative explanations, see Mulherin, *supra* note 5; and David A. Butz, Durable Good Monopoly and Best-Price Provisions, 80 Am. Econ. Rev. 1062 (1990).

[38] There are 7,620 possible combinations of the processes, factors, and other provisions listed in Table 1 alone.

[39] In twenty-seven of the contracts in our sample, the deregulation provision was added after the original contract was signed. In those cases, DURATION is the number of years remaining on the contract beyond the signature date of the deregulation provision.

[40] The size of take-or-pay obligations range from 0 to 100 percent of the stipulated contract maximum. For more detailed discussions of these provisions, see Scott E. Masten & Keith J. Crocker, Efficient Adaptation in Long-Term Contracts: Take-or-Pay Provisions for Natural Gas, 75 Am. Econ. Rev. 1083 (1985); Mulherin, *supra* note 5; and Scott E. Masten, Minimum Bill Contracts: Theory and Policy, 37 J. Indus. Econ. 85 (1988).

The lower the required take percentage, the more discretion buyers have over the quantity of gas exchanged, and, hence, the less restrictive is the contract in this regard.

Constructing a meaningful proxy for the uncertainty associated with a given transaction is problematic. On the surface, a measure of energy market volatility, such as the variance in oil prices around the date the contract was signed, would seem suitable. However, uncertainty of a type that a researcher can easily capture in an index could also be accounted for and incorporated in a contract by the parties themselves.[41] The uncertainty that poses the biggest hazard to contracting is specific to a particular transaction and therefore hard to quantify adequately with a statistic. Even though we include a variable, OILVAR, in the estimations to represent disturbances in energy markets generally (see Table 2), a finding that this type of uncertainty does not influence the choice between renegotiation and redetermination provisions would be consistent with the theory.[42]

Although relational contracting arguments offer no firm prediction regarding the effects of asset specificities on the adoption of renegotiation provisions, the importance of this variable in general discussions of relational contracting motivates its inclusion here as well. In gas transactions, asset specificities are primarily locational. Once in place, the immobility of pipelines and wells limits the ability of both producers and purchasers to seek alternative trading partners if the original partner were to behave opportunistically. The smaller the number of buyers and sellers in the immediate vicinity, the greater the hazards of ex post negotiation. Accordingly, our proxy for appropriable quasi rents, QUASIR, is inversely related to the number of buyers and sellers serving the field in which

[41] The fuel index to which prices in natural gas contracts are most commonly tied (see Table 1) is the BTU (British thermal unit) equivalent price of no. 2 or no. 6 fuel oil. In fact, the use of fuel indices is highly correlated with the level of energy market volatility measured by OILVAR, suggesting that indexing to oil prices is a useful way of adjusting gas rates when energy market volatility is a major source of uncertainty.

[42] This measure of uncertainty did not perform well in our earlier estimations of the determinants of contract length. See Crocker & Masten, *supra* note 10. A dummy variable representing discrete changes in the nature of energy markets following the oil embargo in 1973 had a more profound influence on contract duration but, because gas pipelines and producers did not begin to insert deregulation provisions regularly in contracts until around 1978, could not be used to estimate the structural equations in the present study. In their study of jet engine procurement, Keith Crocker and Kenneth Reynolds were able to develop a measure of engine-specific technological uncertainty and found that such uncertainty did result in the adoption of more flexible procurement contracts. See Keith J. Crocker & Kenneth J. Reynolds, The Efficiency of Incomplete Contracts: An Empirical Analysis of Air Force Engine Procurement (Working Paper No. 9-90-1, Pennsylvania State Univ., Dep't Economics 1990).

TABLE 2

DATA DEFINITIONS AND DESCRIPTIVE STATISTICS

| | Definition | Mean | Minimum | Maximum |
|---|---|---|---|---|
| RENEG | = 1 if renegotiation provision, = 0 if redetermination provision | .222 | 0 | 1 |
| BASEDON | = 1 if the adjustment process in the contract is "based on," = 0 otherwise | .222 | 0 | 1 |
| EQUALTO | = 1 if the adjustment process is "equal to," = 0 otherwise | .436 | 0 | 1 |
| HIGHEST | = 1 if the adjustment process is "highest of," = 0 otherwise | .286 | 0 | 1 |
| SELECBY | = 1 if the adjustment process is "select by seller," = 0 otherwise | .056 | 0 | 1 |
| DURATION | = the duration of the contract (in years) | 12.979 | 1 | 20 |
| TAKEPCT | = the contractually specified take percentage | 79.085 | 0 | 100 |
| QUASIR | = 1/[(the number of independent purchasers serving the field in which the well is drilled) × (the number of independent producers operating in the field)] | .199 | 0 | 1 |
| OILVAR | = the standard error of real oil prices over the eight quarters in and preceding the year in which the contract was written | .316 | 0 | 1.01 |
| REGCONST | = $p^* - \bar{p}$, if the price constraint is binding, where $p^*$ is the predicted unconstrained price and $\bar{p}$ the ceiling price; = 0 otherwise | 2.6614 | 0 | 7.48 |

the well is located and is constructed to reflect the hypothesis that each additional buyer or seller has a diminishing effect on the size of quasi rents at stake.[43]

[43] Thus, introducing an additional buyer or seller to a location where there are already one hundred transactors has less of an effect on quasi rents than doing so where there is just a single buyer and seller operating in a particular gas field.

We have argued elsewhere that drainage problems may also increase the potential for holdups in natural gas transactions; where a producer is exposed to the threat of drainage

Finally, our earlier research indicated that nonprice competition in response to price ceilings in place at the time the contract was written may influence other contract terms.[44] Again, although we have no specific hypothesis regarding how nonprice competition should affect the choice among price-adjustment provisions scheduled to apply *after* deregulation, we include the variable REGCONST as a measure of the degree to which the price constraint was binding at the time the contract was written in order to control for this possibility.[45]

In addition to the basic estimation, we perform two sets of corrections. Because contract duration and take percentages are endogenous contract terms,[46] we correct for the possibility of simultaneity bias by substituting predicted values, DURATION* and TAKEPCT*, from reduced-form estimations of these variables.[47] In addition, there is a potential selection bias associated with truncation of the sample for contracts whose lengths

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by other sellers operating in the same field, a purchaser might seek to force price concessions by delaying purchases from the producer. See Masten & Crocker, *supra* note 40; and Crocker & Masten, *supra* note 10. Additional variables included to reflect the extent of the drainage on the choice of adjustment process were, like QUASIR, insignificant and did not significantly influence other results.

[44] See Masten & Crocker, *supra* note 40; and Crocker & Masten, *supra* note 10.

[45] The extent to which price ceilings are binding depends on whether a particular transaction is subject to price constraints and the price that would obtain in the absence of a price ceiling. Since the latter is observable for those transactions where a price ceiling is not binding, it is possible to estimate unconstrained prices for all contracts as a function of characteristics of the transaction using Tobit estimation procedures. The estimated unconstrained price can then be compared to actual price ceilings to obtain a measure of the degree to which the ceilings are binding. See Masten & Crocker, *supra* note 40, for a formal description of the procedures used to estimate this variable. Because contract price is an endogenous variable, the price equation is estimated in reduced form. The independent variables employed in the estimations are listed in note 47 *infra*.

[46] More flexible contracts, for example, may induce the parties to adopt longer-term agreements.

[47] In addition to OILVAR and QUASIR, the regressors in these estimations included or were functions of the following variables: well depth; the number of purchasers serving the corresponding gas field; the number of producers operating in that field; a Herfindahl-numbers-equivalent measure of the concentration of pipelines serving each FERC gas region; gross national product in the year in which the contract was written; and dummy variables corresponding to gas regions, whether the purchaser was a gas pipeline company, and post–oil embargo and post-NGPA contracts. Because the reduced-form equations for these variables do not involve the adjustment process variables (which are endogenous to the system), we were able to estimate contract duration and take percentages using a larger sample than that used to estimate the structural equations in the text. In particular, because deregulation provisions appeared only in relatively recent vintage contracts, the expanded sample included many older vintage contracts, which permitted the use of the two era dummies described above in the reduced-form estimations. See note 42 *supra*. The exogenous variables listed above that do not appear in the process estimations, and that therefore identify the system, are significant beyond the $.1 \times 10^{-10}$ level in both the contract-duration and take-percent equations.

TABLE 3

PROBIT ESTIMATION OF ADJUSTMENT PROCESSES

Dependent Variable = 1 If Renegotiation Provision

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| CONSTANT | −2.85160 | −5.86105 | −5.55308 | −5.34007 |
| | (−5.169) | (−4.993) | (−4.519) | (−4.444) |
| QUASIR | .116193 | .0894184 | .250413 | .183061 |
| | (.353) | (.269) | (.723) | (.540) |
| OILVAR | −.610790 | −.220057 | −.525018 | −.456681 |
| | (−1.632) | (−.574) | (−1.259) | (−1.108) |
| DURATION | .0670760 | . . . | . . . | . . . |
| | (3.499) | | | |
| TAKEPCT | .0146802 | . . . | . . . | . . . |
| | (3.073) | | | |
| DURATION* | . . . | .0955810 | .0757232 | .0780524 |
| | | (3.298) | (2.250) | (2.366) |
| TAKEPCT* | . . . | .0440879 | .0476193 | .0411660 |
| | | (3.575) | (3.695) | (3.498) |
| REGCONST | .0703153 | −.0479919 | −.113803 | |
| | (.937) | (−.594) | (−1.313) | |
| *H* | . . . | . . . | −10.1294 | −9.16021 |
| | | | (−1.573) | (−1.376) |
| $\chi^2$ | 32.887 | 35.813 | 43.156 | 41.416 |
| df | 5 | 5 | 6 | 5 |

NOTE.—*t*-ratios are in parentheses.

were less than the date of the survey minus the date the contract was written. Estimations were also conducted including a variable, *H*, that corrects for this bias along lines first suggested by Heckman.[48]

Probit results of estimations of the use of renegotiation provisions are reported in Table 3.[49] The coefficients in column 1 are uncorrected for simultaneity and selection biases. Column 2 results have been corrected for simultaneity, and column 3 for both simultaneity and selectivity. Col-

[48] See James Heckman, Sample Selection Bias as a Specification Error, 47 Econometrica 153 (1979); and G. S. Maddala, Limited-Dependent and Qualitative Variables in Econometrics (1983), chs. 6 and 8. Specifically, $H = [(1/\sigma)g((L - \beta X)/\sigma)]/[1 - G((L - \beta X)/\sigma)]$, where $L$ = 1981 minus the year in which the contract was written, and $g$ and $G$ are the standard normal density and distribution functions with variance $\sigma^2$. Joskow faces the same selection problem. See Joskow, *supra* note 4. Note that the density in the numerator of Joskow's definition of $H$ should be $g(L - \beta X)$, as above.

[49] The estimations use RENEG as the dependent variable. The argument could be made that because "select by seller" provisions give some discretion to one of the parties to choose price, it is really more relational than the other redetermination processes. In addition to the probit estimations reported in Table 3 and the multinomial logit estimations described below, we also ran probit estimations combining "select by seller" and "based on" as the dependent variable. The results were not qualitatively affected by this change.

umn 4 reports the corrected results omitting REGCONST for comparison.

The results in all four equations are similar. The greater uncertainty associated with contracts of longer duration, for instance, appears to favor more flexible pricing. Specifically, the adoption of renegotiation provisions increases with the duration of natural gas contracts. Using column 3, the results indicate that, at the mean values of the right-hand-side variables, a one-year increase in contract length increases the probability of selecting renegotiation as the adjustment process by approximately three percentage points.

The results also support the predicted relationship between the use of renegotiation provisions and the size of take-or-pay percentages.[50] In all specifications of the equation, renegotiation provisions are significantly more likely to be adopted where quantity flexibility is limited. At the means, a percentage point decrease in take-or-pay obligations increases the probability of adopting redetermination provisions by about two points. Thus, the potential for mutually advantageous adjustments where quantity is variable appears to reduce the disadvantage of redetermination relative to renegotiation. Stated conversely, the flexibility of renegotiation provisions are more highly valued where quantity variation is limited. Notice that this contrasts with what would be expected if the role of prices in contracts were mainly to provide buyers with the incentive to choose quantity optimally.[51] In that case, price flexibility would be most important in variable-quantity contracts and would, in fact, serve no function at all in fixed-quantity agreements. The fact that price flexibility appears to be more important where take obligations are high thus supports the relational view of contracting in which process and evasion costs play a more central role.

Neither QUASIR nor OILVAR, however, has a significant effect on the choice of price-adjustment process.[52] Although previous research by Joskow and by ourselves indicates that the presence of asset specificities motivates the use of longer-term contracts, there is no indication here that the level of quasi rents influences the choice between redetermination and renegotiation provisions.[53] This result may reflect either: (1) the success of good faith requirements in attenuating opportunism or offsetting effects

[50] Both DURATION and TAKEPCT are obviously measured with greater precision than the characteristics proxied by QUASIR and OILVAR.

[51] See note 14 *supra*.

[52] There also appears to be no pronounced effect on the choice of adjustment mechanism to apply after deregulation resulting from the prior existence of price ceilings under regulation.

[53] Joskow, *supra* note 10, and Crocker & Masten, *supra* note 10.

of quasi rents on the costs of alternative adjustment processes as hypothesized earlier, or (2) simply the poor quality of the available proxies. And while the theory unambiguously predicts greater reliance on renegotiation provisions the greater the level of uncertainty associated with a transaction, the type of general market uncertainty measured by OILVAR would be easy to account for in a contract and thus should not greatly impair the efficiency of redetermination relative to renegotiation.

Such easily quantifiable uncertainty should, however, influence the frequency with which price adjustments occur. Although indexing can accommodate most measurable variations in the surrounding environment, all contracts are fixed-price contracts over the intervals between adjustments. Since fixed-price contracts do not account even for generic uncertainty, the hazards of lengthening the period between adjustments should rise with measurable changes in market volatility. More generally, we would expect contractors to choose the frequency with which they schedule adjustments to balance the expense of implementing each adjustment against the increasing likelihood that interim prices will become incompatible with the surrounding conditions as the period between adjustments lengthens. Because renegotiated adjustments are more expensive to execute than formulaic changes, we would expect renegotiations to be scheduled at greater intervals. More uncertainty, meanwhile, should raise the expected costs of delaying adaptations in either contract type and therefore lead to more frequent adjustments.

Information on the frequency of adjustments was available for 214 of the observations in the preceding sample, with scheduled frequencies distributed among five categories as follows: less than one year (33), annually (100), biennially (44), three to five years (20), and more than five years (17). The following results from an ordered probit estimation on these five categories reveal significant correlations between the frequency of adjustment and both the adjustment process and the level of general energy market volatility:[54]

$$\begin{aligned}\text{frequency of adjustment} = {} & 1.61170 + .283574^{*}\text{QUASIR} \\ & \quad (4.706) \quad (.995) \\ & + 2.63896^{*}\text{OILVAR} - .01184^{*}\text{DURATION} \\ & \quad (6.960) \quad (-.793) \\ & - .00172^{*}\text{TAKEPCT} - 1.11108^{*}\text{RENEG.} \\ & \quad (-.555) \quad (-4.347)\end{aligned}$$

[54] For discussions of ordered response models like ordered probit, see Takeshi Amemiya, Advanced Econometrics (1985); or Maddala, *supra* note 48. The categories are ordered from lowest to highest frequency of adjustment; *t*-ratios are in parentheses. Results using predicted values of DURATION, TAKEPCT, and RENEG were consistent with those reported.

TABLE 4

ESTIMATED FREQUENCIES OF PRICE ADJUSTMENTS

| | ADJUSTMENT FREQUENCIES (by Years) | | | | |
|---|---|---|---|---|---|
| | >5 | 3–5 | 2 | 1 | <1 |
| OILVAR = .311: | | | | | |
| Redetermination | .01 | .05 | .19 | .64 | .11 |
| Renegotiation | .14 | .19 | .34 | .32 | .01 |
| OILVAR = .610: | | | | | |
| Redetermination | .00 | .01 | .06 | .60 | .33 |
| Renegotiation | .03 | .08 | .26 | .57 | .06 |

Table 4 reports estimated probabilities of choosing each of the frequency categories for redetermination (RENEG = 0) and renegotiation (RENEG = 1) provisions using the preceding equation. In the top half of the table, the probabilities are evaluated at the mean values of each of the variables other than RENEG. In the bottom half, the probabilities were recalculated using a value of OILVAR one standard deviation above the mean. These OILVAR values correspond roughly to the values of this variable in 1975 and 1980, respectively. At the initial value of OILVAR, the distribution of redetermination frequencies is centered around annual adjustments, with three-quarters of the contracts predicted to adjust prices at intervals of one year or less. The distribution for renegotiation provisions, in contrast, centers around biennial revisions, with adjustments predicted to occur with a frequency of one year or less in only a third of the agreements. Both distributions shift toward more frequent modifications following periods of increased energy market volatility, however, with adjustments scheduled at intervals of one year or less rising to 94 percent of redetermination contracts and 63 percent of renegotiation contracts. Other variables, included as controls, show no significant affect.

Thus, overall, the process and frequency of price adjustment chosen by transactors in natural gas contracts are consistent with the magnitude and incidence of costs hypothesized earlier. In particular, the frequency-of-adjustment estimations provide evidence that renegotiation is a more costly way to effect price changes than is redetermination. This cost is overcome, however, as the relative inflexibility of redetermination provisions becomes more burdensome. The latter is likely to occur, in turn, where the duration of the contract is long (hence, uncertainty about the costs of future performance great) and quantity flexibility (and the corresponding prospect of reaching mutually advantageous modifications) limited, as the process choice estimations attest. Finally, general market uncertainty appears to affect the frequency but not the process by which

prices get adjusted, a finding consistent with the proposition that only uncertainty that is relationship specific and noncontractible undermines the performance of redetermination processes.

### C. *Multinomial Logit Estimations of Process Selection*

An alternative way of estimating the process selection decision that makes use of more information is to partition the sample by the four adjustment processes: "equal to," "highest of," "selected by seller," and "based on." Both "equal to" and "highest of" use relatively mechanical formulae for determining price and are in that regard the least relational of the processes, other things being the same. At the other extreme, "based on" merely sets a reference point—in the majority of cases, just market factors—for negotiations and is thus the most relational.

By conferring discretion over price to the seller, the final category, "select by seller," offers a greater degree of flexibility than either "equal to" or "highest of" provisions. But the seller's power to select price also affords him considerable control over the distribution of rents. As a result, "select by seller" contracts usually restrict the set of prices from which the seller may choose. Furthermore, whereas price changes in fixed-quantity contracts have a zero-sum nature, the buyer's ability to withhold purchases in variable quantity agreements would tend to constrain seller opportunism and introduce the prospect of mutually beneficial modifications. Hence, other things being the same, we would expect "select by seller" processes to be more common in long-term but *low*-take requirement contracts.

Results of multinomial logit estimations on these four processes are reported in Table 5.[55] Note that BASEDON is the omitted category so

[55] If we assume that transactors wish to maximize the net benefits from exchange, the choice among adjustment processes becomes a straightforward application of McFadden's random utility model, for which multinomial logit is a standard estimation procedure. See Daniel McFadden, Conditional Logit Analysis of Qualitative Choice Behavior, in Frontiers in Econometrics 105 (Paul Zarembka ed. 1974). Although the apparent ordering of adjustment processes in terms of their flexibility might suggest application of an ordered response model, such models require that the categories representing the dependent variable be logically and consistently ranked with respect to a single latent index. See Amemiya, *supra* note 54, at 292. The choice among adjustment processes, however, involves trade-offs in multiple dimensions; transactors, for example, care not only about the responsiveness of adjustment processes to changes in the surrounding environment but the degree to which contracts deter opportunism as well. Thus, higher take percentages raise the value of price flexibility, which should increase the use of more flexible processes like "select by seller" and "based on," but also increase the relative costs of implementing "select by seller" processes by expanding the scope for seller opportunism. Where there are reasons to suspect that the logical requirements are violated, "[w]e should be cautious in using an ordered

TABLE 5

MULTINOMIAL LOGIT ESTIMATION OF ADJUSTMENT PROCESSES

| | Equal to | Highest of | Selected by Seller |
|---|---|---|---|
| CONSTANT | 13.1560 | 15.1251 | 12.8149 |
| | (3.747) | (4.221) | (3.222) |
| QUASIR | −.340730 | −.304543 | −.633058 |
| | (−.524) | (−.429) | (−.545) |
| OILVAR | −.138487 | .797736 | 1.05796 |
| | (−.172) | (.952) | (.926) |
| DURATION* | −.118348 | −.189396 | −.124344 |
| | (−1.963) | (−2.690) | (−1.231) |
| TAKEPCT* | −.130374 | −.141549 | −.15049 |
| | (−3.605) | (−3.826) | (−3.736) |
| REGCONST | .352129 | .0338269 | .224031 |
| | (2.128) | (.189) | (.857) |
| *H* | 17.7407 | 16.0577 | 19.9631 |
| | (1.484) | (1.331) | (1.608) |
| | | $\chi^2 = 71.009$ | |
| | | df = 18 | |

NOTE.—The omitted category is "based on"; *t*-ratios are in parentheses.

that the coefficients reflect the effect that each of the right-hand-side variables has on the probability that a particular adjustment process will be adopted relative to BASEDON.

The coefficients on DURATION and TAKEPCT are again all of the correct sign and, with the exception of the coefficient on DURATION for the category SELECBY, significant beyond the .05 level. However, none of the three included processes differ significantly *from each other* with respect to these two variables. In addition, as in the probit equations, neither QUASIR nor OILVAR contribute to our ability to distinguish among the categories, except for weak evidence that increasing

model because if the true model is unordered, an ordered model can lead to serious biases in the estimation of the probabilities. On the other hand, the cost of using an unordered model, when the true model is ordered, is a loss of efficiency rather than consistency" (*id.* at 293). Nevertheless, the following results from an ordered probit estimation of the categories ranked from least ("equal to") to most flexible ("based on") are presented by comparison and are consistent with the probit results reported in Table 3:

$$\text{adjustment process} = \underset{(-1.877)}{-1.22480} \underset{(-.053)}{-.013548}\text{*QUASIR} + \underset{(.149)}{.045687}\text{*OILVAR} + \underset{(1.793)}{.040834}\text{*DURATION*} + \underset{(2.037)}{.013676}\text{*TAKEPCT*} \underset{(-1.616)}{-.114668}\text{*REGCONST} \underset{(-1.184)}{-1.74285}\text{*}H.$$

energy market volatility led to the adoption of more "highest of" processes relative to "equal to" processes (the hypothesis that the coefficients on OILVAR for "highest of" and "equal to" are the same can be rejected at the 10 percent level in a one-tail test).[56] Finally, the results indicate that "equal to" is more likely to be chosen than "highest of" or "based on" the larger REGCONST.

Table 6 presents estimated probabilities of adopting each of the adjustment processes for alternative take percentages and contract durations based on the estimates reported in Table 5. The first row reports the probabilities evaluated at the means of each of the independent variables. In the remaining rows, the probabilities associated with selected values of the indicated variables (and the mean values of the other independent variables) are presented. As indicated by the table, the relative probabilities vary in directions consistent with our hypotheses. Specifically, the probability of using "based on" increases for long-term and high-take percentage contracts. For twenty-year, 100 percent take-or-pay agreements, that probability becomes 66 percent. Transactors are more likely, however, to let the seller choose price in long-term but low-take percentage contracts. Although the estimated probabilities remain small, a twenty-year contract with zero-take percent has a 25 percent probability of using "select by seller" as the adjustment process. The probability of adopting "highest of," in comparison, declines as contract length and quantity restrictions rise, reaching its maximum of 68 percent for single-year, variable-quantity agreements. The estimated probabilities for "equal to" *relative* to "based on" also move in the predicted direction, rising for short-term and low-take percentage agreements.

Overall, the results do not suggest much of a basis for distinguishing between "equal to" and "highest of" provisions in process terms. Although the relative probabilities suggest that the implicit costs of "highest of" provisions rise more rapidly with contract length and quantity restrictions than do those of "equal to" provisions, the differences are not statistically significant. The results, however, support the claim that the hazards of both should rise more rapidly than those of renegotiation provisions. Permitting the seller to choose price, meanwhile, appears intermediate between these extremes in the sense that this process is neither significantly inferior to explicit renegotiation in dealing with the uncertainty associated with longer-term contracts nor substantially better in this regard than the more mechanical processes of "equal to" and "highest of." But the infrequency with which "select by seller" is chosen in

[56] "Highest of" contracts are also more likely than "equal to" contracts to contain a fuel index provision. See Table 1.

TABLE 6

ESTIMATED PROBABILITIES FOR SELECTED VALUES OF DURATION AND TAKE PERCENTS

| | Equal to | Highest of | Selected by Seller | Based on |
|---|---|---|---|---|
| At mean values of all variables | .514 | .303 | .060 | .123 |
| DURATION: | | | | |
| = 20 | .497 | .181 | .056 | .266 |
| = 1 | .387 | .542 | .049 | .022 |
| TAKEPCT: | | | | |
| = 100 | .353 | .181 | .032 | .434 |
| = 0 | .308 | .483 | .210 | <.0001 |

practice suggests that the hazards of assigning price discretion to a single party are large in most settings. And although the likelihood of adopting "select by seller" increases the more power afforded the buyer to mitigate seller opportunism through quantity variations, the uniformly low estimated probabilities for this category indicate that other concerns not addressed in this article also play a role in the decision to adopt this process.

## V. CONCLUSIONS

The terms on which parties actually trade in contractual relationships do not, like Athena, spring full-blown from the brow of Zeus. Ultimately, they are the outcome of a process of negotiations guided broadly by the rules set out in the contract and by the applicable law. Occasionally, the contract is so clear and the law so obvious that application of the contract is virtually automatic. But frequently the contract or the law is vague and the responsibilities of the parties ambiguous, leaving ample room for opportunistic behavior. Such imprecision, moreover, is often intentional. Transactors deliberately adopt terms like "good faith" and "best efforts" to describe their obligations under contractual agreements.

In light of these facts, it seems more appropriate to view contracts as means of establishing procedures for adapting exchange and resolving disputes rather than purely as incentive mechanisms. Whereas economic theory normally treats contract price as firm once chosen, the relational contracting approach regards contractually stipulated prices as little more than starting points for future negotiations. Thus, purchase decisions are made not just in response to price signals in the contract but also for any effect they might have in eliciting a more favorable price. The more precise the contract, the more secure the agreement. But some scope for opportunism inevitably remains, and the problem for transactors be-

comes devising agreements flexible enough to permit rent-increasing adaptations but rigid enough to deter rent-dissipating efforts to reallocate contractual surpluses.

In this article, we have applied relational contracting theory to analyze the processes by which parties adjust prices in long-term relationships and to conduct some preliminary tests of propositions derived from that literature. Generally, the theory predicts that transactors will value flexible arrangements most highly where uncertainty about circumstances at the time of performance is greatest. Conversely, environments where opportunism is expected to be rife or where economic conditions are relatively simple and static will tend to favor more precise but rigid agreements.

Our findings indicate that price adjustment processes tend to be more flexible the longer the duration of the contract, presumably reflecting the greater uncertainty associated with performance at more remote dates. Transactors, meanwhile, appear more willing to adopt mechanical pricing arrangements where contracts allow flexibility in other dimensions such as quantity, a finding consistent with the proposition that evasion costs will be lower where the possibility exists of realizing mutually advantageous modifications in price and other aspects of performance. We did not, however, find any evidence that a higher level of appropriable quasi rents favors redetermination over renegotiation independent of its effect on contract length—a result that may reflect the relative ease of formulating satisfactory adjustment formulae where there exists a significant number of similar transactions. The difficulty of constructing a satisfactory measure of quasi rents using our data, however, leaves this proposition open to future investigation.

Finally, as one might expect, market volatility that is easily quantified does not appear to undermine the efficiency of formulaic price-adjustment processes relative to renegotiation. Increases in generic uncertainty do, however, increase the frequency with which parties schedule price adjustments. Furthermore, the interval between adjustments tends to be greater in contracts containing renegotiation rather than redetermination provisions, which is consistent with the higher costs of implementing negotiated price changes.

The tendency for conventional economic theory to treat contract execution in a mechanical fashion stems in part from a failure to appreciate the richness of real-world contractual relationships and the laws that govern them. The evidence provided here suggests that an approach oriented more toward contracting as a process can be useful in explaining at least some of that diversity. At a minimum, it poses a challenge to economists to account for and explain a widely used class of contracts in which

performance is often only vaguely circumscribed by the terms of the agreement.

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