# NATURAL GAS CONTRACT PERIODIC PRICE REDETERMINATIONS: A STATISTICAL METHODOLOGY WITH PRELIMINARY EMPIRICAL RESULTS

Al H. Ringleb\* Frances L. Edwards\*\* Michael W. Pustay\*\*\*

## I. INTRODUCTION<sup>1</sup>

In this article, we are concerned with the enforcement of those natural gas purchase contracts calling for periodic price redeterminations.<sup>2</sup> The redetermination clause of particular interest here calls for the contract price to be adjusted periodically by equating it to "the average of the three [two] highest-priced contracts of *comparable* terms and conditions within the production area."<sup>3</sup> In the majority of such redeterminations, comparability of terms and conditions is established by an agreement among the parties after they have selected jointly three contracts deemed to be comparable.

In cases where the parties disagree as to the comparability of any three contracts, and litigation ensues, comparability is established subjectively using anecdotes referencing contracts for natural gas supplies of similar depth and vintage within the area. Such an anecdotal resolution to the assessment of contract comparability, however, relies on the competing *subjective* opinions of "industry experts." Moreover, the theoretical basis for assessing comparability anecdotally is deficient, if not nonexistent.

Here, we assert that comparability can be much more accurately and

\*\*\* Ph.D. (Economics), Yale University, 1973. Professor, College of Business Administration, Department of Management, Business, Public Policy, and Law Group, Texas A&M University.

<sup>\*</sup> Ph.D. (Economics), Kansas State University, 1980; J.D., University of Kansas, 1981; Professor of Law and Economics, Department of Law and Economics, College of Commerce and Industry, Clemson University. This article is based upon ongoing research. Support for this research by the Center for Energy and Mineral Resources, Texas A&M University, is gratefully acknowledged. Helpful comments were provided by an anonymous referee, numerous colleagues at Clemson University, Richard J. Pierce, Jr. and Steven N. Wiggins. Special thanks go to Mr. Richard Arbaugh and Mr. Allen Weed for their assistance on this project.

<sup>\*\*</sup> J.D., University of Kansas, 1980. Associate Professor, Department of Law and Economics, College of Commerce and Industry, Clemson University.

<sup>1. &</sup>quot;Contracts will not determine the price of gas. The market value of gas, rather, will determine which contracts will be honored, which contracts will be renegotiated, and which will be repudiated with impunity." Tussing & Barlow, *The Rise and Fall of Regulation in the Natural Gas Industry*, 109 PUB. UTIL. FORT., Mar. 4, 1982, at 18.

<sup>2.</sup> For a general discussion of price redetermination clauses, see E. NEUNER, THE NATURAL GAS INDUSTRY 100-07 (1960).

<sup>3.</sup> Such a clause is referred to as a "three (or third) party favored nations clause." See E. NEUNER, supra note 2, at 91; Pierce, Natural Gas Regulation, Deregulation, and Contracts, 68 VA. L. REV. 63, 80-81 (1982).

objectively assessed through the use of a standard statistical technique. Using a *hedonic multiple regression analysis*, the parties can attach the appropriate "economic (or commercial) weights" to each important natural gas contract clause. Comparability is then measured by undertaking a statistical comparison of the generated *hedonic* prices for the contracts in question. If the hedonic prices of two contracts are found to be similar statistically, then the comparability of those contracts is established. In contrast, if the hedonic prices are dissimilar statistically, the contracts are not found to be comparable in their terms and conditions. Thus, comparability is established *objectively* through a statistical analysis as opposed to the subjective methods of determination currently employed to resolve such disputes.

In addition to its applications in establishing comparability among contracts subject to the price redetermination clause of interest here, this hedonic technique also provides a theoretical and empirical foundation for the design, implementation, and enforcement of comparability clauses in future natural gas and other long-term natural resource purchase contracts. While a number of pipelines have relied heavily on spot contracts for their more recent purchases of natural gas, many pipelines are returning, or planning to return, to more traditional, longer-term contracts. Although a majority of those purchase contracts are presently tying price redeterminations to selected indices-for example, a percentage of no. 6 fuel oil-many include "modified" comparability clauses. Those comparability clauses are a manifestation of buyer and seller efforts to more accurately reflect existing market conditions in purchase contracts through the price redetermination process. For example, several pipelines require that the three comparable contracts must have been negotiated within a specified and limited time period. Others provide that the price redetermination process may be initiated by either party at any time. Given its objective, statistical properties, the hedonic pricing technique described herein could be specified in the contract as the methodology for establishing comparability among such contracts. While such important applications are beyond the scope of this article, they are the subject of considerable ongoing natural gas contract formation and enforcement research.

The article begins in section II with a discussion of the redetermination process and the current subjective methodology used to assess contract comparability in the natural gas industry. The basic theory and conceptual framework for the use of hedonic pricing in measuring comparability is presented in section III. Section IV discusses the database used in the analysis, applies the hedonic technique developed in section III to that database, and then presents preliminary empirical evidence on the application of the hedonic technique in comparing natural gas contracts subject to the redetermination process discussed in section II. The empirical evidence demonstrates that while a number of the generalizations used by industry experts in assessing contract comparability subjectively may be accurate in *isolated* cases, the hedonic approach is far superior in the *global* assessment of contract comparability required under the typical price redetermination clause. The hedonic technique allows the analyst to establish the overall value of a particular clause to the parties, and to account for important interactive effects among those 1989]

clauses. The technique thus provides a superior methodology for assessing comparability, and for assessing the viability of comparability and other clauses in future natural gas and other natural resource purchase contracts in both the drafting and enforcement stages.

### II. THE REDETERMINATION PROCESS: EXISTING METHODOLOGY

The redetermination clause at the focus of this article calls for the buyer (pipeline) to pay the seller (producer) "the average of the three highest-price contracts under comparable terms and conditions within the area." For purposes of illustration, consider the following typical price redetermination clause:

Within thirty (30) days following the effective date of the deregulation of the price for natural gas to be sold and delivered hereunder in accordance with the provisions of the Natural Gas Policy Act of 1978, and thereafter within thirty (30) days following each anniversary date of such deregulation, representatives of Buyer and Seller shall redetermine the price payable for natural gas hereunder to equal the arithmetic average of the three (3) highest prices then being paid by recognized natural gas pipeline companies for natural gas of *comparable* terms and conditions in the area.<sup>4</sup>

This clause was largely viewed as necessary by the seller, and as unobjectionable by the buyer, in a market where steady price increases had long been the norm. Under market conditions experienced more recently, the clause provided the buyer with little downward contract price flexibility. Furthermore, to the extent that at least three other gas purchase contracts within the area contained this clause and provided the existing contract price or better, the established contract price could arguably prevail until the natural gas dedicated to the contract is exhausted or the buyer goes bankrupt as long as there is no other market price adjustment clause in those contracts, renegotiation by the parties, or major regulatory intervention. Contracts containing specific provisions that prohibit any downward price adjustment further exacerbate this problem.

Thus, given the dramatic decline in natural gas prices experienced by the industry after 1981,<sup>5</sup> it was not surprising that buyers resisted the contractprice rigidity redetermination clauses imposed, particularly in periodic price redeterminations of high-cost gas contracts. In those cases where sellers were unwilling to renegotiate, buyers attempted to readjust contract prices through a variety of means.<sup>6</sup> In most instances, those attempts prompted the seller to

6. In the majority of cases, pipeline efforts to adjust contract prices involved ordinary contract amendments. See Amoco Trims Pipeline's Take or Pay Obligation, 81 OIL & GAS J., April 25, 1983, at 69 (producer agreed to reduce take-or-pay provisions for high-cost gas sold to Northern Central Pipeline Corporation from 90% of contract volumes to 50% during 1983 and to 60% during 1984); Columbia, Mich Wis Reduce Natural Gas Prices, 81 OIL & GAS J., Oct. 24, 1983, at 52 (Columbia Gas Transmission Corporation renegotiated lower prices for about 75% of the high-cost gas it buys from unaffiliated

<sup>4.</sup> This clause was taken from a contract in our data base. The emphasis is ours.

<sup>5.</sup> According to the court in *Gulf Oil Corp. v. Tenneco*, "[c]ontributing to the [industry's] ... problems were the economic recession of 1981-82, the market distortions caused by the ... Natural Gas Policy Act of 1978..., the world-wide glut of crude oil, which resulted in a drop in the price of this competing fuel, and the extremely mild 1982-83 heating season ...." Gulf Oil Corp. v. Tenneco, 608 F. Supp. 1493, 1495 (E.D. La. 1985).

assert contract breach on the part of the buyer and to bring a legal action to enforce the contract's provisions. While a number of arguments in defense of such a breach were asserted, largely unsuccessfully,<sup>7</sup> several buyers argued that the contracts proffered by the seller to satisfy the redetermination requirements were not comparable in their terms and conditions.

In those instances where the parties disagreed on comparability, and took the issue to litigation for resolution, evidence on comparability was presented through expert testimony. Expert witnesses for sellers generally asserted that based on their years of experience in industry contractual practices, the contracts were comparable in their terms and conditions; the experts for buyers asserted the contrary in similar fashion. The analysis offered by both parties, however, was often subjective and anecdotal, lacking in any formal, statistically-based approach or technique. Consider, for example, the following interchange between a seller's expert witness and the attorney representing the buyer:

Producers and pipelines have a joint incentive to minimize the costs that result from disruptions in the relationship. If contractual disputes block the flow of gas, pipeline deliveries may be upset and producers may face a possible loss of their leasehold interest in the producing property. Such leases may be cancelled if the lessee-producer violates his obligation to produce from the well. See R. HEMMINGWAY, THE LAW OF OIL AND GAS 393-401 (1971). Also, there may be no alternative outlet for the producer's gas if the relationship is disturbed.

Some pipelines resorted to such extraordinary measures as unilateral market-outs. See Forest Oil Corp. v. Tenneco, Inc., 626 F. Supp. 917 (S.D. Miss. 1986) (describing Tenneco's actions in late 1982 as the pipeline attempted to adjust its severe supply/demand imbalance). Regarding unilateral price reductions. Tenneco, in 1983, announced its "emergency gas purchase policy." Under that policy, the company either "suspended or construed in its favor contractual provisions concerning price, deliveries, take-or-pay, nomination of gas categories, and other related matters." *Id.* at 920. Regarding coercive renegotiations, the court in *Garshman v. Universal Resources Holding, Inc.*, stated:

Columbia [Gas Transmission Corporation] sought to renegotiate the prices it paid to producers ... in order to bring ... prices in line with market levels. Columbia allegedly coerced producers into renegotiating price terms by threatening that it would not assign leases for future exploration to producers who did not renegotiate existing contracts. Columbia allegedly threatened to curtail the amount of gas it took from those producers by cutting production allocation and manipulating pressure in the pipeline. In other words, Columbia allegedly threatened to refuse to deal in the future with producers who failed to comply with its present demands.

Garshman v. Universal Resources Holding, Inc., 625 F. Supp. 737, 740 (D.N.J. 1986).

7. In defending their breach, pipelines have asserted force majeure. See, e.g., International Minerals & Chem. Corp. v. Llano, Inc., 770 F.2d 879 (10th Cir. 1985), cert. denied 475 U.S. 1015 (1986); Resource Inv. Corp. v. Enron Corp., 669 F. Supp. 1038 (D. Colo. 1987); Exxon Corp. v. Columbia Gas Transm'n Corp., 624 F. Supp. 610 (W.D. La. 1985); Sid Richardson Carbon & Gasoline Co. v. InterNorth, Inc., 595 F. Supp. 497 (N.D. Tex. 1984); Kaiser-Francis Oil Co. v. Producer's Gas Co., No. 83-C-400-B (N.D. Okla. June 19, 1983). Regarding impossibility, see, e.g., Universal Resources Corp. v. Panhandle E. Pipe Line Co., 813 F.2d 77 (5th Cir. 1987); International Minerals, 770 F.2d at 879; Resource Investment, 669 F. Supp. at 1038. Regarding unconscionability, see, e.g., Resource Investment, 669 F. Supp. at 1038. Regarding public policy arguments, see, e.g., Koch Indus., Inc. v. Columbia Gas Transm'n Corp., No. 83-990-A (M.D. La. Mar. 14, 1985); Sid Richardson, 595 F. Supp. at 497; Southport Expl'n Inc. v. Producer's Gas Co., No. 83-C-550-B (N.D. Okla. June 1, 1984); Kaiser-Francis Oil Co. v. Producer's Gas Co., No. 83-C-400-B (N.D. Okla. June 1, 1984); Kaiser-Francis Oil Co. v. Producer's Gas Co., No. 83-C-400-B (N.D. Okla. June 1, 1984); Kaiser-Francis Oil Co. v. Producer's Gas Co., No. 83-C-400-B (N.D. Okla. June 1, 1983).

producers in the Appalachian basin); *Transco, Producers Renegotiate Natural Gas Contracts*, 81 OIL & GAS. J., Dec. 5, 1983, at 76 (more than 100 producers have accepted lower prices for natural gas and waived all or part of past take-or-pay claims against Transcontinental Gas Pipe Line Corporation).

#### On methodology:

- Q: What analysis did you go through to determine the comparability of these contracts?
- A: I depend on a knowledge or experience of having worked with gas contracts over a period of five years and in my judgment these contracts are comparable.
- Q: Did you analyze them in depth?
- A: No.
- Q: It's just kind of a gut feeling, is that correct?
- A: No. I think it's a studied, reasoned feeling of looking at contracts, being familiar with what the contracts contain.
- Q: But you didn't familiarize yourself with every term and condition in the contract before you made that determination?
- A: No. I look at the purchaser, whether it is an interstate or intrastate pipeline, date, vintage, pricing provisions, tax provisions, and the existence of any amendments.

#### On the redetermination process:

- Q: In your judgment is a contract containing an annual redetermination clause comparable to one containing a bi-annual redetermination clause?
- A: I think that by comparison to the general types of contracts we saw prior to 1980, I think they are comparable.
- Q: Whether the contracts call for a redetermination every year or every five years, they are comparable?
- A: Yes, I think they are because they tried to set the contract price on a fixed time interval.
- Q: If those are all comparable, why do you even look to that part of the contract to determine comparability?
- A: Just as a matter of information.
- Q: Are contracts that are only redeterminable at the option of one party comparable to contracts providing both parties with the option?
- A: Yes, I think they are comparable.

#### On the contract term:

- Q: Is a five-year contract comparable to a ten, fifteen, or twenty-year contract?
- A: I think they are comparable.

On the existence of a market-out clause:

- Q: Do you consider contracts that have a market-out clause to be comparable to a contract that doesn't have one?
- A: They are comparable, but less comparable than if both contracts had the clause or did not have the clause.

As the excerpt illustrates, the methodology employed is largely subjective, with inferences based solely on experience in the industry. The sheer complexity of the comparability question forces the expert to concentrate on certain clauses, ignoring the potential interactions of those and other important clauses. Judgments on the comparability of specific clauses are purely anecdotal, with little reference to the potential consequences of changed market conditions.

# III. THE BASIC THEORY AND APPLICATION OF HEDONIC PRICING ANALYSIS

In an effort to provide a more objective, statistical assessment of contract comparability, the formal model suggested here is a *hedonic pricing technique*. The statistical tool employed to facilitate the application of this technique is multiple regression analysis. In contrast to the intuitive or subjective models being used currently to establish contract comparability, hedonic analysis can establish comparability much more objectively.

More specifically, the model allows for a more global consideration of the important interrelationships among and between the clauses that affect natural gas prices through the contracting process. Because of their complexity, these latter considerations remain largely ignored in current applications of the subjective models. The parties, for example, may have included a certain clause which by itself appears to be detrimental to the buyer. A more formal examination of the entire contract, however, may reveal that although the buyer accepted the seeming detrimental clause, he recouped a significant portion of the potential loss by requiring the seller to either accept another clause(s) or modify an existing clause(s) in the buyer's favor.

In a competitive market, all things being equal, a comparison of a "standard contract" for the period and another contract containing such seeming detrimental clauses, with both having been negotiated at about the same time, would likely not find a significant difference in their initial negotiated contract prices. In subsequent periods, an informal, intuitive examination of the two contracts to establish comparability, particularly if the methodology employed relied heavily in some way on similarity in initial contract prices, would likely conclude that they are comparable in their terms and conditions regardless of existing market conditions. A formal statistical analysis, however, would reveal the underlying interrelational differences. Depending upon the market conditions under which the contracts were to be compared, the analyst may find that they are or are not comparable. A hedonic pricing technique is a formal model that allows the analyst to make this more accurate, objective assessment.

## A. The Theory of Hedonic Pricing

The underlying theory of hedonic<sup>8</sup> pricing originated with Professor Lancaster's insight that a buyer does not simply buy a product per se.<sup>9</sup> Rather, buyers perceive that a product possesses certain characteristics or attributes, and it is actually those attributes that buyers wish to acquire.<sup>10</sup> Those impor-

10. For research predating Lancaster on these points, see Morishima, The Problem of Intrinsic

<sup>8.</sup> The term hedonic is drawn from the Greek word *hedone*, meaning "pleasure." See WEBSTER'S NEW WORLD DICTIONARY 648 (2d college ed. 1980).

<sup>9.</sup> Lancaster, A New Approach to Consumer Theory, 74 J. OF POL. ECON. 132 (1966). The existing theory had assumed that goods are the direct objects of utility. It had ignored the relevance of the intrinsic properties of goods as the mechanism for creating demand for the goods. It also had particular difficulties in directly predicting consumer responses to new commodities and to quality changes in existing commodities. Lancaster's approach, in contrast, focused explicitly on the characteristics of individual goods and on the ability of different goods to supply consumers with a given characteristic.

tant attributes may include, among other things, the product's physical appearance, its performance capabilities, and, for some products such as housing, even the surroundings in which the product is set.<sup>11</sup> Through the use of hedonic pricing analysis, an analyst is able to estimate objectively the *marginal contribution* each such attribute makes toward the price of the product. That determination is important in that those marginal contributions, or attribute "prices," are not otherwise determined explicitly in any marketplace.<sup>12</sup>

Hedonic pricing techniques have been used by analysts to measure and account explicitly for a wide variety of product attributes. To illustrate, suppose that an analyst wants to evaluate the value to buyers of an automatic cold-water dispenser bought as part of a normal household refrigerator. It is not possible to simply buy an automatic cold-water dispenser without buying some other set of features, for example, the freezer section, the refrigeration unit, the doors of the refrigerator, the compressor, and the other components of the standard refrigerator. Through hedonic pricing techniques, the market value of each important feature or attribute can be estimated. In this way, the value of an individual feature or attribute for which there exists no explicit market (here, for example, no explicit market exists for the cold-water dispenser individually) can be assessed even though the buyer must buy that feature or attribute as part of a bundled package (the product). In this same manner, hedonic price analysis can be used to value each component of a natural gas purchase contract, including, among others, its term, take-or-pay clause, and the nature of any price or price adjustment clauses.

In mathematical notation, hedonic pricing theory provides that the price (P) of a product can be determined by examining the functional relationship (f(X)) among and between the product's components and attributes;<sup>13</sup> that is,

$$(1) P = f(X_b, X_b, X_b, \dots, X_n)$$

Complementarity and Separability of Goods, 11 METROECONOMICA 187 (1959); Strotz, The Empirical Implications of a Utility Tree, 25 ECONOMETRICA 269 (1957).

11. See, e.g., Goodman, Hedonic Prices, Price Indices, and Housing Markets, 5 J. OF URBAN ECON. 471 (1978) (finding that physical improvements to property yield larger increases in property valuation in the suburbs than in the central city); Linneman, Some Empirical Results on the Nature of the Hedonic Price Function for the Urban Housing Market, 8 J. OF URBAN ECON. 47 (1980) (finding that neighborhoodspecific traits caused differences in valuations between structurally identical sites of up to 100%); McMillan, Reid & Gillen, An Extension of the Hedonic Approach for Estimating the Value of Quiet, 56 LAND ECON. 315 (1980).

12. Hedonic pricing analysis was initially utilized as a technique to overcome the failure of government price indexes to properly correct for changes in the quality of goods. Construction of a price index for a simple good such as durum wheat is simpler than construction of an index for a complex good such as an airplane. To construct a price index for durum wheat, one must measure the prices charged for a bushel of durum wheat over time, holding relatively few features of the wheat constant, such as, its quality, moisture content, and point of delivery. Construction of a price index for airplanes is much more difficult. Significant differences exist in the characteristics of airplanes at any one point in time and over time. Because of technological change, the features contained in airplanes in one time period may not exist in other time periods, thus complicating the construction of a price index. See E. HOFSTEN, PRICE INDEXES AND QUALITY CHANGES (1952); E. HOFSTEN, QUANTITY AND PRICE INDEXES IN NATIONAL ACCOUNTS (1956).

13. For a similar theoretical development, see White, Quality Variation When Prices Are Regulated, 3 BELL J. OF ECON. & MGMT. SCI. 425 (1972).

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where  $X_1$  through  $X_n$  summarize and represent those product components and attributes affecting the buyer's economic evaluation of the product. For example,  $X_1$  may measure the product's performance capabilities,  $X_2$ , its energy efficiency, and  $X_3$ , the product's color. With regard to natural gas contracts,  $X_1$  may be the term of the contract,  $X_2$  may indicate the existence of a marketout clause,  $X_3$  may indicate the existence of a tight sands provision, and so on. The essence of the analysis is in the determination of the marginal contribution that each of those attributes  $X_1$  through  $X_n$  makes to the product price (P). That determination requires the use of the statistical tool, multiple regression analysis.

#### B. The Statistical Tool: Multiple Regression Analysis

Multiple regression analysis<sup>14</sup> is one of the most widely used statistical tools. It uses the statistical relationship between two or more quantitative variables to determine the extent to which one variable, called the *dependent variable*, can be estimated, described, or predicted from other variables, called explanatory, or *independent variables*. A *regression model* attempts to explain observed changes in a dependent variable as being caused by changes in those independent variables.

Multiple regression analysis has several basic applications. According to Professors Snedecor and Cochran:

Regression has many uses. Perhaps the objective is only to learn if Y *does* depend on X. Or, prediction of Y from X may be the goal. Some wish to determine the shape of the regression curve. Others are concerned with the error in Y in an experiment after adjustments have been made for the effect of a related variable X. An investigator has a theory about cause and effect, and employs regression to test this theory. To satisfy these various needs ... regression methods [are] necessary.<sup>15</sup>

Here, we are concerned with making a prediction of the hedonic price (P) by estimating the marginal contribution the various attributes (X's) of natural gas contracts make toward that price.

1. A Brief Overview of Multiple Regression Analysis

In using multiple regression, the analyst specifies the major independent variables that are believed to influence the dependent variable. In our analysis, and with reference to equation (1), the dependent variable is the contract price (P); the independent variables are the various clauses in the contract, that is, the attributes of the contract designated  $X_1, X_2$ , through  $X_n$  in equation (1).<sup>16</sup> We are interested in estimating the marginal contribution each of those

16. In the more typical application of multiple regression analysis, the analyst is required to uncover the important independent or explanatory variables. As expected, legal proceedings examining regression results in such circumstances can become little more than arguments as to the appropriateness or

<sup>14.</sup> The discussion of multiple regression analysis provided here is very brief. For a basic discussion, see Fisher, *Multiple Regression in Legal Proceedings*, 80 COLUM. L. REV. 702 (1980). For a more general discussion, see T. HU, ECONOMETRICS: AN INTRODUCTORY ANALYSIS (1973); J. NETER & W. WASSERMAN, APPLIED LINEAR STATISTICAL MODELS (1974); G. SNEDECOR & W. COCHRAN, STATISTICAL METHODS (1973); H. THEIL, PRINCIPLES OF ECONOMETRICS (1971).

<sup>15.</sup> G. SNEDECOR & W. COCHRAN, supra note 14, at 135.

contract clauses makes toward the contract price. That estimate will establish the marginal value the buyer and seller have placed on that particular clause as reflected in its contribution to the contract price. The multiple regression analysis will estimate those values objectively, as opposed to relying on the subjective judgments of witnesses using only industry contractual experience and intuition, by assigning statistical "weights" to each of the clauses.

In mathematical notation, equation (1) can be estimated by the following multiple regression model:

(2) 
$$P = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + \ldots + b_n X_n + e$$

where  $b_0$  through  $b_n$  represent the regression parameters or statistical weights to be estimated by multiple regression analysis for each corresponding clause or attribute  $X_i$  in the contract and e is a random error term. Since the explicit functional form of equation (1) is unknown, we have approximated its functional form in equation (2) by assuming that it is linear.

The parameter value  $b_1$  which corresponds to the variable  $X_1$  in equation (2) will tell us by what amount the product price (P) will change in response to a change in  $X_1$  when the variables  $X_2$  through  $X_n$  are held constant, that is, the value of  $b_1$  is the marginal contribution of attribute  $X_1$  to the product price (P). However, a mathematical solution that provides the exact values of the parameters is unattainable. We do not know the actual functional form of equation (2), and we cannot measure all of the attributes (X's) that influence the product price (P). Rather, we will estimate the values of the parameters (b's) using a procedure called ordinary least squares (OLS). Relative to other methods of estimation, OLS will provide us with a solution that minimizes the sum of the squares of the residuals (e's). "The [ordinary] least square criterion is as follows: The line of best fit is said to be that which minimizes the sum of the squared deviations [of the estimated observations from the actual observations]."<sup>17</sup> While some other estimation technique may perform better in predicting the dependent variable in a few observations, OLS will minimize the error in estimating the dependent variable for all observations. More importantly, under OLS the estimates of  $b_1$  through  $b_n$  will be the best linear unbiased estimates of the relationship between the product price (P) and the product's attributes  $X_1$ ,  $X_2$  through  $X_n$  respectively.

Multiple regression analysis will allow the analyst to account for interactive effects<sup>18</sup>—the fact that an independent variable, say  $X_1$ , may have an effect both on the dependent variable P and on another independent variable, say  $X_3$ . In our analysis, this interactive effect is likely to be important if producers and pipelines tradeoff contract clauses. The producer, for example, may have insisted that  $X_1$  be changed in such a manner that the pipeline would be will-

inappropriateness of the variables selected. See generally Finkelstein, The Judicial Reception of Multiple Regression Studies in Race and Sex Discrimination Cases, 80 COLUM. L. REV. 737 (1980). Here, the vast majority of the independent variables are dictated by actual contract clauses. The problem of including inappropriate or excluding appropriate variables is of considerably lesser concern as a consequence.

<sup>17.</sup> R. PINDYCK & D. RUBINFELD, ECONOMETRIC MODELS & ECONOMIC FORECASTS 6 (1976).

<sup>18.</sup> See generally, J. NETER & W. WASSERMAN, supra note 14, at 219-20.

ing to accept that change only if the contract price were lowered or if changes were made in other clauses. That is, the pipeline would accept changes in clause  $X_1$  only if clause  $X_3$  is changed, or possibly even removed to its advantage. If these interactive effects are not accounted for statistically, a visual examination of clause  $X_1$  in several contracts may lead to the conclusion that a contract with a different clause  $X_1$  is incompatible with the other contracts. A statistical consideration of the interactive effects through the use of multiple regression analysis, however, may demonstrate that the contracts are similar as measured by their hedonic prices when the interactive effects of clauses  $X_1$ and  $X_3$  are taken into account. Furthermore, those changes may have profound effects on comparability if market or regulatory conditions were to change.

#### 2. Application to Hedonic Pricing

The use of multiple regression analysis requires the estimation of equation (2) from an appropriate data base. That estimated equation then provides a vehicle for measuring the comparability of other contracts. After equation (2) has been estimated appropriately, the analyst takes the contracts whose comparability is in question, determines their  $X_i$  values, and then inserts those values into the estimated equation (2). After the appropriate arithmetic, the result generated for each contract in question will be the *hedonic price for that contract* as measured against the contracts making up the data base.

To determine whether a contract is comparable to the data base contracts, and to other contracts similarly measured, the analyst must establish a confidence interval for the hedonic prices that correspond to the data base values of the  $X_i$ 's.<sup>19</sup> That confidence interval is an *interval estimate* that effectively sets the endpoints from which statistical implications can be drawn. The wider we make that interval, the less confidence we have about the implications or predictions that can be drawn from those estimates falling within the interval; the more narrow the interval, the more confidence we have about the accuracy of those implications or predictions. As a general rule, statisticians prefer a confidence probability of 95%. (A confidence probability of 99% would provide a more narrow confidence interval. A 90% interval would be wider.) Thus, contracts outside the data base whose hedonic prices do not fall within this 95% confidence interval are not comparable statistically. Contracts whose hedonic prices do fall within the interval are comparable statistically both with contracts within the data base and with each other.

To construct a 95% confidence interval, the analyst adds and subtracts a t-value<sup>20</sup> from a new contract's hedonic price. The appropriate equation in mathematical notation is as follows:

(3) 
$$\hat{P} - t(.975;m-n)s(P) < E(P) < \hat{P} + t(.975;m-n)s(P)$$

<sup>19.</sup> For a similar approach, see id. at 231-34.

<sup>20.</sup> A t-statistic allows an analyst to derive confidence limits for small samples. See G. SNEDECOR & W. COCHRAN, supra note 14, at 59-60.

where t (.975; m-n) is a t-value with m-n degrees of freedom,<sup>21</sup>  $s^2(P)$  is the variance of P as P was predicted by the regression model in equation (2), E(P) is the mean of that same prediction, and  $\hat{P}$  is the hedonic price generated by the new contract. The degrees of freedom for the t-test are determined by subtracting the number of independent variables (n) from the number of contracts in the data base (m). Thus, if the data base contained 425 contracts, the hedonic pricing model contained fifteen independent variables, the variance of P was 0.00757 so that s(P) equaled 0.0870, and E(P) equaled \$2.70 per Mcf, then equation (3) would become:

(4) 
$$\$2.53 \text{ per Mcf} < P < \$2.87 \text{ per Mcf}$$

If the hedonic prices generated by another new contract does not fall within this range, that contract can be said to be not comparable with 95% confidence.

# IV. THE PRELIMINARY EMPIRICAL ANALYSIS

The principal objective of this article is to develop and evaluate empirically an objective methodology for assessing the comparability of contracts subject to a redetermination provision within a natural gas contract. The methodology advocated is a hedonic pricing technique. As discussed in section III, the application of this technique employs the use of multiple regression analysis. In this section, we examine the data base upon which we conducted that analysis, and then consider the preliminary empirical results.

#### A. The Natural Gas Purchase Contract Data Base

The data used for this study were developed from nearly 3,500 original and amended natural gas purchase contracts. All of the contracts are from the interstate market, and come from three major natural gas pipeline companies. The oldest contract in the data base dates to 1938, while the most recent contract was entered into in March of 1986.

Each contract within the data base had the potential to contain seventyeight different clauses and subclauses. The contracts from earlier periods were very simple and varied relatively little from contract to contract. As we progressed toward the present, the contracts became considerably more complex and creative, particularly contracts from small and medium-sized producers. Table I provides a select list of the major contract clauses included in the data base. The variable names given in the right-hand column of table I for the clauses in the data base contracts correspond to the  $X_1$ 's in our estimating equation (2).

#### 1. The Development of Sub-Databases

Our preliminary observations indicated that natural gas contracts written

<sup>21.</sup> To create a 95% confidence probability requires that 0.5 or 2.5% be placed in each side. Since the t-statistic is a "one-tailed" test, the calculation of a 95% confidence interval requires that a t-value corresponding to .975 be used in each side.

during the fifty-year period after World War II strongly reflected both the economic and regulatory environments facing the parties when they entered into their agreement. In categorizing our data base contracts by date of signing, our observations indicated that the contracts clearly reflect the influence of six discernible regulatory periods:

- (1) Natural Gas Act (NGA) Regulation: Pre-Phillips (1938-1952)
- (2) NGA: Phillips to Area Rates (1952-1960)
- (3) NGA Regulation: Area Rates to National Rates (1960-1972)
- (4) Natural Gas Regulation: National Rates to Natural Gas Policy Act Regulation (NGPA) (1972-1978)
- (5) Early NGPA Regulation (1978-1981)
- (6) Present NGPA Regulation (1982-present)

Although natural gas contracts are virtually all influenced by a multitude of similar attributes regardless of its vintage, a contract written in any one of these periods generally contains either a specific clause(s) or a particular wording in a clause otherwise commonly included in gas contracts that makes the contract unique to its period.<sup>22</sup> Thus, we found it necessary and desirable to separate the contracts according to their original signing dates and to estimate an equation (2) for each of these six regulatory periods.

#### 2. The Quantification Process: Computerizing the Contracts

The principal difficulty in establishing the data base for use with multiple regression analysis was in *quantifying* each relevant contract clause. To accomplish this, we initially examined each clause to determine the alternative ways in which the parties had structured the clause in our data base contracts. We were concerned about which party was obligated to perform, the required performance, which party had the right to initiate action, and whether the other party had any recourse after that action was initiated. Surprisingly, our preliminary observations clearly indicated that the structure of the clauses and the obligations they impose is correlated loosely to the regulatory period in which the contract was executed.

To illustrate our approach to quantifying a particular clause, consider the relatively straightforward application to the depth limitation clause. For the depth limitation clause, we used the following quantification scenario:

<sup>22.</sup> Interestingly, in examining the contracts within our data base, we noticed that smaller companies tended to write contracts that both reflected the regulatory and market environments in which they were written and anticipated future changes in those environments much more quickly than did the larger, more established companies. In several cases, we found that larger companies were more inclined than small and medium-sized companies to use old contracts with few modifications, other than in the price, instead of writing new contracts.

While there are several possible explanations for these findings, they appeared to be a function of the information flows within the business. The roles each member of the firm played were influenced strongly by his available information. For example, in smaller companies, the person negotiating, writing, and signing contracts was better informed of the company's financial status, the regulatory environment, and the impact of a long-term contract within those confines than was his larger company counterpart.

|          | Formation               | Depth  |
|----------|-------------------------|--|
| 0 =      | Formation not specified | $0 = \overline{\text{Depth}}$ not specified                        |
| 1 =      | Formation specified     | 1 = 5,000 feet or less   |
|          |                         | 2 = More than 5,000 feet but less than or<br>equal to 10,000 feet  |
|          |                         | 3 = More than 10,000 feet but less than<br>or equal to 15,000 feet |
|          |                         | 4 = More than 15,000 feet  |
| <b>T</b> | - C                     |  |

Thus, for example, a contract calling for natural gas to be taken from a specific formation and from above 7,000 feet would be coded "1" and "2" in the appropriate places.

For those contracts written under the NGPA, the quantification scenario ranked the NGPA pricing categories according to their ceiling price from the highest-priced category (deregulated section 107 gas) to the lowest. Other clauses, such as the take-or-pay provision, the contract term, quantity, and measurement clauses, that could be quantified in this manner had a similar quantification scenario.

For other, less quantifiable clauses, we elected to enlist the services of several natural gas contract experts. Those experts were asked to examine the ways in which a particular clause was written, and then to rank-order those alternative clauses from the most favorable to the seller to the least favorable to the seller.<sup>23</sup> In its simplest state, the quantification scenario for this type of clause took the following form:

- 0 = Clause not present in this contract
- 1 = Clause favors the seller
- 2 =Clause favors the buyer

For some clauses, there were as many as ten alternative ways in which the clause was structured, ranging from "1" for that form of the clause most favoring the seller to "10" for that form most favoring the buyer.<sup>24</sup>

- (1) 20 year contract; third-party favored-nation; multi-district favored-nation area;
- (2) 20 year contract; third-party favored-nation; single-district favored-nation area;
- (3) 20 year contract; two-party favored-nation; 5 year price redetermination at average of 3 highest prices;
- (4) 20 year contract; no favored-nation; 5 year price redetermination with arbitration;
- (5) 5 year contract; no favored-nation; no price redetermination;
- (6) 20 year contract; no favored-nation; 10 year price redetermination;
- (7) 10 year contract; no favored-nation; no price redetermination;
- (8) 20 year contract; two-party favored-nations clause; price-index inflation clause;
- (9) 20 year contract; two-party favored-nation; wide favored-nation area; no price redetermination;
- (10) 20 year contract; time-limited, two-party favored-nation, narrow favored-nation area; no price redetermination;
- (11) 20 year contract; time-limited, two-party favored-nation; no price redetermination;
- (12) 20 year contract; no favored-nation; no price redetermination.

E. NEUNER, supra note 2, at 110.

24. While this approach does provide considerably more objective results upon which to assess contract comparability than the anecdotal approaches currently being used, a more econometerically

<sup>23.</sup> A similar approach by Professor Neuner, who concentrated on certain *combinations* of clauses within contracts rather than on individual contract clauses, generated the following results (ranking from greatest to least advantageous to the seller):

| Contract Clause                   | Variable Name |
|-----------------------------------|---------------|
| Pooling                           | CL7           |
| Lease Separation                  | CL9           |
| Price                             | <i>CL14</i>   |
| Maximum Price                     | <i>CL15</i>   |
| Take-or-pay                       | <i>CL17</i>   |
| Drainage Protection               | CL18          |
| Force Majeure                     | <i>CL23</i>   |
| Deregulation                      | <i>CL24</i>   |
| Redetermination                   | <i>CL25</i>   |
| Reregulation                      | <i>CL27</i>   |
| Evergreen Provision               | CL31          |
| Ratchet Provision                 | <i>CL33</i>   |
| Casinghead Gas Provision          | CL38D         |
| Minimum Daily Contract Quantity   | CL39A         |
| Term                              | CL44A         |
| Term Conditioned on Deregulation  | CL44B         |
| Termination                       | <i>CL45</i>   |
| Renegotiation                     | CL49          |
| Market Out                        | CL50A         |
| Market Out Limited to Future Date | CL50B         |
| FERC Out                          | CL52A         |
| FERC Out Limited to Future Date   | CL52B         |
| Btu Adjustment                    | CL56          |
| Depth Limitation                  | CL59          |
| Tight Sands Gas                   | CL61          |
| Market-Clearing Price Adjustment  | CL63A         |
| NGPA Price Category               | CAT           |

# TABLE I Selected Data Base Natural Gas Purchase Contract Clauses With Assigned Variable Name\*

\* The actual data base has information on 78 clauses and subclauses.

After every clause had been examined and a quantification scenario developed, each contract in the data base was evaluated according to those scenarios. For every clause in every contract, therefore, we used the quantification scenario we had constructed to assign a number(s) that most closely described that clause. All data were then taken and stored in a computer. Thus, by

In a more econometrically accurate approach, the  $X^5$  clause would be represented by 10 separate variables, say  $X^{5a}$ ,  $X^{5b}$ ,  $X^{5c}$ , through  $X^{5j}$ . The order would be irrelevant. That is, the particular alternative  $X^5$  which was ranked tenth by the experts may be anyone of the  $X^5$  values. If it is the seventh value, say  $X^{5g}$ , the  $X^5$  variable in the regression model would be represented as:

$$X^{5a}=0; X^{5b}=0; \ldots; X^{5g}=1; \ldots; X^{5j}=0$$

Multiple regression analysis would then estimate the appropriate value or weight to be attached to the each  $X^{5}$  clause alternative. See S. Wiggins & A. Ringleb, Hedonic Price Assessment of Natural Resource Contract Comparability (unpublished manuscript).

accurate approach avoids even the subjective clause rankings by industry experts. To illustrate, assume that the variable in the regression analysis to be measured is  $X^5$  and that there are 10 possible alternative ways of writing the clause it represents. In the approach outlined above, the experts would rank those alternatives from that alternative most favoring the seller to the alternative most favoring the buyer. Thus, for the alternative most favoring the buyer the inputed value of  $X^5$  used in the regression analysis would be "10." Those rankings, despite being the judgment of experts, represent a subjective evaluation of the clause.

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calling up any contract in the data base, the analyst could determine the essence of the individual clauses making up that contract by examining the respective quantification codes for that contract.

## B. The Application of Multiple Regression Analysis

After all the contracts were quantified, they were separated by their execution dates into the six regulatory periods. Because we were concerned mostly with the comparability of contracts entered into in the 1978 to 1981 period and now subject to redetermination, our analysis centered on contracts in that period. Multiple regression analysis was then used to determine which particular clauses most influenced contract price in the period. In statistical terms, we were concerned about which of the "weights" or regression coefficients (b's) were statistically significant, according to its t-statistic, in equation (2). The clauses not meeting this statistical test generally included clauses that differed little from contract to contract within the period, but were nonetheless important to the parties,<sup>25</sup> or else appeared in too few contracts to be relevant in that period.

The multiple regression results generated by our preliminary analysis are presented in table II. As can be seen, a number of clauses were important determinants of contracts negotiated during the 1978 to 1986 period. Most importantly, clearly, is the NGPA price category. Relatively fewer clauses are important in the 1978 to 1981 period, although the relationship between the clauses in each period is quite similar. The statistics for the equation itself indicate that the regression fits the data very well (the *F* statistic is significant at the 99% confidence level) and the  $R^2$  statistic (which measures the movement in the dependent variable that is explained by the independent variables) is very good for this type of data. Thus, the estimated equations appear to be sufficiently reliable to warrant their use in assessing contract comparability. Our estimating equation (2) for the period 1978 to 1981 therefore becomes:

(5) P = 3.732 + 0.184CL7 + 0.02CL9 - 0.038CL31 - 0.216CL33 - 0.007CL39A - 0.382CL44B - 0.180CL45 + 0.428CL61 - 0.188CAT

$$R^2 = 0.420$$

Recall from the excerpt in section II that the expert considered contracts containing an annual redetermination clause to be comparable to one containing a biannual redetermination clause. In the 1978 to 1981 and the 1978 to 1985 periods the expert's assessment is correct, although not likely in the manner he intended. According to the statistical results, redetermination clauses (CL49) were not major clauses affecting contractual practices. It would

<sup>25.</sup> To illustrate, consider a hedonic pricing analysis of automobiles. The color, engine size, weight, radio quality, and interior fabric are attributes that would clearly influence consumer purchasing decisions. Of those autos *purchased*, virtually all would have such attributes as tires, steering wheels, brakes, lights, and other items essential to the safe operation of the automobile. Their absence would very likely result in the automobile not being purchased regardless of its other attractive attributes. Thus, although their individual statistical relevance is not significant, their collective impact is reflected in the intercept term,  $b_0$ .

| Clause                | Multiple Regression<br>Coefficients <sup>a</sup><br>1978-1985 | Multiple Regression<br>Coefficients <sup>a</sup><br>1978-1981 |
|-----------------------|---|---|
| Intercept             | 2.769   | 3.732   |
| CL7                   | 0.152 (4.901)*  | 0.184 (4.837)*  |
| CL9                   | _   | 0.032 (2.423)*  |
| CL15                  | 0.024 (2.365)*  | <u> </u>  |
| CL18                  | -0.039 (2.649)*   | _   |
| CL31                  | -0.044 (3.248)*   | -0.038 (2.077)*   |
| CL33                  | -0.158 (5.106)*   | -0.216 (5.802) <b>*</b>                                       |
| CL38D                 | 0.204 (4.039)* ·  |   |
| CL39A                 |   | -0.007 (3.619)*   |
| CL44B                 | -0.213 (2.524)*   | -0.382 (3.376)*   |
| CL45                  | -0.142(3.338)*  | -0.180 (3.534)*   |
| CL49                  | -0.019 (2.726)*   |   |
| CL52A                 | 0.042 (2.860)*  | _   |
| CL52B                 | 0.038 (1.841)**   | _   |
| CL61                  | 0.149 (2.200)*  | 0.428 (4.381)*  |
| CAT                   | -0.162 (16.27)*   | -0.188 (11.98)*   |
| <b>R</b> <sup>2</sup> | 0.418   | 0.420   |
| F                     | 7.240   | 8.050   |

TABLE II PRELIMINARY MULTIPLE REGRESSION RESULTS: HEDONIC PRICING TECHNIQUE

a T-statistics in parenthesis.

\* Significant at the 95% level.

\*\* Significant at the 90% level.

appear that the overwhelming majority of contracts contained such a clause, and that the buyer did not "charge a different rate" for an annual or biannual redetermination period. Thus, contracts containing either of such clause structures could be comparable in this period.

Clauses, however, that did show significant difference between periods included the minimum contract quantity clause  $(CL39A)^{26}$  and the FERC-out clauses. Interestingly, the market-out clause was not a determining factor in either regression result reported here. However, in the regression results for the 1982 to 1985 period, results that are not reported here, the market-out clause was one of the leading determinants, reflective of the buyer's improved bargaining position in that period.

#### C. Assessing Comparability with Hedonic Pricing

To visualize the use of hedonic pricing in establishing comparability, consider the comparability estimates presented in table III. Table III contains the hedonic prices generated by five natural gas contracts. The objective is to establish which, if any, of these contracts are comparable. To generate those hedonic prices in table III, we first quantified the five contracts according to

<sup>26.</sup> We know that minimum take requirements were significantly higher in the 1978 to 1981 period. Buyers very likely agreed to higher minimums but demanded some compensation for that clause.

the approach outlined above—that is, we established each contract's X, or attribute, values. The quantified contracts were then inputed individually into equation (5), generating the hedonic prices listed in table III. The confidence interval applicable to the analysis was that interval estimated and provided earlier in equation (4).

Assume we are attempting to find three contracts comparable to the data base contracts for the 1978 to 1981 period. Three contracts found comparable with the data base would therefore be comparable with each other, satisfying the redetermination requirements. Although under current subjective methodologies all five contracts would very likely be found to be comparable to each other, the hedonic pricing technique finds that only contracts "2" and "3" are comparable statistically. Only the hedonic prices generated by contracts "2" and "3" fall within the confidence interval provided in equation (4).

| Contract | Hedonic Price<br>1978-1981 |
|----------|----------------------------|
| 1        | \$3.35                     |
| 2        | 2.80*                      |
| 3        | 2.55*                      |
| 4        | 3.43                       |
| 5        | 3.01                       |

TABLE III COMPARABILITY ANALYSIS: HEDONIC PRICING TECHNIQUE

\* With the 95% confidence interval, 2.53 < P < 2.87, these contracts are comparable under the hedonic pricing technique.

## V. CONCLUSION

With the decline in natural gas and other energy prices in the early 1980s, economic realities forced buyers of natural gas to attempt to renegotiate gas purchase contracts. The vast majority of contracts executed before 1982, and particularly those contracts executed in the 1978 to 1981 period, did not contain adequate mechanisms to adjust the contract price to correspond more closely to declining market conditions.

In their efforts to reduce contract prices, buyers attempted a variety of means to effectuate that reduction including such extraordinary measures as unilateral market-out, unilateral price reductions, and coercive renegotiations. In addition, buyers focused on that contractual redetermination process calling for the buyer to pay the seller a per Mcf price equivalent to the "average of the three highest-priced contracts of comparable terms and conditions within the area." The buyers focused on the term "comparable" and challenged the contracts submitted by sellers as part of that process on the basis that they were not comparable to the existing contract. Although it is difficult to estimate, it is conceivable that several hundred contracts or more are subject to such a dispute.

In the vast majority of disputes over the comparability of contracts sub-

ject to redetermination, evidence on comparability has been provided largely by anecdotal and subjective testimony. Here, we have provided a hedonic pricing approach to determining the comparability of contracts and have substantiated its usefulness through empirical evidence. The hedonic pricing technique presented herein clearly allows for the objective statistical determination of the comparability of contracts subject to the redetermination process. The empirical evidence establishes that the hedonic pricing technique is a superior methodology for assessing comparability, and thus for assessing the viability of comparability and other clauses in future natural gas and other natural resource purchase contracts.