Footnotes:

1 Southern Natural Gas Company also received authorization for such a rate in July 1983.

2 American Gas Association, Distribution Industry Ratemaking Options, 1984 duplicate.

3 Federal Energy Regulatory Commission, "Statement of Policy on Offsystem Sales," Docket No. PL82-2, April 2, 1983.

4 By expanding self-implementing transportation under NGPA Section 311.

5 U.S. Department of Energy/Energy Information Administration, Statistics of Interstate Pipelines, 1974 and 1982.

6 U.S. Department of Energy/Energy Information Administration, Natural Gas Monthly, July 1984.

7 Natural Gas Intelligence, October 22, 1984, p. 2.

8 Platt's Oilgram News, October 31, 1984.

9 The FERC also imposed substantial and detailed reporting requirements including both the name of each end-user and the price each paid for the gas it received.

10 Sales through September 1984 by Columbia Gas Transmission under its Transport program, Panhandle Eastern Pipe Line under its PanMark Program and Transcontinental Gas Pipeline under its ISP and CCP programs. Includes estimated September 1984 volumes from monthly reports with the FERC in October 1984.

11 Sales through September 1984 under Tenneco Oil Company's Tenneflex program and under TXP Operating Company's TransMart program. Includes estimated September 1984 volumes from monthly reports with the FERC in October.

12 Foster Natural Gas Report, August 30, 1984, pp. 1-4.

13 Natural Gas Intelligence, July 16, 1984, p. 2.

14 Interstate Natural Gas Association of America (INGAA) report, New Directions for Interstate Natural Gas Pipelines: Phase I of the Special Marketing Programs (August 1983 to August 1984), October 1984.

Contracting and Regulation Under Uncertainty: The Natural Gas Market

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INTRODUCTION

Studies of the regulation of industry almost always proceed in a framework of classical, Walrasian market-clearing. Whether the market structure is assumed to be perfect competition or monopoly (as in the case of public utility regulation), economists take for granted that supply and demand would match at the "market price" were government intervention absent. Indeed, in the absence of uncertainty it is difficult to conceive of an alternative.

Once uncertainty is admitted, however, buyers and sellers may find it advantageous to enter into long-term contracts, in order to reduce risk associated with price fluctuations, or to reduce Williamsonian (1975) transactions costs that arise from small-numbers bargaining. Contracts signed at different times will in general have different price provisions.

The causes of contracting have been investigated in industrial organization and labor economics. Their effects on inflation and unemployment have been studied by macroeconomists (e.g., Okun, 1981). Regulation in markets with contracting holds promise as an area for new research. This paper examines price regulation in an industry characterized by bilateral bargaining -- the domestic natural gas industry. We develop a simple model of contracting between a single buyer and seller, with and without uncertainty or regulation. We then address the implications of introducing contract heterogeneity into the model for the impact of regulation.

The domestic gas industry, comprising production, transport ("upstream" activities), and distribution, has a long history of regulation. Public-utility regulation of local distribution companies, dating from the gas-lighting era of the late nineteenth century, was joined by regulation of interstate pipeline tariffs at the federal level (by the Federal Power Commission--FPC) under the Natural Gas Act of 1938. The Supreme Court extended the FPC'S jurisdiction to setting wellhead (i.e., producer) prices in the Hope Natural Gas case in 1954. Except for intrastate commerce, the FPC and its successor, the Federal Energy Regulatory Commission (FERC), have regulated natural gas prices at both ends of the pipeline ever since. Increasing dissatisfaction with the regulations, along with severe shortages and curtailments of natural gas supplies in the 1970s, led to the Natural Gas Policy Act of 1978, which overhauled the regulatory rules and provided for partial deregulation by 1985.

Analyses of natural gas regulation have closely reflected the perception of the problem prevailing at the time. Alleged pipeline monopoly power downstream and monopsony power at the wellhead provided the justification for the Natural Gas Act and early statistical studies aimed at evaluating horizontal structure and conduct in the industry. Of these, two

(Neuner, 1960; MacAvoy, 1962) stand out for their careful attention to detail and methodology, and remain among the best work done on the subject, despite the advances made in economics, and changes in the gas market, over the past twenty-five years.

In the 1970s, concern focused on the regulation-induced shortage of natural gas. Modelers assumed the industry was perfectly competitive, and attempted to estimate the response to higher prices of exploration, production, and consumption (see for example Breyer and MacAvoy, 1973; MacAvoy and Pindyck, 1973; Loury, 1983; and the survey in Braeutigam, 1981).

A major policy issue now is the so-called "contracts problem." The problem is detailed below; it is briefly summarized as follows: In the 1970s pipeline companies, finding themselves constrained from competing for supplies by wellhead price ceilings, bargained on non-price contract provisions instead. Chief among these was the guarantee to purchase a minimum quantity each year, regardless of downstream demand--the so-called "take-or-pay" clause. Now that these ceilings are being phased out, the pipelines face take-or-pay obligations that exceed the value of their assets. Some pipelines confront the choice between contract abrogation and bankruptcy.[1]

Congress has considered legislative measures that would release pipelines from their contract commitments, on the grounds that their predicament is itself due largely to government regulation.[2] While there has been much discussion in policy circles of the role played by regulation in the contracts problem (Broadman and Montgomery, 1983; Broadman and Toman, 1984); analysis has thus far been lacking. As noted above, in a market with uncertainty and contracting, different pipelines will pay different prices for gas. Without an empirically testable model, it is not possible to separate the "blame" for the contracts problem due to regulation from the natural vagaries of events in an uncertain market.

A MODEL OF PIPELINE-WELLHEAD CONTRACTING

In this section, we model a contract between a pipeline and a producer as the solution to a bilateral bargaining problem.[3] We ignore risk aversion, both because it has received considerable attention in the literature already (Leland, 1972; Roberts, 1980; Newbery and Stiglitz, 1981), and because it facilitates simplicity in exposition. The addition of risk aversion does not qualitatively affect our results.[4]

Our goal is to model contract provisions as economic responses to uncertainty. It is natural to divide these provisions into "price" and "quantity" categories. The model presented is static, designed to focus sharply on the current imbroglio over prices and take-or-pay terms. What we sacrifice is the richness of escalator-clause dynamics.

We start with the unregulated ("market-clearing") case. Although counterfactual, this case serves to introduce the conceptual framework for subsequent analysis of field price regulation's impact on contract terms. It also demonstrates that the contract provisions observed in the real world, although perhaps anathematic to a neoclassical economist, need not be due to government interference in the market.[5] Thus, calls for public policy intervention to overturn the structure of contracts need not be warranted.

In devising a framework for consideration of the

contracts problem in natural gas, we draw on the implicit contracts literature in labor economics, in which efficient contracts depend on the structure of demand and supply shocks (Azariadis, 1975; Green and Kahn, 1983; Hall and Lilien, 1979).

Contracts in the Absence of Regulation: The Certainty Case

At first, we assume no regulatory intervention. Certainty and uncertainty cases will be reviewed in turn. Pipeline technology, rolled-in pricing,[6] and final demand for natural gas are summarized in a revenue function $R(Q)$, which gives dollar net revenue to the pipeline (sales less operating costs) as a function of the intake Q of gas from the wellhead. Let $C(Q)$ represent the wellhead producer's opportunity cost of producing Q. If both producers and pipelines were perfectly competitive in a given field, no contract would be necessary, and equilibrium would be given by the interaction of the supply and demand curves, so that $R'(Q) = C'(Q)$.

In the natural gas industry, however, the cost of switching suppliers or purchasers is often prohibitive. The two parties have little recourse but to deal with each other—a situation of bilateral monopoly. The contracts that arise from such a bilateral monopoly serve to distribute the rents between the pipeline and the producer.

We define a <u>contract</u> to specify a payment $B(Q)$ from pipeline to producer as a function of output, so that the profit of the pipeline is

$$(1) \qquad \pi_p = R(Q) - B(Q).$$

Under such a contract, the net benefit accruing to the producer (that is, the amount he receives less his opportunity cost of production) is

$$(2) \qquad \pi_W = B(Q) - C(Q).$$

Under certainty, any contract payment rule B(Q) is <u>efficient</u> as long as marginal production cost and benefit are equated; i.e.,

$$(3) \qquad B'(Q) = C'(Q).$$

Note that the rule could allow pipelines to choose "takes" unilaterally; i.e., set Q subject to the payment B(Q). Note also that the efficiency condition says nothing about the division of the rent R(Q) - C(Q). It does, however, specify the condition under which the pie to be divided is as large as possible.

<u>Uncertainty Case</u>

As a general proposition, however, there is likely to be substantial uncertainty over circumstances prevailing over the duration of the agreement. Such uncertainty arises from demand shocks -- because of fluctuations in economic activity or exogenous changes in the prices of alternative fuels, particularly oil-- and supply shocks--changes in the cost of production or exogenous changes in expected future gas prices. We make no restrictions <u>a priori</u> on the probability distributions of the shocks. Demand shocks are captured in a random variable α, so that the revenue function becomes $R(Q,\alpha)$. On the supply side, supply shocks are characterized by a

random shock β, so that the cost function becomes $C(Q,\beta)$.

Both pipelines and wellhead producers are assumed to be risk neutral, maximizing expected profits, given by

$$(4) \qquad \pi_p = R(Q,\alpha) - B(Q,\alpha,\beta)$$

and

$$(5) \qquad \pi_W = B(Q,\alpha,\beta) - C(Q,\beta),$$

respectively.

Given realizations of α and β, the efficient level of output $Q^*(\alpha,\beta)$ still requires equality of the marginal revenue product of gas as a pipeline input and the marginal opportunity cost of wellhead production, so that

$$(6) \qquad \frac{\partial R(Q,\alpha)}{\partial Q} = \frac{\partial C(Q,\beta)}{\partial Q}.$$

Equation (6) implicitly defines the set of efficient payment rules $B(\alpha,\beta,Q^*(\alpha,\beta))$. Problems arise because the rules themselves can depend on the outcomes of the supply and demand shocks. Not all variables affecting the contract may be anticipated by the transacting parties. Moral hazard problems surface as well with respect to correct reporting of the marginal cost of production and final pipeline demand.

Suppose that the contract establishes a payment rule B(Q), contingent only on output and not directly on the shifts α and β. The profit to the pipeline is now

(7) $\pi_p = R(Q,\alpha) - B(Q),$

while the net benefit to the wellhead producer is given by

(8) $\pi_w = B(Q) - C(Q,\beta).$

Again, the efficient output level satisfies both

(9) $\frac{\partial R(Q,\alpha)}{\partial Q} = B'(Q)$

and

(10) $\frac{\partial C(Q,\beta)}{\partial Q} = B'(Q)$, for all values of α and β.

Such an output level not only is efficient ex post, but is enforceable since the two signatories can observe output, Q.

As before, the distribution of monopoly profits is not specified by the efficiency conditions. The shape of the payment function B is determined by efficiency, but not its level. In general, the ideal output-contingent contract does not exist, because in the absence of futures markets, prices allocate both risk and commodities (Newbery and Stiglitz, 1981). The payment function is "lacking in instruments" to target efficiency under all potential realizations of α and β.

Given the current state of the natural gas market, the case wherein all uncertainty is on the demand side (i.e., $C(Q,\beta) = C(Q)$) is most instructive. There the efficiency conditions are:

(11) $\frac{\partial R(Q,\alpha)}{\partial Q} = B'(Q)$, for all α, and

(12) $C'(Q) = B'(Q).$

Pipelines pay a marginal cost for gas, which is exactly equal to the marginal cost of production. Integrating the differential equation (12) over Q yields a payment rule of the form

(13) $B(Q) = \bar{B} + C(Q),$

where $\bar{B}$ is independent of output and is determined through contract negotiation. The lump sum $\bar{B}$ encompasses inframarginal "payments" (e.g., minimum purchase or take-or-pay provisions). Under the contract in (13), wellhead compensation is

(14) $\pi_w = B(Q) - C(Q) = \bar{B} + C(Q) - C(Q) = \bar{B},$

so that wellhead producers are indifferent to the level of production, which is determined unilaterally by the pipelines. Hence, to the extent that disturbances occur solely on the demand side (say movements in the price of oil or in economic activity), the efficient contract leaves output choice up to the pipeline, with a payment rule combining "price" and "non-price" provisions so as to leave producers indifferent as to the level of production. In other words, the demand risk is borne entirely by the demander.

In the real world, output-contingent contracts of the types delineated above are likely to be designed so as to preserve efficiency in the face of the most likely source of substantial fluctuations. Contracts will be of finite duration, so that changes in market structure can be worked into provisions. Thus the sort of contract that is likely to prevail depends on the source of uncertainty.

If demand-side fluctuations (in the price of oil and economic activity) are much more significant than supply shifts, contracts of the first type discussed above are likely to prevail. That is, output decisions in the efficient contract are determined primarily by the pipeline, with an accompanying set of inframarginal payments to make the producer roughly indifferent as to the level of production. Thus, even in the absence of field price regulation, an expectation of rising oil prices would cause pipelines to increase the total compensation to producers in new contracts. That price expectations turn out to be wrong <u>ex post</u> vitiates neither the <u>ex ante</u> desirability of the contract nor its efficiency.

<u>Contracting Under Field Price Regulation</u>

Under binding field price control regulation, there is a gap between the marginal willingness to pay for new supplies and the marginal opportunity cost of production at the controlled price. Given a price ceiling of $\overline{P}$, there is excess demand for natural gas.

While the price-quantity pair (P^*, Q^*) corresponds to the efficient contract (since the marginal revenue product of additional gas purchased is equal to the marginal compensation and to the marginal opportunity cost of production), regulation yields production of Q_S, with excess demand equal to the difference between Q_D and Q_S. Introducing demand shifts influences the level of excess demand.

A positive demand shift raises the excess demand at the ceiling price $\overline{P}$, while a negative shift moves the price-quantity outcome closer to one of market-clearing. In the gas market, shifts of the first type could occur because of an increase in the price of oil or in aggregate economic activity; the latter shift might occur during periods of recession or of declining prices of alternative fuels.

If demand shifts are the only source of market uncertainty, then an efficient output-contingent contract requires a payment rule to the producer of

$$(15) \qquad B(Q) = \bar{B} + C(Q) + \hat{\Omega},$$

where

$$(16) \qquad \Omega = \int_{Q^S}^{Q^*} C(Q)dQ,$$

and where $\bar{B}$ is a distributive constant as before. The net position of the wellhead producer is then

$$(17) \qquad B(Q) - C(Q) = \bar{B} + \int_{Q^S}^{Q^*} C(Q)dQ.$$

A ceiling on the marginal payment to the producer (i.e. a price ceiling) causes the inframarginal payment necessary to achieve the efficient output to rise. Of course, price regulation which permits such a change in payments is no regulation at all. In general, binding price controls prohibit efficient output.

To the extent that field price controls are binding, there will be excess demand for gas, and uncertainty materializes in demand fluctuations. Given that uncertainty is borne by the pipeline, the discussion of the previous section implies that output decisions would be made by the pipeline, with non-price provisions used to keep the producer at a constant profit level. Equilibrium production would no longer be efficient, as pipelines would be willing to raise producer prices to attract more gas, but price regulation would stop them from doing so.

This situation persists as long as controls are expected to remain. Price regulation, then, introduces no new dimensions per se to the negotiation problem between producer and pipeline. At an aggregate level, however, binding price controls on old-vintage contracts influences the provisions of newly signed contracts (see Hubbard and Weiner, 1984).

Phased Deregulation

A discussion of the current problem requires an analysis of optimal contracting behavior during the transition from regulation to total deregulation. While contract provisions may be similar in the two extremes, a period of transition can bring unanticipated gains or losses to parties as long as market conditions are uncertain. Those gains and losses depend as well on the type of deregulation considered, e.g., immediate decontrol versus phased deregulation.

We can now introduce market uncertainty of the sort outlined earlier in the market-clearing case. Consider the case in which there is a positive demand shift corresponding to a permanent increase in the price of oil. Marginal willingness to pay for gas increases.

The demand shock causes the market-clearing price-quantity combination to shift; given immediate

and total decontrol, marginal compensation will rise to its level in the new equilibrium. Inframarginal payments will be unchanged (that is, no change in price escalators, take-or-pay requirements, etc.).

Given phased decontrol (or, in general, anticipated future decontrol), however, competition for new supplies in the current period will require an increase in "other payments" (higher future prices, minimum-purchase requirements, etc.). As long as the demand shock is expected to be permanent, the pipeline should be willing to grant concessions, as with the anticipated price change due to future deregulation. As we discussed in the theoretical model under demand uncertainty, output decisions will be made by the pipeline, with the compensation rule (inclusive of non-current-price provisions) leaving the wellhead producer indifferent with regard to the level of production.

A "contracts problem" can arise under phased decontrol, however, if the demand shock is not permanent (particularly if non-price contract provisions include high take-or-pay requirements or downwardly rigid prices). Suppose for example that the oil price increase is temporary and oil prices decline. To avoid the higher marginal payment, the pipeline would have to increase its inframarginal payments (such as higher minimum purchases), also incurring a loss.

The possibility of a loss given demand uncertainty is independent of regulatory intervention. Contracts whose expected value to a signatory is positive *ex ante* may very well impose losses *ex post*. Such losses are in no way indicative of inefficiency, but merely reflect the risks of operating via contracts in a market subject to shocks. That such losses on average are less than the transactions costs associated with reliance on a spot market are evident from the prevalent use of long-term contracts. Heightened uncertainty may very well reduce the length of the contract period (Roberts, 1980). For evidence that this is the case in the natural gas market, see U. S. Energy Information Administration (1981-1983a).

The foregoing argument does not imply that natural gas price regulation is "blameless" in causing the contracts problem. First, as pointed out earlier, the excess demand for natural gas accompanying a binding price ceiling will lead to increased reliance on contract provision other than current-period price, leaving (in the demand-uncertainty-only case) pipeline profits more vulnerable to external forces (e.g., changes in the price of oil or in economic growth).

Moreover, the type of transition from regulation to laissez-faire is important. Immediate decontrol will focus the negotiation of new contracts on marginal (i.e. price) compensation, while anticipated phased decontrol will require inframarginal concessions (e.g., minimum purchase provisions), which increase vulnerability to market shifts. With respect to energy policy, discussion of the second point involves a comparison of the benefits of phased decontrol with the costs imposed by contract rigidities.[7]

CONCLUSION

In summary, three main points surface from the discussion of efficient contracts in the natural gas market. First, given market uncertainty and transactional considerations, long-term contracts involving

both price and non-price provisions would be expected in the gas market.

Second, field-price regulation should not in general alter the types of provisions in long-term contracts, though it may increase the reliance on inframarginal (non-price) compensation over marginal (price) compensation in reaching the contract bargain.

Third, the type of transition from regulation to deregulation (e.g., immediate total decontrol versus phased decontrol) is likely to be important, both in determining the mix between price and non-price provisions in contracts negotiated during the transition, and in determining the distribution of gains and losses due to unanticipated demand or supply fluctuations.

It is the interaction of market uncertainty with regulation that is responsible for the "contracts problem" in natural gas. The contracting process between producers and pipelines serves an important rent-sharing function.[8]

As a direction for future work, contracting parties' expectation of regulatory intervention will affect both contract provisions and the willingness of parties to negotiate. For example, if producers knew that pipeline contracts would be effectively void if pipeline losses exceed a certain critical level, they would emphasize current-price provisions more heavily.[9] Pierce (1983) argues that repeated intervention in the past to "rescue" pipelines makes the current situation more difficult, noting that there are precedents in contract law for excusing a party from performance by the "doctrine of mutual mistake."[10] Sweeping policy interventions to reduce reliance on the current contract structure are likely to be neither efficient nor productive.

FOOTNOTES

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1. An extended discussion of contracting and deregulation is available in U.S. Energy Information Administration (1981-1983a, 1983b). A discussion of related legal issues can be found in Pierce (1983). In addition to "take-or-pay" provisions, natural gas contracts typically include a set of price escalator provisions and a set of buyer protection provisions. The former divide into both "definite" and "indefinite" (indexed to the price of oil or to the highest price paid for gas in the same area) components. Moreover, "minimum-price" provisions set a floor to the price paid or to a price increase. The latter category is typified by "market-out" clauses allowing the pipeline to default on contractual obligations if the gas is not marketable at the agreed-upon price. We discuss these provisions again later in the paper.

2. Policy concern extends beyond the contracting parties (see U.S. General Accounting Office, 1983).

3. In this paper, the term "contract" refers to an ongoing agreement between trading parties, as opposed to a spot trade in the future--e.g., a futures contract. Hubbard and Weiner (1984) review motivations for contracting in the gas market. For a more general discussion, see Coase (1937), Williamson (1975), Klein, Crawford, and Alchian (1978), and Carlton (1979).

4. For example, see the modification of Hall and Lilien (1979) in Green and Kahn (1983).

5. These take-or-pay requirements were used extensively in producer-pipeline contracts even before the 1954 advent of field-price regulation. Indeed, MacAvoy (1962) notes a typical contract specified a take-or-pay of about 80 percent of wellhead capacity, even in the early 1950s.

6. "Rolled-in pricing" is the industry term used to refer to downstream regulation, which is essentially based on rates of return. Gas purchased by a piepline at various prices is "rolled in" to come up with an average acquisition cost.

7. These rigidities lead to losses of efficiency in exchange and production. Specific examples include (i) cases in which pipelines must reduce takes of low-priced gas (from "old" contracts), while continuing to distribute higher-priced gas because of higher minimum-purchase provisions, and (ii) inefficient capacity utilization in production and transmission because some (low-priced) gas is "shut in," even though $\partial R/\partial Q > \partial C/\partial Q$.

8. Our approach to the analysis of natural gas contracts suggests a program of empirical research. In particular, changes in the use of combinations of contract provisions can be used to distinguish the "rent sharing" and "regulatory response" features of producer-pipeline contracts, as suggested in the theoretical discussion. We have in progress a project to construct such data sets over different regulatory regimes.

9. The combination of phased deregulation and this type of intervention could lead to decreased production, since greater reliance on "current price" as a negotiating variable is blunted by the ceiling.

10. In his (1982) paper, Pierce cites one recent such case, <u>Aluminum Company of America v. Essex Group</u>, in which the parties chose the Wholesale Price Index as indicator of the cost of raw materials. Alcoa suffered losses when the index failed to reflect rapidly rising electricity prices. The court determined that the <u>intent</u> of the parties to limit Alcoa's risk through cost increases was a fundamental assumption of the agreement.

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Emerging Trends in Natural Gas Pricing and Contracting

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INTRODUCTION

This paper is the result of a recent survey of twelve large pipelines done on behalf of a small independent oil and gas company that wished to know what to expect in the way of future pricing and contract terms which would be offered by pipelines operating in regions where they were considering new developmental and exploratory drilling. The author feels that these questions probably concern other independent operators who are responsible for about 82% of the drilling in this country. These operators have watched demand for their gas decrease significantly, both spot and contract prices decline, and the net asset values of their companies as well as their borrowing ability contract during the last 18-24 months.

RECENT PERSPECTIVES ON GAS MARKETS

The natural gas industry has been going through significant changes in the last six years, but most especially in the last two years. There were shortages of supply in the mid-1970's and gluts in 1982-84. Wellhead prices were essentially flat in the early 1970's and rose dramatically at 21.5% per year after OPEC increased the price of oil in the 1973 - 1983 period and the Natural Gas Policy Act of 1978 (NGPA78) was passed by Congress. Demand reacted to these price changes by declining 2.3% per year on average, due to the combined effects of conservation, recession in 1980 and 1982, and interfuel substitution.