Bottlenecks and Governance Structures: Open Access and Long-term Contracting in Natural Gas

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1. Introduction

In a number of regulated industries, market evolution has made one (or more) vertical stages of production increasingly competitive.[1] The challenge for public policy is to deregulate these largely competitive activities while maintaining adequate antitrust and/or regulatory safeguards over remaining "bottleneck" facilities such as local telephone switches, pipelines, and electric transmission lines.[2] These industries historically provided a tied or bundled[3] product, combining upstream production with transportation to downstream markets. However, recent policy has generally involved unbundling upstream supply from transportation through the bottleneck, and requiring bottleneck facilities to operate as common carriers providing transportation services on a

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1. For example, new telecommunication technologies have allowed entry into long-distance telephone service; extensive development of the natural gas pipeline network has facilitated competition at the wellhead; reduced transmission losses on new electric power lines have made the wheeling of electricity less costly and facilitated competition in power generation.

2. The antitrust issues are discussed by Werden (1987), Tye (1987), and Owen (1990). Key antitrust cases include *MCI Communication Corporation v. AT&T,* 708 F.2nd 1081 (7th Cir., *cert. den.*, 464 U.S. 891 (1983); *United States v. Terminal Railroad Association,* 224 U.S. 383 (1912); and *Otter Tail Power Co. v. United States,* 410 U.S. 366, 372 (1973).

3. We use these terms interchangeably below.

nondiscriminatory basis.[4] We use the shorthand "open access policy" to refer to policy of this type, and "transporter" to designate the operator of a bottleneck facility.

This article offers an initial transaction-cost analysis of open access policy and its effects on the institutions used to govern exchange through bottleneck facilities. While much of the existing empirical work on contracting involves transactions in regulated industries, there has been relatively little investigation of the effects of regulation on vertical integration or long-term contracting, and what there is focuses mainly on the effects of price regulation rather than access policy.[5] The only prior article of which we are aware that integrates open access regulatory policy with an assessment of institutional change is Doane and Spulber's 1991 study of the natural gas spot market. They show that in the wake of open access policy for natural gas pipelines, price movements in regional spot markets have become closely correlated. Their findings suggest that the gas pipeline network has developed to the point that interregional arbitrage opportunities have been largely eliminated.

The novelty of our approach is twofold. First, we identify a set of transactional and regulatory attributes common to most bottleneck facilities. We then use these attributes to structure a general framework that addresses the timing and welfare effects of open access policy (Section 2). As in the antitrust analysis of mergers, there is a trade-off between enhancing competition and exploiting potential cost efficiencies (see Williamson, 1968). Perhaps the most important of the latter are economies that flow from network coordination.[6] We also investigate the implications of open access policy for long-term governance structures in upstream supply, and identify a number of motives for long-term contracting in an open access environment (Section 3).

Our second contribution is to apply our analytic framework to bottleneck facilities in the natural gas industry (Section 4). Gas pipelines historically provided delivered gas service through long-term contracts. The Federal Energy Regulatory Commission (FERC) has recently mandated full unbundling of gas supply and transportation. We discuss the costs and benefits of this policy, arguing that FERC appears to have been oblivious to transaction-cost motives for bundled pipeline service. We then assess the role of long-term contracts after open access, focusing on the fact that gas buyers are heterogeneous in their valuation of supply reliability. We develop testable hypotheses based on the contracting motives identified in Section 3 and evaluate them in light of

4. For example, in telecommunications, open access was implemented by vertical divestiture resulting from antitrust proceedings; the regional Bell operating companies (RBOCs) remain regulated. In electricity, access requirements have evolved on a case-by-case basis under antitrust principles.

5. For example, Goldberg and Erickson (1987) and Crocker and Masten (1988) have shown that price regulation tends to shorten contractual length. For other empirical work on contracts, see Joskow (1987), Hubbard and Weiner (1991).

6. As pointed out by Coase (1937), if control over a complex system is shifted from a single firm to a decentralized price system, transaction costs ("marketing costs" in Coase's terminology) of various types are increased.

the available evidence on recent contracting practices. The dominant motive for long-term contracting after open access appears to be economizing on the transaction costs of providing reliable supply. Concluding comments are made in Section 5.

2. Bottlenecks and Governance Structures: Overview

The electricity, natural gas, long-distance telecommunications, oil, and rail freight industries feature bottleneck transportation facilities with relatively large economies of scale, and substantial asset specificity. Moreover, these facilities initially linked otherwise isolated buyers and sellers. These circumstances have led to similar institutional adaptations and regulatory control.

First, because transportation links feature extremely large quasi-rents, they typically require protection via some form of long-term governance structure. For example, electric transmission lines historically were vertically integrated with both generation and distribution. Similarly, oil pipelines were vertically integrated with refineries.[7]

Second, exchange relationships associated with bottleneck facilities have been governed by regulatory policies that protect both investors and customers. Markets for these infant industries were relatively small, and investment in site-specific transportation capital was risky. Specific investment was protected by limiting entry through elaborate certification procedures. Yet protecting a transporter's specific investment implied that many downstream customers and upstream suppliers would be served by monopoly transporters. To protect consumers, regulators also imposed price and profit controls.

A third important characteristic of bottleneck facilities is that they began as providers of a service that tied upstream supply with transportation of that supply—for example, *delivered* natural gas, electricity, oil, freight, or station-to-station communications. In contrast, after service unbundling, bottleneck facilities must provide a transportation access service, and the remainder of the delivered service bundle may be provided by other firms. Thus, after the breakup of the Bell system, the regional Bell operating companies allow customers to use rival long-distance firms. Likewise, as a condition for a merger, railroads may be required to provide trackage access and so allow customers to ship freight on other firms' trains.[8]

Transporters may choose to tie upstream supply with transportation to enhance efficiency by exploiting vertical economies of scope. These occur when it is cheaper to coordinate upstream and downstream production in a single firm than through arms-length contracts or markets. For example, Kaserman and Mayo (1991: 499) estimate that arms-length contracting between electricity generators and distributors raises costs by 11.95 percent

7. In addition, long-distance telecommunications lines were vertically integrated with the local switch. The Public Utilities Holding Company Act (PUHCA) of 1935 forced vertical disintegration of the natural gas industry.

8. Open access pipelines allow buyers to purchase oil or gas from alternative upstream suppliers. Electricity distribution companies can procure electricity from independent electricity producers by "wheeling" power through open access transmission facilities.

relative to vertically integrated production. One important vertical economy results from the internalization of network externalities. Such externalities occur when the actions of individual buyers and sellers impose external congestion or reliability costs on others. For example, if markets for wellhead gas supply and transportation are separated, individual wellhead producers lack incentives to maintain the systemwide pressure required to provide reliable service to downstream customers.[9]

Transporters may also choose to tie to exploit market power opportunities created by perverse regulatory incentives.[10] If the bottleneck is regulated, backwards integration may allow for cost inflation upstream and the collection of rents through an unregulated upstream affiliate. For example, AT&T was accused of using its manufacturing affiliate, Western Electric, for this purpose prior to divestiture, and the Bell operating companies were excluded from the equipment business for the same reason (Noll and Owen, 1989).[11] If a vertically integrated monopolist's prices (but not its quantities) are regulated, it also might restrict output to increase profits in upstream markets.

A fourth and final bottleneck characteristic is that networks tend to grow in scope and complexity over time. This creates the potential for greater competition upstream of the bottleneck facility (e.g., at the gas wellhead or electric power generation stages).[12] As we discuss more fully below, the natural gas pipeline network grew threefold between 1945 and 1970. The pro-competitive implications of this development are suggested in Doane and Spulber's (1991) finding that regional gas spot markets have merged into a unified national market. On the other hand, more numerous network transactions and greater network complexity imply that the vertical economies associated with network coordination may also increase.

The benefits of open access policy follow from enhancing competition in upstream markets, while the costs derive from the (potential) loss of vertical economies of scope.[13] Greater upstream competition has several beneficial

9. Similarly, a franchise has an incentive to use substandard inputs when the reputational costs are shared throughout the chain. Tying contracts can attentuate this external cost; see Klein and Saft (1985).

10. With a structurally competitive upstream sector, an *unregulated* bottleneck facility would generally have no incentive to foreclose the upstream market. It would, of course, have incentives to charge supracompetitive downstream prices.

11. In a similar vein, the Nevada Public Service Commission recently disallowed $6.2 million from Nevada Power's $18 million coal cost request, arguing that the company's relations with its supposedly unaffiliated coal-production subsidiary "raised major questions about the company's relationship with its subsidiary and its coal contracting practices in general" (*Wall Street Journal*, November 12, 1991).

12. Similarly, extensive development of the oil pipeline network has facilitated competition in the wellhead market; new telecommunication technologies have lowered the cost of long-distance phone calls, and allowed entry into long-distance telephone service.

13. Open access can substantially increase the competitiveness of markets upstream of the bottleneck, as evidenced in the markets for long-distance telecommunications (upstream of the local switch) and wellhead sales of natural gas (upstream of the pipeline). Greater competition would presumably arise in electric power generation (upstream of transmission lines) if mandatory wheeling were enacted. The benefits and costs we identify here are similar to those consid-

effects. Perhaps the most important is that allocative efficiency is enhanced as market prices gradually supplant regulated prices. For example, open access in natural gas alleviated persistent shortages by eliminating long-term contracts with formula-driven prices exceeding market-clearing levels. Greater upstream productive efficiency should also follow from open access policy; for example, independent electric power producers often bid below the cost a regulated utility would incur if it constructed its own new capacity.[14] In addition, removal of rate-of-return regulation allows for a reduction in the resource costs of regulatory oversight. These savings include reduced regulatory personnel, less use of lawyers and expert witnesses in regulatory proceedings, and reduced use of court time in the appeals process. Enhanced upstream competition may also produce spillover efficiencies in related markets. For example, entry into long-distance telecommunications, made possible by open access policy, undermined the traditional cross-subsidy from long-distance to local service (see Noll, 1985). Finally, the presence of a verifiable market price reduces information-gathering costs for those services that must still be regulated.

On the other hand, open access may undermine Coasian efficiencies of coordination. First, as mentioned above, bottleneck facilities commonly feature network externalities which can be internalized through bundling. Second, coordinating interrelated markets by prices rather than bundling may require sequential commitment to transportation and upstream supply. Laboratory experiments find that overall efficiency is reduced substantially when buyers must contract sequentially, committing to one component of delivered service (either transportation or upstream supply) before the other.[15] Finally, valuable transaction-specific assets (e.g., specialized knowledge) may be lost, which reduces the credibility of forming enforceable long-term contracts in the future.

3. Governance Structures in an Open Access Setting

Previous authors have suggested there is little role for long-term governance structures in an open access environment.[16] However, we identify a number of motives for the use of long-term governance structures in transactions with upstream suppliers:

(i) If product quality differs across suppliers but is difficult to verify prior to

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ered in the antitrust literature on "essential facilities"; see, for example, Tye (1987). However, we view things from a regulatory, as opposed to an antitrust, perspective, and place more emphasis on transaction costs and economic institutions.

14. Competition in the market for long-distance telephone service forced AT&T to cut overhead expenses such as underwriting the *Bell Journal of Economics* and sponsoring pure science at Bell Labs; this presumably increased productive efficiency.

15. The Federal Energy Regulatory Commission has sponsored two sets of laboratory experiments in this area, the results of which are summarized in Alger and Toman (1990: 274).

16. Hubbard and Weiner (1991:65) point out: "It is often argued, for example, a switch from private to common carriage [of natural gas] would allow spot markets and short-term marketing arrangements to displace long-term contracts." Note that their distinction between private and common carriage parallels ours between bundled service and unbundled service with nondiscriminatory access.

purchase (an experience good), and if buyers value service quality (e.g., uninterrupted delivery of gas or electricity), then long-term relationships may emerge to protect costly information about supplier quality. To the extent this information is relationship-specific, long-term relational contracts will arise between buyers who value reliability and suppliers found to provide it.[17]

(ii) Unless spot prices are free to adjust instantaneously, demand or supply shocks will periodically cause markets to fail to clear. Reliability-sensitive buyers fear even temporary shortages, and may prefer long-term contracts or bundled service to spot purchases.

(iii) Long-term relationships may be desired, as Coase argued, because they reduce the transaction costs of repeated spot market purchases.

(iv) Long-term contracts may be used to reduce price risk if a complete set of markets for hedging does not exist. Even where futures markets exist, they may not extend far enough into the future to meet all hedging needs.

(v) Imperfections in the access market may create quasi-rents in the upstream market that require protection under long-term contract or integration. Because the bottleneck facility remains a natural monopoly, the terms of access typically will remain regulated. The rigidities that thus arise are similar to those under traditional price regulation. Furthermore, the comparability of access across different users may not be exact; a particular concern is that the bottleneck operator will offer preferable terms to its own upstream affiliate.

4. Open Access and Governance Structures in the Natural Gas Industry

In the remainder of this article, we apply the general arguments made above to the specific case of the natural gas industry. We begin with a brief history of the industry through the 1980s, highlighting the coevolution of technology, regulation, and vertical structure. FERC policy over the last decade has consistently moved toward open access, in the process placing restrictions on contract forms. Our assessment of open access policy turns on two key industry characteristics: (i) buyers vary in their valuation of supply reliability; and (ii) enhanced supply reliability is costly. Two organizational issues are associated with the provision of reliability. First, vertical economies of scope may be associated with bundled service, making FERC's policy of mandatory unbundling (promulgated in Order 636) a policy with questionable economic merit.[18] Second, given an open access setting, the transaction costs of providing reliable service may be minimized through the use of long-term contracts, as argued above. Building on the motives for long-term contracting identified in Section 3, we develop a number of testable hypotheses and assess them using the available evidence on contracting in the open access environment.

17. Experiments on relational contracting by Hackett, Wiggins, and Battalio (1993) find that when supplier quality information is costly and relationship-specific, long-term exchange relationships form when buyers successfully find quality suppliers.

18. While we would also like to offer some numerical estimates of the welfare effects of open access policy, data availability precludes such analysis at this time. It will be some years yet before an organizational equilibrium can be reached. A particular difficulty is the FERC Order 636 imposes mandatory unbundling of transportation from gas supply. This precludes the observation of the bundled service alternative, even if it were the most efficient organizational form.

4.1 Historical Background

The governance of vertical relationships in the natural gas industry has changed greatly over time.[19] In the early 20th century, gas supplies were predominantly from the Appalachian area, and relatively short pipelines were adequate to move the supplies to markets in the northeast. Most producers had access to multiple pipelines, and—consistent with predictions from transaction-cost reasoning—short-term contracts were the typical mode of exchange between wellhead producer and pipeline. In the 1920s, new supplies in the southwest and improved pipeline technology led to the building of long-distance pipelines to end-use markets in the midwest and northeast. Many producing fields were served by a single pipeline, taking advantage of the scale economies in pipeline gas transportation. Vertical integration became common. Many pipelines and producing fields were owned jointly by several local distribution companies downstream, thereby countering the increased potential for opportunism arising from highly specific assets. Vertical relationships were transformed again in the 1930s by the Public Utility Holding Company Act (PUHCA) of 1935 and the Natural Gas Act (NGA) of 1938. The PUHCA separated most distribution companies from the upstream pipeline/production entities. The NGA subjected the pipelines to public-utility-style regulation by the Federal Power Commission (FPC). FPC accounting practices had the effect of reducing the profitability of pipelines owning gas production sites, and, according to Mulherin (1986: 533), "interstate pipelines constructed after the Natural Gas Act was implemented produced no gas of consequence themselves but instead purchased their supplies from unaffiliated producers."

While the originally proposed text of the NGA called for pipelines to provide unbundled transportation services on a nondiscriminatory basis, pipeline protestations eliminated this requirement, and pipelines were allowed to provided bundled service to downstream ("citygate") markets. Bundled service increased the scope of pipeline opportunism by allowing pipelines to credibly threaten to cut off a producer's market access. Producers thus had incentives to obtain long-term contracts with minimum purchase guarantees ("take-or-pay clauses"). Pipelines in turn passed these purchase obligations downstream via contracts with local distribution companies (LDCs) that included minimum bills.

Contracts between producer and pipeline typically had a variety of price adjustment provisions, the most common of which 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" (Crocker and Masten, 1991: 80). Contracts between pipeline and local distribution company generally set price at the pipeline's weighted average cost of gas (WACOG).

In 1954 the Supreme Court's decision in *Phillips Petroleum v. Wisconsin,* 347 U.S. 672 (1954), required the FPC to regulate prices at the wellhead. By

19. Our discussion of industry history closely follows Mulherin (1986).

the 1970s, price regulation was causing serious shortages in the interstate gas market, and in 1978 the U.S. Congress attempted to remedy this problem by passing the Natural Gas Policy Act (NGPA). The NGPA divided the wellhead market into a complex set of categories with differing price ceilings that escalated over time. Price ceilings for categories such as "high cost" gas were high enough to induce substantial new exploration and development, and new contracts often indexed the highest applicable NGPA price ceiling.

During the 1950s and 1960s, the pipeline network expanded rapidly, growing from a total of 82,000 miles in 1945 to 252,000 miles in 1970. Growth rates dropped precipitously after 1970, indicating the maturation of the transmission network. However, the higher wellhead prices allowed under the NGPA brought forth substantial growth in gathering lines connecting pipelines to wells (American Gas Association, 1948; U.S. Bureau of the Census, 1970, 1991). Thus, by 1985 technological improvement and network expansion had created a system in which open access stood to significantly enhance competition at the wellhead.

FERC policy from the mid-1980s into the 1990s has moved consistently toward enhanced competition in the wellhead market and greater access to pipeline transportation.[20] The first major regulatory step toward open access was Order 436, promulgated in 1985. Under Order 436, a pipeline was free to choose whether to adopt open access status, but if it wanted to provide any unbundled transportation services at all, it had to offer these services on a nondiscriminatory basis to all customers. Eventually, all major pipelines chose to become open access transporters.

Open access fostered the growth of a successful market in interruptible gas supply. However, increased sales by non-pipeline suppliers came at the expense of reduced pipeline sales, and pipelines were left with contractual obligations to "take or pay" for gas at prices well above market-clearing levels. The D.C. Court of Appeals eventually remanded Order 436 to the FERC for reconsideration, largely because of its "insouciance" on the take-or-pay issue. FERC's response, Order 500, attempted to (among other things) lay the groundwork for an industry structure in which a take-or-pay crisis could never again emerge. One part of its program was the establishment of "gas inventory charges" (GICs) that would allow pipelines to recover the costs of assuring reliable gas supply, but would be more flexible than the old take-or-pay contracts.

While FERC's open access program was largely successful for interruptible supply, a growing chorus of complaints eventually made clear to FERC that the provision of firm supply and transportation was a much more complex task. One key concern was that pipelines were unduly favoring their own gas supply affiliates in developing transportation arrangements. However, pipelines argued that they were forced to hold substantial capacity in reserve for

20. Because the evolution of recent gas policy has been well documented in several other papers, here we limit ourselves to a very broad overview of recent policy developments. See, for example, Pierce (1988).

peak periods, in order to meet their ongoing obligations to provide reliable delivered supply to LDCs. Consistent with both of the above arguments, bundled pipeline service in 1991 accounted for 52.5 percent of peak day deliveries, but only 18.8 percent of total annual throughput (FERC, 1992: 13273).

FERC Order 636 was designed to solve a number of problems in the provision of reliable gas deliveries. FERC Order 636 sought to assure competitive access to firm transportation by requiring pipelines to unbundle all services (e.g., gas supply, transportation, storage, etc.) and offer them individually on a nondiscriminatory basis. At the same time, pipelines were no longer required to petition FERC for permission to abandon service to buyers whose contracts had expired. Our assessment of Order 636 turns on several important transactional characteristics, which we briefly describe below.

4.2 Transactional Characteristics of the Natural Gas Industry

An important feature of the natural gas industry is the heterogeneity of consumers. Residential customers can neither store gas nor readily switch their heating and cooking appliances from gas to other fuels in response to short-run price variations or delivery interruptions. High short-run switching costs make reliability particularly important for these customers, who comprised roughly 26 percent of sales volume in 1990. In contrast, many industrial and electric utility customers have dual-fuel boiler technology that allows them to switch instantaneously to on-site storable fuels in the event of gas price increases or delivery interruptions. Low short-run switching costs make reliability a minor concern for these customers, who comprised roughly 32 percent of sales in 1990.[21]

In natural gas, reliable service takes two slightly different forms. One, called "instantaneous" service, allows a buyer to take gas out of the pipeline downstream as soon as the buyer has gas put into the pipeline upstream. The pipeline typically requires a producer selling under an instantaneous service contract to nominate its demand level a few days in advance of actual delivery. The pipeline then monitors whether the designated supplier has delivered on a timely basis, and, if it has not, can interrupt the service of the buyer whose supply has failed. A second type of service, called "no notice" peak service, allows a buyer to take as much gas as needed without giving advance warning to the pipeline or putting equivalent amounts of gas into the pipeline upstream.

Reliability costs can be divided into two components. First are inventory costs of holding excess gas deliverability at the wellhead or in downstream storage facilities. Second are pipeline costs such as holding excess transportation capacity, maintaining extra system pressure (called "linepack"), and monitoring suppliers. When gas supply and transportation are unbundled, there

21. Industrial and electric utility customers comprised 58 percent of gas sales in 1990. According to the *Wall Street Journal* (October 12, 1992: A1), 55 percent of these customers have dual-fuel capability. Commercial customers account for 16 percent of total sales. Data on sales by customer class are from *Natural Gas Monthly* (U.S. Dept. of Energy, 1991), p. 13.

are potential network externalities in maintaining system pressure. If a producer takes costly actions to maintain system pressure, the benefits are shared by all users of the system, thus creating a standard free-rider problem. When the pipeline provides bundled service, its rights to control operation of the system are more complete than under decentralized contracting in an unbundled environment. These residual rights of control are similar to those identified by Grossman and Hart (1986) as central to vertically integrated production. A maintained hypothesis in the contracting literature is that residual rights of control cannot be separated from asset ownership. Because bundled service allows the pipeline to internalize network externalities, an unbundled system that achieves the same level of reliability is expected to generate greater costs.

4.3 Reliable Gas Delivery: A Transaction-Cost Critique of Order 636

In a recent issue of this journal, Joskow (1991) argues that transaction-cost economics merits an increased role in public utility policy-making, particularly with respect to issues of vertical restructuring. Recent refinements of open access policy in natural gas demonstrate well the value of transaction-cost reasoning in the policy process. We focus on the transactional complexities involved in the organization of a market for "firm" (reliable) transportation services. This issue has been of particular difficulty for the FERC, and was addressed in the recent FERC Order 636, which mandates the unbundling of gas supply from pipeline transportation. Keeping in mind the costs and benefits of open access discussed in Section 2, we argue that FERC has paid insufficient attention to the transaction costs of mandatory unbundling.

The FERC is clearly sensitive to the benefits of unbundling, but appears less aware of the potential costs. This is illustrated in Order 636, where the FERC states that after full unbundling, a customer will be able to "receive its natural gas supplies in a fashion as reliable as the customer had been receiving under a bundled, citygate service, with the added advantage of providing greater opportunities to purchase that supply at competitive prices. Hence, the customer will have the 'best of both worlds'—reliable service and competitively priced gas" (FERC, 1992: 13288). While FERC clearly recognizes—but rejects—the possibility of degraded service reliability, it appears to assume that organizational form has no impact on transportation *costs.*

Throughout Order 636, the FERC discusses in surprising detail the operational consequences of full unbundling for pipelines, illustrating in the process the complexity of the transactions involved. For example, FERC has been quite explicit regarding unbundled pipeline tariffs, which will clearly be very complex contingent contracts. FERC requires that pipelines set forth in their tariffs

> their methods for allocating aggregate receipt point capacity, individual receipt point capacity, mainline segment capacity, storage capacity, and delivery point capacity[;] . . . provisions governing shipper flexibility in changing receipt and delivery points[;] . . . provisions concerning supply and capacity curtailments, the scheduling of gas injections into the mainline and into storage, the scheduling of gas deliveries from storage and from

> the mainline, the setting and charging of penalties, balancing rights, and the instantaneous receipt and delivery of gas[;] . . . [and] provisions under which they will provide the "no-notice" transportation service required by this rule. (FERC, 1992: 13282)

FERC also recognizes the importance of network externalities and the usefulness of vertical command-and-control governance structures.

> Because the pipeline is operating as a transporter, its ability to effectively manage its system will depend in part on its shippers injecting gas into the mainline (packing the line) and into storage at the right place and time. While the pipeline and its shippers (or their suppliers or agents) may be able to achieve what is needed through communication, cooperation, coordination, and compromise, it may be necessary for the pipeline to retain compulsory powers where it dictates to shippers where and when to act by, for example, operational flow orders. All shippers must recognize that the action or nonaction by a single shipper may affect a pipeline's ability to serve all other shippers. (FERC, 1992: 13287)

While the exact contractual meaning of "compulsory powers" is unclear, it suggests that contracts must be incomplete, and assigns residual rights of control to the pipeline independent of ownership of gas in the system.

The one place in Order 636 where the FERC explicitly recognizes the potential transaction costs of unbundling comes when it states that pipelines and customers need to consider

> the need for appropriate equipment to accurately monitor and measure injections into the system on a timely basis. It may not be cost-effective on some pipeline systems to install the necessary equipment. In those cases, the pipelines should consider allowing other gas merchants to provide the pipeline with pre-determined allocation plans for the merchant's gas. (FERC, 1992: 13290)

The above quotes show that the provision of reliable supply in a fully unbundled marketplace will involve the coordination of many individual transactions; the use of detailed contingent contracts between suppliers, buyers, and the pipeline; extensive monitoring of supplier quality; and a considerable amount of residual command-and-control authority on the part of the pipeline. These are exactly the sort of transactional characteristics that we identified above as likely to lead to bundled service.

Concern over the transaction costs of unbundling was manifested during FERC deliberations over Order 636. In their recorded comments to the Notice Of Proposed Rule (NOPR) for Order 636, a number of pipeline companies argued that bundling was *necessary* for reliable no-notice service. A later technical conference sponsored by FERC, however, determined that such service can be provided *as long as* pipelines are allowed to "retain adequate operational control of the use of their facilities" (FERC, 1992: 13278). This policy represents an experiment in divorcing residual rights of control from asset (gas) ownership. Even if we accept the apparent industry consensus that system reliability can be maintained, we predict the cost of internalizing externalities in the unbundled system will be greater than in the bundled system.

4.4 Governance Structures in an Open Access Setting: Transaction-Cost Predictions and Evidence

In this section we combine our general framework for analyzing the governance of bottleneck transactions with the microanalytic detail of natural gas institutions and regulations from the preceding section to arrive at some potentially testable hypotheses. We begin by identifying the hypotheses that follow from each of motives for contracting discussed in Section 3. We then evaluate these hypotheses using the available evidence on the scope, pricing, and structure of long-term contracts in the open access environment.[22]

4.4.1 Summary of Hypotheses.

Although we have identified five motives for long-term contracting after open access, their relative importance is an empirical question. As we discussed above, customers are heterogeneous with respect to their demand for supply reliability, and reliability implies added costs. Recognizing these characteristics, we develop below a number of testable hypotheses regarding the role of long-term contracts in the open access environment.

First, suppliers vary in their ability to deliver reliable service, so if supplier quality information is important and costly, then we should observe the coexistence of spot transactions and long-term contracts. Duann, Burns, and Nagler (1989: 51) note that "[l]iterally thousands of potential suppliers and many gas transporters exist. All have diverse sizes, financial conditions, gas field locations, ownership affiliations, and years of experience in the gas industry. Tasks such as finding suppliers, evaluating their reliability, and arranging transportation require an intensive effort in collecting data and analyzing alternatives." Roughly 32 percent of gas sales are to dual-fuel customers who assign a small value to gas supply reliability. These customers will not pay to assess the quality of a supplier, and have no incentive to lock in particular suppliers via long-term contract. In contrast, residential customers comprise roughly 25 percent of total sales, and assign a high value to service reliability. This characteristic generates a motive for assessing supplier quality. Assessment costs are minimized by locking in quality suppliers, once they are found, to long-term contracts. In the resulting separating equilibrium, spot sales should be bounded between 32 percent and 75 percent. The remainder of sales occur through contracts with reliability-sensitive buyers, who pay a price premium that reflects the added resource costs of providing premium reliable service. Furthermore, contracts should have considerable quantity flexibility, since reliability-sensitive buyers have demand that is strongly affected by temperature.

Second, price stickiness also leads to a mix of spot purchases and long-term contracting, but for slightly different reasons. Because gas is a flow good, the Coasian transaction costs of continuous real-time pricing are high; instead, prices remain fixed for at least some minimal length of time. (The standard

22. Unfortunately, the study of contracting within the gas industry has become more difficult since FERC ceased requiring the filing of contract information for transactions in which the pipeline serves only as a transporter.

"spot" contract in the industry lasts for 30 days.) Supply or demand shocks that occur during this period thus can lead to temporary shortages. Reliability-sensitive buyers are willing to bypass the market and enter a contract with a supplier at a price reflecting the added cost of reliability. Again, quantity flexibility should be observed in such contracts.

Third, if the transaction costs of repeated spot exchange dominate other motives for contractual choice, we should observe only long-term contracts. We would expect these contracts to allow considerable quantity flexibility, allowing buyers to adjust to temperature-induced shifts in demand. Conversely, if the costs of repeated exchange are small, "spot" (or short-term contract) exchange should be adequate for all transactions, regardless of the degree of reliability involved. In either case, we would expect a price premium for reliable supply that reflects the added costs of providing reliability.

Fourth, if some buyers and sellers are averse to income variance, we should observe long-term contracts with relatively rigid prices and quantities coexisting with a spot market. As shown by Hubbard and Weiner (1992), the size of a contract price premium and the scope of the spot market depend upon the distribution of risk preference among buyers and sellers, and the relative importance of demand and supply shocks in the industry. In the gas industry, we would expect demand shocks to be more important, since uncertainty over both future weather conditions and the price of alternate fuels is critical. Given this, the Hubbard and Weiner (1992) model predicts that relatively rigid contract prices should be *below* expected spot prices.[23] Furthermore, an increase in demand uncertainty should increase reliance on contracting. One can argue that gas demand uncertainty increased over the 1980s, as the number of dual-fuel customers grew and interfuel competition intensified. Thus, the scope of the spot market should have narrowed.

Fifth, if there are regulatory rigidities in the transportation market or imperfect comparability of access, sellers lack perfect access to alternative buyers. This lowers the value of their product in the next best use, creating quasi-rents appropriable by the pipeline. We expect to see such quasi-rents protected under long-term contracts with minimum quantity constraints, as occurred before open access.

4.4.2 Evidence.

Extent of the Spot Market. The spot market in natural gas grew steadily from 5 percent of total sales in 1983 to 75 percent in 1988. Since then it has

23. If there is no long-term contracting, a sudden outward shift of the downstream demand curve will increase sales and raise spot prices. Producer profits rise, and consumer surplus also increases, at least for additive demand shocks. Hence, spot prices covary positively with income for both producers and consumers. Now suppose market participants consider signing a forward contract at a fixed price, a move akin to speculating on the futures market. For buyers, speculative profits increase with the spot price, adding to net variance. Risk-averse buyers will require a contract discount to offset the increase in income variance. For sellers, speculative profits decrease with the spot price, reducing net variance. Risk-averse sellers find this reduction in variance desirable, so competitive pressures lead to a contract price discount.

declined to 65 percent in 1989, 50 percent in 1990, 45 percent in 1991, and is estimated to be 35 to 40 percent in 1992.[24] These sales are solely for undifferentiated interruptible gas supply.

Since 1986, the percentage of trade in the spot market has been in the range predicted by the reliability-based explanations for contracting. As the data show, for several years the scope of the spot market trended near the top of the predicted range. This high reliance on the spot market was driven in large part by regulatory pricing distortions. As we discussed in Section 4.1, the NGPA created incentives for massive sunk investment in new wellhead supplies. While this investment was taking place, falling oil prices enticed many gas buyers to switch fuels, ultimately leading to a collapse in natural gas prices. At the same time, pipelines retained an obligation to stand ready to provide no-notice reliable peak service to LDCs. Thus, LDCs (whose customers highly value reliability) could shop for bargains in the spot market, knowing the pipeline was obliged to be available as a backstop supplier on peak days. As market conditions have begun to equilibrate, however, LDCs have reduced their use of spot supplies. This decline in use of the spot market by reliability-sensitive buyers is unlikely to be reversed, since Order 636 eliminated the pipeline's role as backstop supplier.

The very existence of a spot market shows that pure Coasian transaction costs are not prohibitively high; given this, however, a notion more subtle than simple repeat purchase costs is required to explain the fact that spot sales do not account for 100% of gas trade. The risk-aversion hypothesis is not supported by the evidence, since spot sales grew rather than shrank as oil price shocks increased demand uncertainty in the early to mid-1980s. The emergence of a robust spot market does suggest that open access has reduced the potential for opportunistic holdup by pipelines, though the threat of holdup apparently has not been eliminated.

Relative Prices in Long-term Contracts and Spot Purchases. An analysis of long-term contract and spot price data from Louisiana for the period from November 28, 1988, to February 5, 1990, reveals that the average spot price was $1.68 while the average contract price was $1.83, reflecting a price premium of $.15. The standard deviation of spot prices was .25 while that for contract prices was only .09.[25] Similar findings are reported by Henderson et al. (1988). They collected and analyzed data on a group of 28 long-term contracts that were signed or modified between January 1985 and July 1987; "each contract . . . was matched with a corresponding spot price at the time the long-term contract was signed and at the distributor's location" (Henderson et al., 1988: 58). The estimated relation between contract price P_c and

24. Source: Benjamin Schlesinger and Associates (1992). The convention in the industry is to refer to contracts of 30 days or less as "spot" sales.

25. Source: *Natural Gas Intelligence,* Louisiana region, November 28, 1988–February 5, 1990. The data include all contracts of one year or more in duration, the standard for long-term duration in the gas industry, and are taken from "new contracts, renegotiations, posted prices, and market out actions." Price reports are given as a range from low to high each week.

spot price P_s is $P_c = .363 + .929P_s$. The R^2 for the equation was .917, and the t-ratios for the constant and the coefficient were 2.887 and 16.947, respectively. From 1984 through 1991, spot prices ranged from approximately \$.90 to \$3.50, and in the period for which the regression was estimated, they ranged from approximately \$1.20 to \$3.35 (see Doane and Spulber, 1991: Figure 4). Using the broader range of prices from 1984 to 1991, the resulting contract price premium estimates range from \$.30 to \$.11.[26]

The existence of a price premium is consistent with the notion that contracts are used to reduce the transaction costs of providing reliable supply. As mentioned above, however, the coexistence of spot sales and long-term contracts is inconsistent with the hypothesis that the costs of repeated exchange drive contracting in this industry. Again, the evidence lends little support to the risk-aversion hypothesis, suggesting that reliability costs dominate risk avoidance in the determination of contract prices. Access imperfections do not generate clear predictions regarding price premiums.

Predictions Regarding Contract Forms. The contracts that are emerging in the open access environment exhibit a variety of different structures. In addition to a maximum purchase level, some contain a minimum purchase threshold, below which the buyer is obligated to pay a "deficiency charge" for each untaken unit.[27] This structure initially emerged in applications by pipeline companies to the FERC for permission to include a "gas inventory charge" (GIC) in rates; the GIC was designed to allow the pipeline to cover its costs of providing long-term reliable supply (see FERC, 1987). interestingly, the same contract structures are also appearing in contracts between wellhead producers and downstream customers. For example, Southern California Gas Company recently asked the California Public Utilities Commission (CPUC) to approve a set of contracts with minimum takes of 50 percent to 90 percent of the maximum level, and deficiency charges of \$.25/MMBtu (see CPUC, 1991).

On the other hand, some contracts forgo minimum take provisions. For example, Indiana Gas Company recently signed a set of 13 long-term contracts whose total volume represents about 25 percent of the company's annual purchases and 60 percent of purchases on a peak day. There is no minimum take level in the contracts, and performance is guaranteed by the seller. The contracts use a two-part pricing structure. Commodity prices are indexed to spot price reports from *Inside FERC's Gas Market Report*. The demand charge pays for first place in the allocation queue during peak demand periods.[28]

Either of these contract forms is consistent with the hypothesis that con-

26. The existence of a contract price premium is also reported by Schlesinger in CPUC (1992) based on his firm's confidential analysis of 40 long-term contracts for reliable supply.

27. Under a traditional take-or-pay contract, the buyer pays a lump sum for any quantity below the minimum threshold.

28. Personal communication from Curt Hribernik, Manager of Gas Supply, Indiana Gas Company, March 12, 1992.

tracts are used for supply reliability. A deficiency charge may reflect a producer's opportunity cost of holding excess deliverability in reserve for a given buyer. In a two-part tariff, each part is an instrument that addresses a particular contractual problem. The fixed portion of the contract reflects the value of a high-priority position for the allocation of supplies if demand shocks exceed production capacity. As before, Coasian costs of repeated exchange have little implication for the structure of contracts. If contracting is driven by risk aversion, contracts should have rigid price and quantity terms, which are observed in neither of the contract forms described above. Again the evidence does not support the risk-aversion hypothesis.

Finally, the differences in contract forms are consistent with the notion that the access problems faced by producers vary. When there are potential holdup problems associated with the gas pipeline bottleneck after open access, we would expect contracts with quantity and perhaps price assurance to prevent ex post opportunism. The use of minimum take thresholds with deficiency charges may be appropriate for producers who face restricted alternatives for the sale of their gas and are unable to sell untaken quantities on the spot market. Such restrictions may occur if a new gas field is drilled and has limited access to downstream markets, or may be due to rigidities in transportation markets. On the other hand, even before Order 636's mandatory unbundling, some pipelines had chosen to abandon the merchant function and provide only transportation service. Under these circumstances, pipelines have no incentive to hold up producer sales, and sellers do not need quantity protection in contracts.

Contract price flexibility has the benefit of allowing for efficient adaptation to supply and demand shocks, but thwarts the price stability desired by risk-averse traders. One way to achieve price flexibility is by indexing contract prices to spot prices. Evidence suggests indexed contracts are being used in the gas industry. For example, the regression by Henderson et al. (1988) shows contract and spot prices to be closely correlated. In fact, the hypothesis that the correlation is perfect cannot be rejected at standard significance levels. Moreover, consultant Schlesinger (1991: 5) claims that "[i]ncreasingly, the pricing provisions contained in new long-term gas purchase contracts are being written to reference prices reflective of gas spot markets." Such contracts provide little insurance against price fluctuations, thus further undercutting the risk-aversion explanation for long-term contracts.

The success of indexing here may be surprising to some. Goldberg (1985: 542) remarks that "[i]f a unique, easily observable market price existed, the [price] adjustment problem would not be difficult. However, the conditions that make entering into a long-term contract desirable in the first instance make it unlikely that such prices exist. . . . The problem is that by entering into the long-term contract at least one of the parties deliberately isolated itself from the external market. The relationship between the external price and the opportunity costs of the parties need not be very close." In the case of natural gas, however, the homogeneity of methane molecules combines with the heterogeneity of buyers to make indexing possible. The spot market, made feasible by customers with low fuel-switching costs, provides an external benefit to customers who value reliability more highly, allowing them to write more efficient, indexed contracts.

Summary of Evidence. The above evidence is entirely consistent with the notion that long-term contracts are used to reduce the transaction costs of providing reliable gas supply. The extent of the spot market is consistent with the mix of downstream customer types; the price premium for long-term contracts reflects the added cost of reliability; and the structures used in new long-term contracts are consistent with an attempt to reflect the cost of reliability in an efficient fashion, shaped by potential access restrictions. The hypothesis that contracts are used only to reduce the transaction costs of repeated spot exchange cannot explain the emergence of a sizable spot market, and gives little insight into the prices and structures of the contracts that have been signed. Nor does the risk-sharing hypothesis find much support in the available evidence. Neither the growth of spot sales nor the observed price premium in contracts are predicted by an income-smoothing model with increasingly important demand shocks. Furthermore, contracts lack the price and quantity rigidity predicted by the model. Finally, the growth of a spot market and reduced quantity rigidity in remaining contracts suggest that open access has successfully given producers access to alternative buyers, and so reduced the threat of pipeline opportunism.

5. Concluding Comments

Open access requirements are an increasingly common remedy for problems of market power in network industries such as natural gas, electricity, and telephones. The benefits of such policy—greater competition upstream of bottleneck facilities— must be traded off against the cost of potential loss of vertical economies. The transactional characteristics of each particular industry largely determine the importance of this cost, and also determine the nature of the long-term governance structures that emerge in the wake of open access. We have discussed the key transactional characteristics of these network industries, laid out a framework for assessing costs and benefits, and identified motives for long-term contractual relationships in an open access setting. We then applied these general considerations to a case study involving the natural gas industry.

Given the difficulties inherent in measuring the costs and benefits of unbundling, it seems to us that prudent public policy should leave as much room as possible for efficient governance structures to emerge. FERC's prohibition in Order 636 on bundled service forecloses this potentially efficient option. Furthermore, regulatory costs under Order 636 may increase, since FERC requirements for nondiscrimination will now extend to a vast array of pipeline interactions with buyers and sellers. If FERC later reverses its policy prohibiting bundling, this should be taken as evidence that residual rights of control (of gas flow) cannot easily be separated from ownership.

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