Preventing Exclusion at the Bottleneck:
Structural and Behavioral Approaches[*]

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1. INTRODUCTION

Competition has entered the regulated network industries with a vengeance over the last 15 years. In the natural gas industry, the combination of deregulated wellhead prices and open access to pipeline transportation now supports a robust futures market. In telecommunications, long-distance prices continue to fall as new technologies and corporate restructurings promise even greater competition in the near future. In electricity, bidding markets continue to supplant monopoly provision of power.

In all these industries, concerns about *whether* to provide competitive access to the distribution grid have given way to concerns about the *terms* under which access is offered. Most observers agree that the physical networks of pipes and wires connecting consumers to the system will continue to be regulated monopolies for some time to come. The challenge for policy is how best to govern the vertical relationship between the competitive "upstream" markets for gas, electricity or phone calls and the monopolistic "downstream" distribution networks that deliver these products.[1] Of particular concern is that vertically integrated firms may have incentives to leverage their market power at the distribution "bottleneck" into market power in the content market. For example, the divestiture of the Bell Operating Companies from AT&T was done in significant part because of AT&T's long history of anticompetitive actions designed to suppress competition in the telecommunications industry, despite the attempts of regulators to prevent such abuses.[2] Similarly, regulatory decisions in natural

[*] I would like to thank David Mandy, Saikat Sen, Dennis Weisman, and Frank Wolak for helpful comments.

[1] Long-distance telephone service is both Adownstream@ of the originating local exchange and Aupstream@ of the terminating local exchange. For simplicity and consistency with other utility industries, however, I will use the term Aupstream@ exclusively throughout this paper.

[2] According to Noll and Owen (1989, p. 295), AThe essence of the government=s case against the Bell System was that it had used its status as a regulated monopoly in most of its markets to erect anticompetitive barriers to entry in potentially competitive markets.

gas and electricity have been driven in part by concerns about anticompetitive actions by vertically-integrated incumbents.[3]

The most powerful way to prevent abuse of market power at bottleneck facilities is to require that bottleneck owners divest themselves of their stakes in the upstream market. This *structural* approach was taken in the AT&T divestiture, for example. By separating the local operating companies from the potentially competitive long-distance market, the court aimed to nip all anti-competitive misconduct in the bud. In many cases, however, regulators have been reluctant to impose vertical divestiture; for fear that vertical economies of scope between the upstream and downstream markets would be lost. Instead, they have allowed vertically integrated firms to operate in the upstream market, hoping that *behavioral* restrictions would be adequate to prevent monopolistic abuses.[4]

One approach is to regulate the price of bottleneck access in such a way that the bottleneck owner has no incentive to discriminate. Laffont and Tirole (2000), for example, argue that a global price cap (which covers the price of bottleneck access as well as the price of retail products) can eliminate incentives for discrimination. This approach has not proven popular with US regulatory bodies, however, for several reasons. First, this approach requires ongoing regulation of potentially competitive industry segments like electricity generation, natural gas production or long-distance telephone service. Many industry observers want to see full deregulation of these segments rather than permanent regulatory control. Second, the bottleneck owner's incentive to exclude rivals is only eliminated if access prices include a substantial markup over marginal cost, e.g. if they are at Ramsey pricing levels. Ramsey pricing, while attractive from a theoretical perspective, has never been politically popular with regulators. Third, a global price cap does not prevent the bottleneck owner from engaging in a price squeeze, raising the access price and simultaneously reducing its own retail price, thereby squeezing the profits out of rivals and potentially driving them out of business. For all of these reasons, US regulatory policy is likely to leave bottleneck owners with incentives to discriminate against rivals and attempt to exclude them from access to the bottleneck, and I will assume such throughout the remainder of the paper. As a result, US policy must

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The novel feature of this line of argument was that much of the Bell System=s anticompetitive behavior was economically rewarding to the company only because it was regulated and, consequently, that one arena of public policy, economic regulation, was a cause of illegal acts in another area, antitrust...@

[3] For example, FERC Order 888 Appendix C contains a collection of detailed case studies of such actions in the electricity industry.

[4] There is some variation in the usage of the term Astructural@ in the literature on open access policy. For the sake of clarity, I will reserve the use of this term for policies that effect a change in the ownership of at least some assets within an industry.

also be concerned with behavioral restrictions designed to prevent discriminatory behavior.[5]

The proper form for behavioral restrictions on vertically integrated monopolists, and the appropriate institutions for enforcing them, have been matters of considerable controversy. Much has been written of late on the relative merits of institutions such as independent system operators and regional transmission organizations. Similarly, the use of codes of conduct for bottleneck owners has produced sharp disagreements: "Some... argue that the emerging Codes of Conduct are an unnecessary overlay on existing antitrust laws and that the market should be allowed to govern. Others point to a list of problems as evidence of unwillingness (perhaps, inability) of the incumbents to control themselves. Successful compliance is more difficult than many recognize, but it is clear that a workable solution must be developed."[6] Divestiture, of course, is always a potentially explosive issue.

The purpose of this paper is twofold. First, I lay out a preliminary comparative institutional analysis of several alternative mechanisms for preventing non-price discrimination by bottleneck monopolists. Second, I use this analysis to understand better the differing institutions that have been used in the natural gas, electricity, and telecommunications industries.

The organization of the paper is as follows. Section 2 explores the nature of the economic problem in more detail, while section 3 surveys the regulatory response in the three industries discussed above. Section 5 is the heart of the paper, and lays out the comparative analysis of alternative institutions for bottleneck governance. Section 6 concludes.

2. THE ECONOMICS OF BOTTLENECK FACILITIES

The electricity, natural gas, and telecommunications industries all involve networks of "transportation" facilities with relatively large economies of scale, and substantial asset specificity. (Where these facilities are monopolistic, I refer to them as "bottleneck" facilities.) Moreover, these networks initially linked otherwise isolated buyers and sellers. As a result,

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[5] Theoretical analyses of the incentive for non-price discrimination have been presented by Economides (1998), Sibley and Weisman (1998), Weisman (1999, 2000) and Mandy (2000a). The incentives for discrimination are ambiguous in general, but discrimination is more likely the more efficient is the bottleneck owner in the upstream market and the more homogeneous are upstream products. The foregoing papers generally conclude that conditions in the telecommunications industry are such that bottleneck owners are likely to have an incentive to exclude rivals.

[6] Hogan (1998, p. 13). For sharper positions for and against codes of conduct, see Jones (1998) and Heaton (1997).

these industries have developed similar sets of institutional adaptations and regulatory controls.[7]

Because network links feature extremely large quasi-rents, they typically require protection via some form of long-term governance structure.[8] Regulation supported specific investment 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. These controls further served to support consumer investments in equipment designed specifically for use with a certain type of network, *e.g.* natural gas stoves and furnaces or electric lights and refrigerators.[9]

Bottleneck facilities typically began as providers of a service that tied upstream supply with transportation of that supply, *e.g. delivered* natural gas, electricity, oil, freight, or station-to-station communications. The bundling together of the upstream supply with transportation service may be motivated by efficiency, market power, or both.

Network owners may choose to bundle 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, p. 499) estimate that arms-length contracting between electricity generators and distributors raises costs by 11.95 percent 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 benefits (the ability to call a wider network of people) or costs (such as congestion or unreliability) on other network users. For example, if markets for wellhead gas supply and transportation are separated, individual wellhead producers lack incentives to maintain the system wide pressure required to provide reliable service to downstream customers.

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[7] This section draws heavily upon Lyon and Hackett (1993), which offers a more detailed transaction-cost analysis of the evolution of regulated industries, with special emphasis on the natural gas industry.

[8] Vertical integration has often been an important part of this protection. Electric transmission lines historically were vertically integrated with both generation and distribution. Similarly, oil pipelines were vertically integrated with refineries. 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.

[9] See Lyon and Huang (2000) for a formal model of regulation's role in supporting specific investment by both buyer and seller.

Network operators may also choose to bundle to exploit market power opportunities created by perverse regulatory incentives. 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.[10] If a vertically integrated monopolist's prices (but not its quantities) are regulated, it also might restrict output to increase profits in upstream markets.

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. Greater upstream competition has several beneficial effects. Perhaps the most important is that innovation will be stimulated by competition. Another important benefit is that allocative efficiency is enhanced as market prices gradually supplant regulated prices. For example, open access in natural gas helped alleviate persistent shortages by allowing the emergence of a spot market with flexible prices that respond to market signals. Greater upstream productive efficiency should also follow from open access policy, *e.g.* independent electric power producers often bid below the cost a regulated utility would incur if it constructed its own new capacity. 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. 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

[10] See Noll and Owen (1989).

other.[11] 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. Thus, just as in the antitrust analysis of mergers, there is a tradeoff between enhancing competition and exploiting potential cost efficiencies.[12]

3. STRUCTURAL AND BEHAVIORAL REMEDIES

As mentioned in the introduction, it is possible in theory to set access prices so that bottleneck owners have no incentive to discriminate against rivals. Nevertheless, there are substantial political obstacles to setting such prices in regulated industries. Instead, regulators have generally relied on one of two generic approaches to limiting the market power of bottleneck monopolists in upstream markets: structural or behavioral methods. Both have been used in recent cases. The term "structural" has been used in various ways by different authors, but I will reserve the use of this term for policies that change the ownership of at least some assets in an industry.

The key *structural* remedy for market power is divestiture. Under divestiture, the bottleneck monopolist no longer maintains an ownership stake in the upstream market. In the electricity industry, for example, divestiture is typically accomplished by having the incumbent auction off its generation assets. This approach ensures that the bottleneck monopolist has no incentive or ability to distort competition in the upstream market.

There are numerous *behavioral* approaches to constraining the exercise of market power. They include the creation of an independent system operator to run a firm's transmission assets, creation of a utility marketing affiliate that will operate in the upstream market separately from the utility's operation of its transmission and distribution assets, unbundling the services provided by a vertically integrated bottleneck owner, imposing codes of conduct, and relying on antitrust enforcement to police anticompetitive behavior at the bottleneck.

With the creation of an independent system operator (ISO), the owner of the transmission assets no longer operates them, and assumes a passive role in the transmission market. This approach may allow for the retention of vertical economies of scope, assuming these flow from joint ownership rather than joint control of assets.[13] Some sort of contractual arrangement

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[11] See Alger and Toman (1990) for an overview of laboratory experiments on open access in networks.

[12] For further analysis, see Williamson (1968).

[13] This assumption is diametrically opposed to that made in Grossman and Hart's (1986) seminal paper on vertical integration, who state (pp. 693-694) that "we do not distinguish

must be devised for inducing the ISO to behave in the desired manner. This divorcing of ownership from the rights of control is a fascinating policy experiment, as it violates a maintained assumption in the economic literature on vertical integration and property rights. Typically ISOs are run as non-profit corporations. These have no direct incentive to discriminate among different upstream producers, but—unlike the case of vertical divestiture—nor do they have direct incentives to operate in a cost-minimizing fashion.

Another policy option is to require the incumbent to split off its upstream activities into a separate affiliated entity. This is sometimes called "structural separation" of transmission from upstream production. I classify this as a behavioral policy, however, despite its use of the word "structural" because it does not require a change in ownership of any assets. This approach presents more opportunities for monopoly leveraging abuses than do the preceding two options. It may, however, allow the retention of vertical economies of scope. This approach is often accompanied by a formal set of rules, often called a "code of conduct," promulgated by the state regulatory authority and specifying which behaviors are expected and which are proscribed.

An even more limited policy is to allow the bottleneck monopolist to remain vertically integrated and to operate in both regulated and competitive markets, but to require that the monopolist fully unbundle the different services for which it is the sole provider, and allow these services to be purchased individually and on a non-discriminatory basis. Again, this approach may include a "code of conduct." Alternatively, some would argue that if the price of access is set properly (e.g., through the use of the so-called Efficient Component Pricing Rule (ECPR)), then the vertically integrated firm will have no incentive to discriminate.

Finally, the behavior of the bottleneck owner could be disciplined through the threat of antitrust prosecution if he engages in discriminatory conduct. This is, of course, the approach taken in most industries in the United States, as discussed below.

3.1 Divestiture

The best-known recent example of a structural remedy remains the AT&T divestiture. A litany of monopolistic abuses had been accumulating for nearly forty years by the time divestiture was enacted in 1984. These included refusals to deal, non-price discrimination, abusing the regulatory process through refusals to provide relevant information, and pricing without

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between ownership and control and virtually define ownership as the power to exercise control."

regard to cost.[14] In the Modified Final Judgment (MFJ), potentially competitive services such as long-distance and equipment manufacturing were surgically separated from the remaining regulated services, in order to eliminate the incentive for further abuses. AT&T was forced to divest itself of the Regional Bell Operating Companies (RBOCs), and the RBOCs were prohibited from having manufacturing affiliates. Ironically, the Telecommunications Act of 1996 reintroduced the potential for monopolistic abuses by setting up conditions under which local telephone companies can enter the long-distance business.

An earlier example comes from the natural gas industry, where the Public Utilities Holding Company Act (PUHCA) of 1935 forced vertical disintegration of the natural gas industry, separating wellhead producers from pipelines from local distribution companies.

More recently, some states have required electric utilities to divest themselves of generation assets as the market moves toward competition. For example, the Maine Public Utilities Commission has required that, with a few limited exceptions, all investor-owned utilities must divest all generation assets and generation-related business activities by March 1, 2000. Assembly Bill 366 does allow utilities to retain their existing contracts with "qualifying facilities" (QFs) operating under the Public Utilities Regulatory Policy Act (PURPA) or demand-side management providers, and to retain generation assets the PUC determines are necessary in order for the utility to meet its transmission and distribution obligations. Connecticut has also required divestiture. In Massachusetts, the electric company is required to divest its non-nuclear generating assets if it wishes to receive stranded cost recovery.[15] Interestingly, some utilities, such as General Public Utilities, are voluntarily divesting themselves of their generation assets. These companies have decided to concentrate on the core competence of network management.

In England and Wales, electricity generation has been structurally separated from transmission and distribution. The National Grid Company (NGC) builds, owns, operates and maintains the grid system on a for-profit basis. It is constrained by a set of regulatory policies imposed by the government.

3.2 Independent System Operators

A popular institution for governing restructured electricity markets is the ISO, variants of which have been implemented in Alberta, Canada;

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[14] See Noll and Owen, *op. cit.*, pp. 301-312, for further details.

[15] Stranded costs are historically incurred costs that cannot be recovered at competitive market prices.

Australia; California; Chile; the PJM region (Pennsylvania-New Jersey-Maryland); New York; and New England. Under this institution, the residual rights of control to the transmission network are granted to a separate (usually non-profit) organization. The ISO is typically funded through a small surcharge per kwh, and normally has one or more boards that exercise oversight of the ISO's performance.

There is considerable variety in the details of ISO structure in different locations.[16] For example, both the California ISO and that in Alberta, Canada, have multi-class stakeholder boards. In Australia, the Board of Directors for the Victorian Power Exchange has nine members, five independent of any stakeholder group and four stakeholder representatives; such a board is a "hybrid" between a purely independent board and a pure stakeholder board. Chile, in contrast, has a system in which voting membership is limited to large generators, i.e. it is a single-class board.

3.3 Marketing Affiliates

Less stringent than the foregoing options is so-called "structural separation," which typically requires that utilities create a separate marketing affiliate if they wish to continue operating in the content market.

Structural separation is a popular remedy among state PUCs trying to open up their electricity markets. In Nevada, for example, if a vertically-integrated electric utility wishes to provide competitive services, there must be strict structural separation between the utility and the competitive affiliate. The PUC limits the ownership, operation and control of the utility's assets to prevent anticompetitive actions and ensure the emergence of a competitive market. Similarly, in New Hampshire, House Bill 1392 requires, at a minimum, functional separation of generation from transmission and distribution services. The PUC is authorized to require that distribution and power supply services be provided by separate affiliates. In New Jersey, electric utilities wishing to continue operating in the generation market must do so through separate affiliates.

Often the regulatory requirement of separate marketing affiliates is accompanied by standards of conduct giving explicit guidance regarding behavioral expectations for vertically-integrated sellers. FERC's standards offer states an easy starting point for the development of their own standards; states are free to simply adopt the standards laid out by FERC. Indeed, Maine has done just that. Other states have developed their own standards. In New Jersey, for example, restructuring legislation explicitly

[16] See Barker, Tenenbaum and Woolf (1997) for a good discussion, from which the examples in this paragraph are drawn.

gave the Board of Public Utilities (BPU) authority to impose a code of conduct, which the BPU continues to work on.[17]

FERC's standards lay out specific rules governing employee conduct under five headings: 1) prohibited practices, 2) transfers of employees, 3) access to information, 4) disclosure, and 5) conduct in implementing tariffs. Utilities are required to file written procedures for implementing the standards with the Commission. Arguably the most important issue addressed in the standards involves access to information about the transmission system. Employees providing "merchant" functions are required to obtain all of their information regarding the transmission system through an Open-Access Same-Time Information System (OASIS), just like any other power merchant. A particular worry expressed by FERC is that the transmission provider acquires information from third parties when they make requests for transmission service, and that the transmission provider may choose to deny the transmission request, then turn around and alert its marketing affiliate of a sales opportunity. The code of conduct is designed to prevent this activity.

3.4 Functional Unbundling

A less stringent policy is to allow the incumbent utility to remain vertically integrated, but require it to sell all the components of its services individually on an unbundled basis, and require the firm to operate in a non-discriminatory fashion. Indeed, some would argue that if the component prices are set properly then the bottleneck owner will have no incentive to discriminate against other upstream firms.[18]

A good example of this policy comes from the natural gas industry. From the mid-1980s into the 1990s, the Federal Energy Regulatory Commission (FERC) moved consistently toward enhanced competition in the wellhead market and greater access to pipeline transportation. The first major regulatory step toward open access was Order 436, promulgated in 1985. Under this Order, 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 non-discriminatory 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, but a growing chorus of complaints eventually made clear to

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[17] To date the BPU has completed only a draft of the code.

[18] For example, Baumol and Sidak (1994, p. 122) argue that "The pricing of interconnection should be governed by the efficient component-pricing rule, to ensure that competition is not undermined by input-price discrimination..."

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.[19] 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 non-discriminatory basis. In the process, FERC established standards of conduct for pipelines that were designed to ensure pipelines did not unfairly favor their own gas supply affiliates.

Functional unbundling was also the goal FERC initially aimed to accomplish in the electricity industry. FERC Orders 888 and 889 required that public utilities engaged in the interstate transmission of electricity "functionally unbundled" their transmission operations from their wholesale marketing functions.[20] Utilities were not specifically required to create legally separate marketing affiliates, however; they could simply take measures to prevent employees in the marketing division from talking to employees in the transmission division. To level the playing field and ensure that transmission providers do not unfairly favor their own wholesale transactions, each transmission provider was required to create an OASIS that provides information on transmission capacity to all wholesale suppliers. FERC also created standards of conduct similar to those previously developed for the gas industry.

Finally, functional unbundling is also the approach taken by the Congress and the Federal Communications Commission (FCC) with regard to the Regional Bell Operating Companies (RBOCs). The Telecommunications Act of 1996 established a 14-point checklist that must be satisfied by RBOCs that wish to enter the long-distance market. The FCC has determined that the RBOCs must provide non-discriminatory access to Operational Support Systems (OSS), *i.e.* the systems used by competitive entrants for ordering unbundled network elements (UNEs) and resold services from the RBOCs, and for obtaining maintenance, repair and billing for these services.[21] This requirement parallels the FERC's requirement for OASIS systems. The main thrust of the 14-point checklist is to ensure that RBOCs are offering unbundled network elements on a non-discriminatory basis as a *precondition* to allowing the RBOCs to enter the long-distance

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[19] Pipelines argued that they were forced to hold substantial capacity in reserve for peak periods, in order to meet their ongoing obligations to provide reliable delivered supply to LDCs.

[20] FERC explicitly declined to unbundle transmission control functions from generation control functions, as these were deemed integral components in providing system reliability.

[21] See Mandy (2000b) for more detail on FCC treatment of OSS, as well as a nice overview of the broad set of issues raised by RBOC entry into the long-distance market.

market.[22] This ability to use entry to the upstream market as a reward or "carrot" for providing equal access is unique to telecommunications (at least in the U.S.). The reason is the earlier divestiture of the RBOCs from AT&T, which established vertical separation as the new status quo point for the industry. The FERC's experience with natural gas and electricity has instead started from a status quo point of either long-term contractual relations between the upstream market and the bottleneck (natural gas) or full vertical integration (electricity). Interestingly, the Telecommunications Act of 1996 specifically empowers the FCC to force RBOCs out of the long-distance market if they are shown to have engaged in discrimination.[23]

4. TOWARD A THEORY OF BOTTLENECK GOVERNANCE

This section sketches out the beginnings of a contractual theory of bottleneck governance. The logic follows that of the literature on incomplete contracts and vertical integration.[24] The focus is on the relationship between a buyer and a seller of access services, each of whom may make relationship-specific investments to increase the value of trade. Prior to investment, they can write a contract specifying certain terms according to which they wish trade to take place in the future. However, the completeness of the contract may be limited by the complexity of the environment, or difficulties in observing or verifying important aspects of the state of the world or the actions taken by the contracting parties. Furthermore, I assume throughout that the price of access is constrained by regulation and is thus below the level that would eliminate incentives for exclusionary behavior by the bottleneck owner. Once the investments are in place, the parties may haggle over the terms of trade, including the price and quality of access services. The ability of either party to engage in

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[22] The FCC also requires that local exchange carriers provide an extensive set of quantitative measures of the quality of access to bottleneck facilities. These publicly available measurements make it easier for rivals to determine whether they are receiving the same quality of service at the bottleneck as the LEC provides to itself. See Federal Communications Commission (1998). I discuss these monitoring policies in more detail below.

[23] Section 271d(6) of the Act states that "[I]f at any time after the approval of an application under [§271(d)], the Commission determines that a Bell operating company has ceased to meet any of the conditions required for such approval, the Commission may…suspend or revoke such approval."

[24] See, for example, Williamson (1986), or for more formal models, Hart and Moore (1999) and Grossman and Hart (1986). Crocker and Masten (1996) apply the principles of transaction-cost reasoning to public utility regulation.

opportunistic tactics depends on the status quo point established by the initial contract, adjustment processes specified in the contract, and the state of the world *ex post*.

If few relationship-specific assets are involved, the parties may prefer to simply engage in spot trading rather than bother with more complex governance procedures. As the extent of specific investment rises, the threat of *ex post* opportunism motivates the parties to codify aspects of their future relationship through contract. If the ability to write complete contingent contracts is undermined by environmental complexity or non-verifiability, then the parties may resort to the use of institutions like vertical integration, regulation, or the assignment of property rights to one party or the other.

In the context of the present paper, bottleneck owners may invest in network links that have particular value to upstream buyers of access services in particular location. These buyers, in turn, may invest in site-specific capital like power plants, natural gas wells, or fiber-optic telecommunications lines. The contract governing access defines the price and non-price terms of access, although price terms are constrained by regulation. Environmental complexity emerges when the particular transmission links desired by the buyer depend in complex ways upon future realizations of demand and/or on the transactions of other buyers through the bottleneck facility. Such complexity, or difficulties in verifying the actions of the bottleneck owner, may reduce the value of attempting to write a contract for access services, and may instead lead the parties to the use of institutions such as divestiture or the creation of an ISO

In the remainder of this section, I identify some key industry parameters that may affect the choice of governance structure, and then attempt to map the range of policy and contracting options onto this parameter space with an eye to identifying efficient governance mechanisms.[25]

4.1 Key Environmental Parameters

At least five parameters are relevant to choosing an appropriate governance structure for bottleneck facilities: 1) Verifiability of discriminatory actions by the bottleneck owner, 2) Complexity of the contracting environment, 3) Importance of vertical economies, 4) The extent of vertical integration in the status quo point, and 5) The ability of unbundling and/or structural separation to expose and/or deter violations.

The *verifiability* of discriminatory actions is a key parameter. If violations are readily documented before a court or regulatory body, then

[25] This effort to match institutions to industry setting parallels in some ways the earlier work of Breyer (1982).

relying on *ex post* enforcement through antitrust actions or regulatory penalties may be adequate. If buyers of access services (or their customers) can observe violations, and these violations are verifiable, then they can readily bring suit. In contrast, if discrimination is unverifiable, then antitrust suits and *ex post* regulatory penalties are toothless. Furthermore, functional or structural unbundling may be ineffective as well.[26] If so, then the only options in this case are the use of an ISO or full divestiture. For cases where verifiability is possible (perhaps only imperfectly) but costly, unbundling coupled with a code of conduct may be sufficient.

The *complexity* of the contracting environment limits the ability of contracts to achieve desired outcomes, in this case non-discrimination. In a simple point-to-point delivery system, buyer and seller can write an effective long-term contract for space on the delivery system. This has been the approach taken in the natural gas industry, where trading in pipeline space is common. Electricity, in contrast, flows through all available capacity simultaneously, making a "contract path" a fiction, and requiring a more complex set of transmission rights. Furthermore, the transmission paths that will be used depend heavily on the entire configuration of electricity supply and demand at any time. Hence, contracting for the transmission of electricity is inherently more complex than for natural gas, and it is natural to expect more vertical integration and/or allocation of control rights in electricity.

The more important are *vertical economies*, the stronger is the argument for allowing the bottleneck owner to remain vertically integrated. As suggested above, vertical economies are likely to be larger the more complex is the operating environment. It is worth noting, however, that if upstream firms engage in price competition with homogeneous products, then vertical economies simply produce rents for the bottleneck owner.[27] While these rents certainly have value to the stockholders of the bottleneck firm, they do not contribute to consumer surplus, and may be of secondary concern to policymakers.

Policymakers have very different options depending on the *status quo point* of the industry. As mentioned earlier, if the status quo point involves vertical separation, as in telecommunications, then access policy can use the reward of upstream integration as an inducement to the bottleneck owner to provide equal access. If the status quo point involves vertical integration,

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[26] Sibley and Weisman (1998) show that discrimination may be unprofitable under structural unbundling if there are enough upstream competitors. In this case, there would be no need to verify whether discrimination occurred as long as it were possible to verify whether the vertically-integrated firm was abiding by the code of conduct for affiliate behavior.

[27] If the upstream firms engage in quantity competition or if products are differentiated, then some degree of rents will be shared with consumers.

such a reward is not available to the policymaker. Furthermore, a bottleneck owner's incentive to discriminate is much greater when he has a large share of the upstream market than when he has a small share.[28] Hence, policy must be more stringent in the former case.

Unbundling and structural separation can help deter violations because they make more information public. The quality of this information may vary across industries, however. In electricity, for example, OASIS information about available transmission capacity has been notoriously unreliable. As a result, unbundling was less valuable than it could have been. In telecommunications, the FCC has imposed a set of detailed self-monitoring requirements on Bell Atlantic/NYNEX in allowing it to enter the long-distance market. The hope is that these measures will be sufficient to make any exclusionary actions easy to detect and verify. The usefulness of the information generated through unbundling and structural separation is likely to decline with environmental complexity. Discrete transactions along well-defined transportation links (as in telecommunications) are apt to be more easily monitored than transactions in continuous-flow settings like electricity where loop-flow problems complicate the definition of the contract path.

In summary, the parameters of verifiability and complexity are arguably the most important underlying features of the contracting environment. They are important in themselves, as explained above, but they also have important effects on some of the other parameters. In addition, they are also critical building blocks in modern theories of incomplete contracting. The remainder of this section places particular emphasis on these two characteristics, in an attempt to simplify and move toward a general theory of bottleneck governance.

4.2 Matching Institutions and Environments

Verifiable Violations

Enforcement through *ex post* monitoring and punishment may be optimal when discrimination is readily verifiable. Even in this case, however, there is a question whether responsibility for enforcement should be done through the antitrust laws or through regulation. On one hand, the regulator presumably possesses greater expertise and may do a better job of interpreting the potentially ambiguous evidence of discrimination. Furthermore, adjudication of repeated cases will reinforce this expertise, while antitrust cases might be

[28] See Sibley and Weisman (1998).

scattered across a number of different antitrust courts. The regulator will also presumably apply a consistent set of criteria in the promulgation of standards and the punishment of violations. On the other hand, antitrust courts may be less influenced by pressures from well-organized interests, and may be more likely to pursue economic efficiency in the enforcement process.[29] In addition, the application of treble damages as a remedy may make the threat of antitrust prosecution a stronger deterrent than the penalties that would be imposed by a regulator. Indeed, one of the concerns raised by FERC in Order 2000 is that the penalties it has imposed are too small in the few cases of discrimination that it has actually documented.[30] Regardless of the enforcement agency actually used, my emphasis here is that the penalties can be assessed retrospectively in response to violations that can be verified before a judge.

Costly Verification with Moderate Complexity

If the threat of prosecution *ex post* is not enough to prevent anticompetitive actions, then regulatory safeguards may be useful. One possibility is that regulators can impose requirements that increase the verifiability of exclusionary conduct. This is the goal of the FCC's measurement and reporting requirements for operations support systems. By making data on the quality of bottleneck access publicly available, the FCC aims to facilitate the use of *ex post* enforcement to prevent exclusionary behavior. In its Notice of Proposed Rulemaking on this subject, the FCC notes that "Performance measurements and reporting requirements should make much more transparent, or observable, the extent to which an incumbent LEC is providing nondiscriminatory access, because such requirements will permit direct comparisons between the incumbent=s performance in serving its own retail customers and its performance in providing service to competing carriers."[31] By increasing the threat that violations will be detected, this system should improve bottleneck compliance with nondiscrimination requirements.

Another possibility is that regulatory standards of conduct may be able to increase the probability of compliance. Kolstad, Ulen and Johnson (1990) provide an interesting model of the use of regulation and legal liability in the context of externalities, *e.g.* safety. Although their context differs from that

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[29] Kleit and Michaels (1994) raise serious questions about this presumption, however, in their analysis of the *Otter Tail* case. They argue that requests for wheeling across the *Otter Tail* system were motivated by rent-seeking behavior on the part of buyers seeking access to government-subsidized power supplies, and may well have been efficiency-reducing. The antitrust court, however, did not detect this possibility.

[30] See section 5.2 for further details.

[31] FCC (1998), p. 8.

considered here, the issues are very similar. They also consider the possibility of *ex post* legal liability, though in their case it is tort liability rather than antitrust. In addition, they consider the possibility of *ex ante* safety regulation that requires firms to take a certain minimum level of care to prevent accidents. They find that the combination of regulation and liability may be desirable when liability alone is insufficient to induce the socially optimal level of preventive action by the injurer. Inadequate prevention is especially likely when there is substantial uncertainty about how the courts will decide a case if it comes to them *ex post*. Kolstad et al. also show that if the combination of regulation and liability is desirable, then the optimal regulatory standard should be set below the socially optimal level of care, since the threat of *ex post* liability will provide additional incentives.

In the case of discriminatory behavior by bottleneck monopolists, the Kolstad et al. analysis has some interesting implications. To begin with, it is likely that the threat of *ex post* liability alone will be inadequate, since there is substantial uncertainty as to how the courts will decide a case. This becomes clear in reading recent FERC decisions on discriminatory behavior by electric utilities. For instance, in Order 2000 (p. 36), FERC notes that "instances of actual discrimination may be undetectable in a non-transparent market and, in any event, it is often hard to determine, on an after-the-fact basis, whether an action was motivated by an intent to favor affiliates or simply reflected the impartial application of operating or technical requirement...[W]hile continued discrimination may be deliberate, it could also result from the failure to make sufficient efforts to change the way integrated utilities have done business for many years." Given the difficulty of adjudicating such cases, it seems likely that threats of *ex post* liability will fail to prevent discriminatory acts.[32] In the Kolstad *et al*. analysis, this is exactly the sort of situation in which regulatory standards may be of value. Furthermore, recent decisions regarding the application of antitrust in regulated industries suggest that the presence of regulation does not preempt the future application of antitrust statutes.

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[32] The provision of network service is an inherently complex process. As FERC points out, "Network service is a complex, long-term relationship between a requester and provider that must be investigated in detail because it involves the specification of multiple points of receipt or delivery or both. Because of the long-term nature of network service, the planning process involves a complex interrelationship of future loads and resources, with an impact on the network that is extremely location dependent. A major difficulty in estimating network available transmission capability (ATC) is the lack of specific locations for which to calculate an impact on the network. Each network service request would be unique, with different sets of integrated loads and generating stations affecting the network, including its constrained paths, differently." FERC (1996, p. lxiii).

Non-verifiable Violations and Moderate Complexity

As the difficulty of verifying discriminatory actions grows, *ex post* enforcement of conduct restrictions becomes increasingly ineffective. In the limit as discriminatory behavior becomes impossible to verify, only *ex ante* remedies are feasible. Divestiture may be the appropriate response, assuming complexity (and hence the degree of vertical economies) is not too great. According to Werden (1987, p. 473), "[T]he problems inherent in the regulation of vertically integrated firms may require that divestiture be a component of effective relief. As long as vertical integration remains, so too will cost allocation problems, potentials for regulatory evasion, and an incentive to discriminate against independent competitors." If such violations are difficult to verify, and the benefits of vertical integration modest, divestiture may be the best solution.

Divestiture is a more likely outcome when the political environment encourages a focus on consumer benefits rather than on welfare more generally. Many, if not most, of the advantages of vertical economies will flow to the shareholders of the bottleneck owner. This is especially true when the final product exhibits little differentiation. In this case, price competition in the upstream market should lead to prices that approximate the marginal cost of non-integrated competitors. If the vertically integrated bottleneck firm has a cost advantage, it will not necessarily use this to slash prices to consumers. Under price competition with homogeneous products, for example, it will lower prices just slightly, induce consumers to switch to its service, and collect profits equal to the difference between its marginal cost and that of its rivals.[33] A consumer-oriented regulator or antitrust authority will place relatively little weight on these "windfall" profits, and may choose to require divestiture.

Non-verifiable Violations and High Complexity

When complexity is high but verifiability is not, vertical economies are expected to be substantial and divestiture may be undesirable. In this case, an independent system operator may be preferred. It is interesting to note that FERC points out in Order 2000 (p. 130) that "[W]e do not agree with those who suggest that our electric regulation must follow our natural gas pipeline industry Order No. 636 model, where the Commission did not attempt structural unbundling of the pipeline industry but simply relied on more limited, functional unbundling. The situations in the two industries are different regarding the need for regional entities. Most importantly, there was

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[33] Under quantity competition, or with product differentiation, a vertically-integrated firm's cost advantage will reduce consumer prices. The extent of price reduction will depend upon the number of firms, the extent of differentiation, and the elasticity of demand.

not in the gas industry the degree of vertical integration of production, transmission, and distribution that historically existed in the electric industry. In addition, the gas industry has no analog to loop flow, transmission loading relief, the need for large regional calculations of ATC, or the use of generation energy and reactive power output to manipulate transmission flow, among other reasons."

In a setting where complexity is high but verifiability is not, traditional regulation may dominate deregulation of the upstream segment of the industry. Although most industry observers seem to agree that deregulation of electricity is justified, Borenstein and Bushnell (2000, p. 1) assert that "The gains from restructuring are most likely to occur through improvement in the efficiency and prudency of long-term investment, but these benefits will be very difficult to measure. Though restructuring could have near term benefits in the efficiency of production and consumption, concerns with the efficiency of decentralized dispatch and the exercise of market power make it at least as likely that restructuring will not benefit society in the short run." An authoritative assessment of the ultimate success of electricity deregulation will not be possible for some time.

5. EVALUATING THE SUCCESS OF ALTERNATIVE REMEDIES

It is impossible at this time to give a complete account of the success of the various institutional remedies discussed above. The experience with them varies across industries and jurisdictions, and may depend upon details of implementation in particular situations. Nevertheless, it is possible to make a few general observations. Overall, it appears that behavioral restrictions on bottleneck facilities have been less successful than hoped. I further argue that the greatest problems have emerged in situations where discriminatory actions by the bottleneck owner are readily concealable, or, put another way, in situations where discrimination is difficult to verify.

Natural Gas

Natural gas arguably provides the most successful experience with behavioral remedies. As mentioned above, the functional unbundling that emerged after FERC Order 436 facilitated rapid growth in the natural gas spot market and a concurrent reduction of gas prices. It is important to distinguish between interruptible service and firm service in evaluating FERC policy. The initial success of functional unbundling was in the area of interruptible service. Indeed, gas spot sales were almost exclusively interruptible in nature, and thus occurred only during non-peak periods, *i.e.* periods of excess capacity. During such periods, the storability of gas, along

with the potential of the system to accommodate modest variations in pressure over time, significantly reduced the complexity of the operating environment. As a result, modest attempts by pipelines to discriminate against rivals were unlikely to be successful. Pipelines would have had to undertake heroic efforts (perhaps denying access altogether) if they wanted to reduce the transmission quality offered to rivals by enough to cause buyers to switch to high-priced pipeline gas. Such actions were likely to be verifiable by buyers or pipeline rivals.

Creating a successful open access policy for natural gas during peak periods has been much more challenging. During these periods, system coordination becomes much more important and more complex; discriminatory behavior becomes increasingly difficult to verify at these times. FERC seems relatively satisfied with the changes in the marketplace that have developed since Order 636, however:

> "Since Order No. 636, substantial progress has been made toward realizing the Commission's goal of opening up the pipeline grid to form a national gas market for gas sellers and gas purchasers to meet in the most efficient manner. Today, there are 38 operating market centers as compared to only six when Order No. 636 issued. These market centers provide a variety of services that increase the flexibility of the system and facilitate connections between gas sellers and buyers. These services commonly include wheeling, parking, loaning, and storage.[34] In addition, electronic trading of gas and capacity rights, which did not exist at the time of Order No. 636, is now offered at over 20 market centers and other transaction points throughout North America. Electronic trading systems enable buyers and sellers to discover the price and availability of gas at transaction points, submit bids, complete legally binding transactions, and prearrange capacity release transactions. In addition to the information provided by electronic trading services, electronic information services offer capacity release and tariff information aggregated from pipeline electronic bulletin boards, gas futures pricing information, weather information, and determination of least cost

[34] AWheeling, offered at 33 market centers, is the transfer of gas from one interconnected pipeline to another. Parking, offered at 29 market centers, is when the market center holds the shipper's gas for a short time for redelivery within approximately 15 days. Loaning, offered at 20 market centers, is a short-term advance to a shipper by the market center operator which is repaid in kind by the shipper. Storage is offered at 16 market centers.@ Footnote in original.

> routing. Such information was not widely available electronically before Order No. 636."[35]

The natural gas experience suggests that full unbundling with standards of conduct for integrated entities can succeed in circumstances of relatively low complexity and high verifiability. It is important to recognize, however, that the storability and compressibility of gas greatly eases transmission system constraints and thus simplifies system coordination, relative to the case of electricity.

Electricity

In the electricity industry, FERC has concluded that functional bundling with standards of conduct has not been sufficient to eliminate undue discrimination.[36] Indeed, concerns about continuing discrimination, along with concerns about engineering/economic coordination of multiple transmission grids, motivated the FERC to issue Order 2000. In the Order (p. 36), FERC noted four particular forms of discrimination that it believed to be impeding the development of competitive markets: "(1) calculation and posting of available transmission capacity (ATC) in a manner favorable to the transmission provider; (2) standards of conduct violations, (3) line loading relief and congestion management, and (4) OASIS sites that are difficult to use." Interestingly, the FERC also pointed out that its enforcement mechanism for the standards of conduct was inadequate for a variety of reasons: "transmission customers are reluctant to make even informal complaints because they fear retribution by their transmission supplier; the complaint process is costly and time-consuming; the Commission's remedies for violations do not impose sufficient financial consequences on the transmission provider to act as a significant deterrent; and, in the fast-paced business of power marketing, there may be no adequate remedy for the lost short-term sales opportunities in after-the-fact enforcement."[37] There have been many informal allegations of discrimination, and in at least four cases the Commission has formally investigated and found "serious concerns" about discrimination.[38] Furthermore, "a system that attempts to control behavior that is motivated by economic self-interest through the use of standards of conduct will require constant and extensive policing and requires the Commission to regulate detailed aspects of internal company policy and communication...[T]he perception that many entities that operate the transmission system cannot be trusted is not a good foundation on which

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[35] FERC Order 636-C, ORDER ON REMAND (Issued February 27, 1997), p. 7-8

[36] Federal Energy Regulatory Commission (2000).. See, for example, pp. 35-38.

[37] Ibid., footnote 70, p. 37.

[38] Ibid., p. 66.

to build a competitive power market, and it created needless uncertainty and risk for new investments in generation."[39]

The system coordination issues faced by the electric power system are inherently more complex than those in natural gas, due to its physical characteristics. Electricity cannot practicably be stored, so short-term fluctuations in demand and supply must be coordinated on a real-time basis. Since most customers do not face real-time pricing and thus cannot quickly adjust their demand in response to price changes, prices do not clear the market. Furthermore, electricity is subject to the "loop flow" problem, which means that electricity dispatched into the system flows through all available transmission lines in accordance with Kirchoff's Laws, rather than being shunted through a particular "contract path." For all of these reasons, system operation for electricity is inherently more complex than that for natural gas, and discriminatory actions by bottleneck owners are inherently difficult to verify. Indeed, FERC has discussed this problem in some detail in Order 2000 (p. 36): "instances of actual discrimination may be undetectable in a non-transparent market and, in any event, it is often hard to determine, on an after-the-fact basis, whether an action was motivated by an intent to favor affiliates or simply reflected the impartial application of operating or technical requirement...[W]hile continued discrimination may be deliberate, it could also result from the failure to make sufficient efforts to change the way integrated utilities have done business for many years."

In the wake of these problems the Commission has declared that "The use of standards of conduct is not the best way to correct vertical integration problems. Their use may be unnecessary in a better structured market where operational control and responsibility for the transmission system is structurally separated from the merchant generation function of owners of transmission."[40] The essence of its proposed remedy is a structural shift toward regional transmission organizations (RTOs), which are basically ISOs that operate (on a non-profit basis) the pooled transmission capacities of numerous utilities in particular broad regions.

It is too early to pass judgment on the potential for ISOs to solve problems of discriminatory access. As discussed above, however, there is no reason to expect ISOs to minimize costs, since their incentive structure provides little reward for doing so. It is true that ISOs will collect greater revenues if they can increase the number of Mwh they dispatch. However, the links between cost, price, and demand are so tenuous in the short term that this is unlikely to prove a strong motivation. Detailed analysis by Borenstein, Bushnell and Wolak (2000) indicates that market power remains a problem in the California electricity market. This problem is apparently

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[39] Ibid., p. 38.
[40] Ibid., p. 68.

due to the fact that during peak periods transmission constraints bind, making one or more generators "pivotal" and hence able to influence the market price. It is difficult to be certain whether the rules creating such problems are influenced by bottleneck owners. In California, utilities have some say through the multi-class stakeholder board that governs the ISO, but they certainly do not dominate the board. Thus, it seems difficult to attribute the problems of market power in these cases to influence by bottleneck owners. At the same time, the weak incentives given to ISOs mean that the California ISO has little motivation to improve its market rules.[41]

In sum, electricity presents an industry setting with great system complexity and low verifiability. From the perspective of this paper's theory of governance, the poor performance of functional unbundling is not surprising. More experience with ISOs is required before their benefits, relative to vertical divestiture, can be accurately assessed.

Telecommunications

The Telecommunications Act of 1996 was intended to speed the development of competition in both the long-distance and the local exchange markets. To date, it has been surprisingly ineffective in doing so. Negotiations between Regional Bell Operating Companies (RBOCs) and potential entrants to local exchange markets have been slow and difficult. Several RBOCs have applied to the FCC for permission to enter the long-distance market, only to be rebuffed for failure to comply with the 14 point competitive checklist. Bell Atlantic-New York is the first to have its application accepted by the FCC, but even this success has been tarnished by the recent revelations that Bell Atlantic lost or mishandled orders for service that were electronically submitted to the company by Bell Atlantic's local service rivals.[42] The Consent Decree between the company and the FCC requires Bell Atlantic to file regular performance reports on specified performance measures. The company has also agreed to make a "voluntary" contribution of $3 million to the United States Treasury, with potential additional liability of up to $24 million.

Perhaps the most interesting aspect of the telecommunications experience, from the perspective of the framework developed here, is that the verifiability of discrimination may be affected by regulatory policy. The Bell Atlantic experience raises questions about whether current compliance with the checklist provides any assurance about future compliance, but

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[41] In fairness, it is not clear that the California ISO performs any worse than other electricity grids. For example, Green and Newbery (1992), Wolak and Patrick (1997), and Wolfram (1998) study the electricity market in England and Wales and also finds evidence of market power.

[42] Federal Communications Commission (2000).

nevertheless Bell Atlantic's exclusionary behavior was detected and punished. The FCC's measurement and reporting requirements for Operating Support Systems (OSSs) should increase the chances that future violations will also be detected. The FCC's approach attempts to increase the transparency of information at the telecommunications bottleneck, which should facilitate the correction of exclusionary behavior through *ex post* complaints by customers or rivals. While the FCC's monitoring requirements for OSSs may make this type of policy more successful in telecommunications than it has been in electricity or natural gas, it is still too early to draw that conclusion.

In terms of my framework, the telephone system is clearly complex in a technological sense, but its successful operation does not demand the same degree of system coordination as electricity. If the electric grid is overburdened, even for a brief period, extensive service outages may occur; in the telephone business, however, new callers simply receive a busy signal. Thus, I would argue that the telephone system is in some sense less "complex" than the electric power network. The switched nature of the telephone network, and the resulting clear "contract path" for a given call, may also contribute to the verifiability of discriminatory behavior in telecommunications.[43] On both dimensions, then, one might expect functional unbundling to perform better in telecommunications than in electric power.

Summary

The U.S. experience with non-discriminatory access has been mixed. In natural gas, the policy of providing open access to natural gas pipelines through functional unbundling with codes of conduct has been tolerably effective during off-peak periods. Implementing equal access during peak periods has proven more difficult. In electricity, functional unbundling has been judged a failure by the FERC, and the industry is increasingly moving toward ISOs as the next step in institutional evolution. In telecommunications, divestiture sparked substantial competition in long-distance, but bottleneck owners have been slow to implement equal access to unbundled network elements in the local exchange market. Overall, the aforementioned difficulties indicate vertically integrated bottleneck owners have strong incentives to thwart non-discrimination requirements. They also suggest that unbundling in accordance with a code of conduct is usually not a powerful enough governance structure to prevent discrimination at the bottleneck.

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[43] Recall that AT&T's discrimination against MCI in the early days of long-distance competition was detected by the FCC and the DOJ, and ultimately led the government to file an antitrust case against AT&T.

6. CONCLUSIONS

This paper has taken some initial steps toward an incomplete contracting theory of governance institutions for bottleneck facilities. Different institutions will be appropriate for different industries and different historical situations. I have laid out a schema for matching institutions to situations, focusing on the verifiability of discriminatory actions and the complexity of the contracting environment for access. I have also tried to apply this schema to developments in natural gas, electricity, and telecommunications. Clearly this is a broad agenda, and many fine points will be missed in the process. Nevertheless, I believe the analysis provides a useful framework for thinking about the design of bottleneck governance structures. It also suggests that in most cases behavioral remedies to the problem of bottleneck governance are unlikely to be successful in eliminating anti-competitive practices.

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