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NRRI 96-10

ALMOST SECOND-BEST PRICING FOR REGULATED MARKETS AFFECTED BY COMPETITION

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March 1996

This report was prepared by The National Regulatory Research Institute (NRRI) with funding provided by participating member commissions of the National Association of Regulatory Utility Commissioners (NARUC). The views and opinions of the author do not necessarily state or reflect the views, opinions, or policies of the NRRI, the NARUC, or NARUC member commissions

EXECUTIVE SUMMARY

The *Energy Policy Act of 1992* presumes that each wholesale market for electric power is competitive or nearly so, although each of the associated transmission and distribution markets do not meet the competitive standard at the present time. Two regulatory problems have to be solved when it is necessary to "mix" competitive and noncompetitive markets to produce regulated services. First, regulators have to oversee the noncompetitive markets effectively. Second, they have to avoid the opportunistic bypass of regulated services. This research examines whether price-cap regulation of the transmission market is the solution to the first problem, and whether the efficient component pricing of unbundled transmission services is the solution to the second problem.

The context underlying this research is that utility-owned generation companies and nonutility generators are competing in an unregulated wholesale power market. They sell at market-based prices to wholesale customers. Some of the wholesale customers may be owned by the utility. In addition to buying unbundled power, the wholesale customers have to buy unbundled transmission services from a regulated, monopolistic, utility-owned transmission company. Nondiscriminatory prices are set for these services by federal regulatory authorities, who are assumed to have exclusive jurisdiction over the transmission market. The wholesalers combine the unbundled generation and transmission services with their distribution services to produce bundled retail services. The rates for the bundled retail services are regulated by state authorities when they are sold by utility-owned distribution companies.

The federal authorities can choose to regulate either the profits of the utility-owned transmission company or the prices of the unbundled transmission services. Often, price regulation is thought of as more efficient than profit regulation. In theory, this conjecture is true. However, the complications of real-world regulation can turn this truthful conjecture on its head. One of these complications is the utility's incentive to cross-subsidize its generation companies during the time they are cutting their costs to become competitive with the nonutility generators. Price regulation of transmission services provides an obvious means for cross-subsidization of the utility's generation companies by its transmission company. The additional profit that the utility earns as it cuts its transmission costs can be used to prop up the financial reports of the utility's generation companies in the short term.

To be fair, the regulation of profit earned in the transmission market does not eliminate the threat that the utility will use its transmission company to cross-subsidize its generation companies. Profit regulation provides the utility with less incentive to cut its transmission costs than does price regulation. In fact, under the appropriate circumstances, profit regulation provides the utility with an incentive to increase its transmission costs artificially. In particular, the utility wants to shift generation costs to the transmission market to assist its generation companies in their cost-cutting efforts. Information asymmetries make it possible for the utility to shift costs in this manner.

The threat of cross-subsidization establishes that the regulatory authorities have to be on the lookout for anticompetitive behavior when the utility's generation companies cannot compete effectively in the wholesale power market because their total costs are too high. Although no form of regulation can prevent the utility from using its transmission company to cross-subsidize its generation companies, rate-of-return regulation of the utility-owned transmission company is the safer bet at present. This gives regulators a better chance of detecting cost shifting under rate-of-return regulation as compared to their chances of detecting profit diversion under price-cap regulation. Therefore, the federal authorities should consider continuing the tradition of rate-of-return regulation for the utility-owned transmission company until they are convinced that the utility's generation companies have reduced their costs sufficiently to become competitive with nonutility generators. Once this occurs, the utility does not have a strong motive to shift generation costs to the transmission market in an effort to insulate its generation companies from the effects of competition.

Any reduction in the flow of generation costs to the transmission market induces the utility's generation companies to expand and accelerate their cost-reduction efforts.

After these generation companies are well into their cost-cutting programs, federal regulators can choose to use price-cap regulation with profit sharing, a maximal rate of return, and flexible regulatory review as means to oversee the pricing of transmission services. Profit sharing provides concrete evidence to the public that the utility-owned transmission company is lowering its costs. The maximal rate of return on transmission investments represents a believable limit on the amount of additional profit that can be earned by the utility's transmission company. Both of these restrictions on price-cap regulation mitigate political risks by establishing that the public can benefit from such regulation. A flexible regulatory review is a cost-saving measure. Its purpose is to make it unnecessary for the utility and the regulatory authorities to incur the administrative costs of a review when price-cap regulation is functioning effectively in the eyes of the public.

Efficient component prices are compensatory and subsidy free. Compensatory pricing guarantees that the utility's transmission company will recover its total costs of production and no more. Furthermore, they encourage the exit of inefficient bypass companies from the transmission market, thereby preventing the opportunistic bypass of the utility's transmission services. Subsidy-free pricing is neutral with respect to the entry of efficient bypass companies into the transmission market.

Although the efficient component pricing of transmission services is a good choice for balancing the equity and efficiency considerations that are part of the implementation of a competitive wholesale power market, it is unrealistic to think that federal regulators actually can determine such prices. A multitude of information asymmetries prevent these regulators from knowing the transmission company's efficient production costs and the competitive rate of return for a perfectly contestable transmission market. Instead, they have limited knowledge of the company's reasonable production costs and a fair rate of return on its investments. Consequently, the best they can hope for is almost efficient component pricing.

Fortunately, almost efficient component pricing minimizes the opportunistic bypass of the utility's transmission services by causing the wholesale customers to choose the most economic transmission or bypass service. In addition, it promotes economic efficiency by inducing the wholesale customers to keep their own distribution costs in check to avoid intercompany differences in the prices of the bundled services they sell to retail customers. Lastly, it is a way to deal with the utility's market power. Almost efficient component prices for transmission services stop the utility from exercising undue influence over the economic decisions of rural cooperatives and municipally-owned utilities because they are subsidy free and almost compensatory.

A vision of a competitive wholesale power market is a good thing. However, the means to achieve this end have to be selected carefully. Above-cost prices for transmission services damage the profitability of existing rural cooperatives and municipally-owned utilities; cause these companies to exit the electricity market prematurely; cross-subsidize the utility's generation companies; encourage market entry by inefficient bypass companies. Below-cost prices for transmission services cause too many rural cooperatives and municipalities to enter the retail market; cause too many nonutility generators to enter the generation market; cause too little investment in transmission facilities by the utility; and damage the financial well-being of the utility and its transmission company. Therefore, federal regulators have a lot to do with respect to the pricing of unbundled transmission services during the implementation of a competitive wholesale power market.

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FOREWORD

Among the Institute's products are technical studies done for the technically oriented readership. This is one. As stated, the researcher tries to determine whether price-cap regulation and efficient component pricing are best applied to the regulation of transmission and distribution with respect to preventing cross-subsidies and the opportunistic bypass of its facilities. Perhaps the most important finding of the study is that rate-of-return regulation of transmission services is superior to price-cap regulation unless and until the utility's generation companies have reduced their costs to competitive levels with nonutility generators. This is explained in the context of the mixture of competitive and noncompetitive markets that characterize the production and delivery of electric power in the U.S.

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March 1996

ACKNOWLEDGMENTS

I wish to express my thanks to Douglas Jones, Kenneth Costello, Larry Blank, and Susan Stratton for reviewing this report. Their comments helped me focus my efforts, clarify my exposition, and correct mistakes. Of course, I alone am responsible for any remaining errors.

I also would like to thank Marilyn Reiss for typing and proofreading/editing the report.

PREFACE

The electric power industry is in the midst of a transition to competitive generation, transmission, and distribution markets. The first breach of the vertically integrated market for electricity occurred when the utilities were ordered to connect cogenerators and qualifying facilities to their transmission networks and to buy the now available nonutility power at avoided costs. Since then it has become increasingly easier for nonutility generators to obtain interconnection with their host utilities. Least-cost and integrated resource planning were the market-making mechanisms that pushed them squarely into the generation market.

We now are at the point where new public policies are making it easier for wholesale customers to buy power from nonutility generators. It is well-established that the regulatory jurisdiction over bundled wholesale services lies with the Federal Energy Regulatory Commission. It seems reasonable to expect that federal regulatory jurisdiction will be extended to cover the unbundled generation and transmission services that are sold to wholesale customers. It also seems reasonable to expect that state regulatory jurisdiction will be extended to the unbundled distribution services that convert wholesale sales into retail sales.

At present, our attention is focused on the pricing of unbundled transmission services. However, very shortly, this pricing challenge will have to share the spotlight with the pricing of unbundled distribution services. Fortunately for state and federal regulatory authorities, unbundled transmission and distribution services have similar functionalities. Whereas unbundled transmission services transport power from the transmission-access gateway to the distribution-access gateway, unbundled distribution services distribute power from the distribution-access gateway to retail customers' gateways. Consequently, approaches to the pricing of unbundled transmission services are directly applicable to the pricing of unbundled distribution services.

The scope of this report is restricted to the pricing of the unbundled transmission services that will be sold to rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. We could have expanded the scope to include the unbundled distribution-access and distribution services that will be purchased by large-volume industrial customers and cooperatives of retail customers when retail competition is implemented. However, it was not necessary to do this for our purposes. The principles for the pricing of unbundled transmission services are transferable without modification to the pricing of unbundled distribution services.

State regulatory authorities can use this report in either of two ways. They can examine it with an eye toward contributing to the debate on the pricing of unbundled transmission services, or they can study it with an eye toward the pricing of unbundled distribution services. Whatever choice they make, now is the time for them to look closely at the pricing of unbundled transmission services. This area of pricing is absorbing large portions of the time and creative energies of large-volume customers with real opportunities to flee service territories or to bypass the utilities. If the pricing of unbundled transmission services can reduce these opportunities substantially, then state regulatory authorities will have obtained very real benefits for their captive customers.

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CHAPTER 1

INTRODUCTION

Like a complex flower that blooms periodically, competition in the wholesale market for electric power is unfolding its petals time and time again to reveal its complicated structure. The seeds of competition were planted in 1978 with the passage of the *Public Utility Regulatory Policies Act* (PURPA). This federal law blossomed first into a quasi-competitive wholesale market that was landscaped with cogenerators, qualifying facilities, independent power producers, and utilities. The appearance of competition was promoted by the PURPA requirement that utilities had to buy electric power from these nonutility generators.

True competition did not appear until technological innovations caused the second blooming of this competitive flower. New technologies decreased the cost of exploring for natural gas by increasing the number of successful wells. More natural gas at lower prices spurred the growth of combined-cycle natural gas turbines as substitutes for the utilities' coal, oil, and nuclear facilities. These new business opportunities stimulated new research into the operation of combined-cycle natural gas turbines. This research paid off eventually, and gas turbines emerged as economically competitive substitutes for the utilities' existing facilities. No longer were "sales for resale" economically beneficial trades between a closed and coordinated group of wholesalers and retailers that was limited to utilities and rural cooperatives. This new species of nonutility generator truly competed in the sales-for-resale market with the established utilities.

The transformation from quasi-competition to competition was grossly unbalanced. The utilities' pricing flexibility was limited to existing tariff regulations, and their participation in competitive bidding was subject to continuous regulatory scrutiny. Meanwhile, the nonutility generators did not have to compete under these restrictions. They set their prices with an eye toward costs and market demand, and they changed them without the approval of regulatory authorities. These differences created a competitive landscape that was uneven and bifurcated. Metaphorically, the new technologies fanned out the petals of competition asymmetrically.

The third blooming of competition began in 1992 with the passage of the *Energy Policy Act* (EPACT). Before this act became law, the nonutility generators competed with regulated companies. With the passage of EPACT, the traditional nonutility generators now have to compete with unregulated generation companies that are owned by utilities. This new competitive arrangement represents an important change in the landscape of the electric power industry. In effect, EPACT unfolds the competitive flower one more time to reveal yet another shape that more closely resembles symmetric competition.

Utilities may stake out their area in the new competitive landscape by creating hybrids from their existing generation facilities. However, this mixing of old and new generation technologies raises an important regulatory question: *Will regulatory authorities separate regulated and unregulated costs with structural or nonstructural methods*? Surely, state and federal regulatory authorities have a legitimate interest in the costs that the utilities incur while they construct unregulated companies.[1] They clearly will have to convince themselves that generation costs have not been shifted improperly to the utilities' regulated companies.

State and federal authorities need to worry about cost shifting. The federal concern is the competitiveness of the wholesale power market as measured by the interplay between nonutility generators and utility-owned generation companies. The utilities' generation companies appear to be at a competitive disadvantage because of their existing generation costs. Therefore, they have an incentive to shift these costs to

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[1] EPACT does not speak specifically to retail competition, nor does it provide the Federal Energy Regulatory Commission (FERC) with any preemptive authority in this area. As a result, the initiative to establish retail competition has to come primarily from the states. This drive has begun with plans for retail competition being announced recently in California and Wisconsin. In addition, retail competition is being examined in Maryland, New York, Rhode Island, and Connecticut. See Edison Electric Institute, *Retail Wheeling Report: A Quarterly Report* (Washington, DC: Edison Electric Institute, March 1995).

the transmission market. If they succeed despite the best efforts of the federal regulators, then they will have come that much closer to an improper equalization of the competitive position of their generation companies relative to the nonutility generators. In particular, the ratio of utilities' delivered cost of wholesale power to the nonutilities' delivered costs of wholesale power is reduced by cost shifting. Consequently, the utility-owned generation companies and the nonutility generators appear to be behaving similarly even though their cost structures differ radically. Unfortunately, the utilities have the market power to enforce this change in the ratio of delivered costs because it is difficult for the nonutility generators to bypass the utilities' transmission-access facilities. State regulatory authorities have to worry about cost shifting when retail customers are allowed to buy unbundled generation services. Generation costs will show up in the prices of unbundled distribution-access and distribution services. If the utilities are able to hide a disproportionate amount of these costs in these prices, then they can raise the delivered costs of the retail customers' competitively-purchased power relative to the prices of their bundled retail services. Consequently, retail customers will be less likely to participate in the wholesale market.

Although state and federal authorities will take the time to investigate the appearance of cost shifting, they cannot expect to detect and reverse each and every instance of this behavior by the utilities. Undoubtedly, they will know that they have missed instances were the utilities have shifted generation costs to the transmission and distribution markets. Some of them may use this knowledge to justify the allocation of too many common and fixed costs to the utility-owned generation companies. Others may hesitate to lighten the regulation of the transmission and distribution markets until they are convinced that cost shifting is not a necessary element of the utilities' competitive generation strategies.

FOCAL POINT OF THE REPORT

Very few utilities and regulatory authorities doubt that vigorous competition in the wholesale market will raise a number of questions: How should the utilities be organized? What are the appropriate forms of regulation for the utilities' transmission and distribution companies? What are the costs of transmission-access, transmission, distribution-access, and distribution services? What are efficient prices for these regulated services? How should the prices of generation, transmission-access, transmission, distribution-access, and distribution services be passed on to wholesale and retail customers?

We do not address this wide range of questions in this report. Instead, we limit ourselves to questions that relate to the regulation, costing, and pricing of unbundled transmission services.[2] This self-imposed constraint places us squarely within the purview of federal regulators, whom we assume have exclusive jurisdiction over transmission and transmission-access services. We focus our attention on these transmission services because they provide us with the clearest picture of how vigorous competition in the wholesale power market affects utility-owned generation companies, nonutility generators, wholesale customers, and retail customers. We could have analyzed questions about the regulation, costing, and pricing of unbundled distribution services. This choice would have placed us squarely within the purview of state regulatory authorities, whom we assume to have sole jurisdiction over the distribution market. The point is that either focal point has sufficient breadth to cover the essential elements of how state and federal authorities might deal with vigorous competition in the wholesale power market. Furthermore, either focal point reveals

[2] Transmission service is comprised of components and interfaces that transport electric power from the transmission gateway to the distribution gateway. To visualize this system, it is best to think of the interface between transmission-access facilities and transmission-network facilities as the beginning of the transmission service, and the interface between the transmission-network facilities and distribution-access facilities as the end of the service. Transmission lines are the components that lie in between these interfaces.

questions that are sufficiently broad to develop an understanding of how the interests of wholesale and retail customers are affected by the opportunistic bypass of the utilities' facilities.

RATIONALE FOR THE REPORT

Existing costing mechanisms are not appropriate for vigorous competition in the wholesale power market because they do not unbundle the costs of generation, transmission-access, and transmission services. Existing pricing mechanisms for these unbundled services are insufficient because they cannot deal with the competitive pressures that are rising in the wholesale power market. Finally, the regulation of unbundled transmission services is a new problem that has not yet been addressed in any systematic fashion.

This report analyzes the regulation, costing, and pricing of unbundled transmission services that are produced by a monopolistic, utility-owned transmission company. We explore the possibility of price-cap regulation, and we examine the characteristics of first-best, second-best, subsidy-free, compensatory, and efficient component prices for transmission services.[3] It has been argued that efficient component prices can help to eliminate the opportunistic bypass of a utility's facilities.[4]

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[3] Second-best efficiency is discussed in subsequent chapters. For now, it is sufficient to note that a monopolist that faces inelastic market demand schedules achieves second-best efficiency by selecting prices that lie above marginal costs and simultaneously minimize the reduction in the sum of the consumer and producer surplus that would be available in a perfectly contestable market.

[4] William J. Baumol, Paul L. Joskow, and Alfred E. Kahn, "The Challenge for Federal and State Regulators: Transition from Regulation to Efficient Competition in Electric Power," in [unknown] ("n.p.", December 9, 1994), Appendix A. See also, William J. Baumol and J. Gregory Sidak, *Toward Competition in Local Telephony*, AEI Studies in Telecommunications Deregulation (Cambridge, MA: The MIT Press and Washington, DC: The American Enterprise Institute for Public Policy Research, 1994).

ORGANIZATION OF THE REPORT

Two forms of price-cap regulation are discussed in Chapter 2. The first is price-cap regulation with profit monitoring. The second is price-cap regulation with profit sharing. Price-cap regulation with profit monitoring appears to have more severe political and risk issues than price-cap regulation with profit sharing. However, the practical realities of price-cap regulation imply that not just any form of price-cap regulation with profit sharing will be acceptable to the regulators, the utility, and the public. The regulators want to avoid political costs. The utility wants to avoid instability. The public wants to avoid excessive profits. Two conditions were placed on price-cap regulation to meet these needs. They are (1) an annually recalculated maximal rate of return and (2) a flexible review date.

Subsidy-free and compensatory pricing are examined in Chapter 3. The prices for inelastically demanded transmission services are subsidy free when they exceed the average incremental costs of these services. Subsidy-free prices for elastically demanded transmission services are obtained when the incremental revenue from the sale of these services exceeds the incremental cost of producing these services. The prices for unbundled transmission services are compensatory when they are subsidy free and meet specific conditions governing the recovery of the transmission company's total costs. In particular, compensatory prices are restricted to the recovery of no more than the competitive total cost of producing unbundled transmission services.

The efficient component pricing of a transmission service that is produced by a single-service monopolist is analyzed in Chapter 4. This price contains three parts. The first and second are the variable and fixed costs that the transmission company incurs to produce it. The third is the opportunity cost that the utility experiences when its transmission company sells this service to rural cooperatives or municipally-owned utilities. Since the incremental cost of a transmission service is equal to the sum of the variable and fixed costs that the transmission company incurs to produce it, the efficient component price for a transmission service simply adds an opportunity cost to the service's incremental cost.

The effects of deviations from the efficient component prices for unbundled transmission services are studied in Chapter 5. These deviations harm the utilities, wholesale customers, and retail customers. Prices that are above efficient component prices drive up the delivered costs of power that is purchased competitively in the wholesale market. Because the competitive purchase of wholesale power is really a purchase for resale, an increase in its delivered costs often causes increases in the prices of retail services. Meanwhile, prices that are below efficient component prices cause the overconsumption of transmission and retail services. Consequently, unnecessary pressures to upgrade transmission and distribution networks are put on utility-owned transmission companies, utility-owned distribution companies, rural cooperatives, and municipally-owned utilities.

The opportunistic bypass of the utility's transmission facilities is explored in Chapter 6. Opportunistic bypass stems from the natural reaction on the part of wholesale customers to inefficiently high prices for unbundled transmission service. It occurs when an inefficient price for unbundled transmission service is thrust up against an efficient or less inefficient price for bypass service. Efficient component prices eliminate the opportunistic bypass of the utility's transmission facilities for the following reasons. These prices cannot support monopoly profits in the transmission market, and they are not consistent with cost shifting from the generation to the transmission markets.

CONCLUDING REMARKS

The objective of this research is to investigate the pros and cons of using efficient component prices to prevent anticompetitive behavior by the utility and to stop the opportunistic bypass of the utility's transmission facilities. It is not to determine whether the wholesale power market should become more competitive. The analysis of whether wholesale competition is appropriate already has been performed in the course of passing EPACT. A more competitive wholesale market is the immediate future of the electric power industry in the United States.

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CHAPTER 2

PRICE-CAP REGULATION OF TRANSMISSION

INTRODUCTION

Economic benefits are realized by society as a result of the price-cap regulation of a monopolistic market. Prices are responsive to the needs of customers. The monopolist is provided with incentives to reduce costs and to introduce new services more rapidly. However, price-cap regulation also has costs that damage the monopolist and its customers. The monopolist has to deal with the efficiency-reducing effects of the regulatory authorities' inability to commit to never again regulate its profits, if and when the monopolist becomes too aggressive in its cost cutting. Meanwhile, some customers have to worry about disproportionate price increases as the monopolist realigns its prices over time.

The purpose of this chapter is to develop an approach for the price-cap regulation of a monopolistic transmission market. We begin with a comparison of the essential elements of price-cap regulation with profit sharing to price-cap regulation with profit monitoring. The notable characteristic of profit sharing is that regulatory authorities and the utilities continue to debate the appropriate methodology for determining the allowed rate of return. The striking characteristic of profit monitoring is the credible threat that "excessive profits" will trigger more earnings constraints. An approach to the price-cap regulation of a monopolistic transmission market is developed in the next section.

COMPARISON OF PROFIT SHARING AND PROFIT MONITORING

The switch from rate-of-return regulation to price-cap regulation with profit sharing continues the debate over the appropriate methodology for determining the allowed rate of return. This debate is not trivial because its outcome will determine the size of the *ex post* transfer of cost savings from the monopolist to its customers. If the winning methodology implies a low allowed rate of return, then profit sharing serves directly and meaningfully to keep down the monopolist's prices. Clearly, profit monitoring cannot play this role. Profit monitoring simply serves to keep tabs on the profits that the monopolist actually earns. As a result, it does not do much directly to quell fears that the monopolist's actual profits are excessive. In fact, profit monitoring would reveal to some that the monopolist is earning too much money. Consequently, it would appear that profit sharing is the preferred option from the regulators' perspective.

A concrete benefit is embedded within profit sharing that points toward the effectiveness of price-cap regulation. It is the price reductions and profit rebates that are part and parcel of all profit-sharing regimes. These benefits provide direct evidence that customers do benefit from price-cap regulation. The concrete benefit that is embedded in profit monitoring does not accrue to the regulators; instead, it accrues to the utilities. It allows the utilities to keep the excessive profits that they already have earned. Therefore, this particular benefit implies that price-cap regulation is working against the interests of the monopolist's customers.

However, profit sharing and profit monitoring also have costs. For some, shared profits confirms their suspicions that existing prices are unnecessarily high. As a result, they are apt to propose price reductions even though the monopolist is rebating some of its profits to its customers. What they fail to recognize is that profits can be earned by cutting costs. They also might not recognize that the monopolist would not cut its costs voluntarily, if it was not allowed to keep some of its profits for a long period of time. Putting it another way, they are likely to perceive shared profits as taking money from the customers' pockets and putting it into the stockholders' pockets. However, this particular perception of ill-gotten gains also would exist under profit monitoring. In this instance, the individuals in question would be angered that none of the excessive profits are being shared with customers.

Persistent reference by critics of price-cap regulation to the utilities' undeserved gains under profit monitoring and profit sharing are meant to suggest to the regulators that they should return to rate-of-return regulation. A rational monopolist should view this suggestion as a possibility that it might once again be subject to rate-of-return regulation. If it fears a return to limitations on its profitability, then a rational monopolist would hold back on its cost-cutting efforts by using a more redundant production process. Another possible behavior by a rational monopolist is to keep its profits within reason by vacillating with respect to cost reduction.

It really does not matter whether the regulatory authorities do or do not decide to return to rate-of-return regulation. The mere suggestion that this reswitching may occur implies that regulatory authorities have retained the right to second guess the monopolist's pricing and production decisions. Therefore, this company might be tempted to propose inefficiently low prices in an effort to soften the possible criticisms by the critics of price-cap regulation that it is preoccupied with profits to the detriment of fairness. Clearly, the threat of reswitching exists under either form of price-cap regulation. Therefore, it appears that the utilities and the regulators have to agree to some trade-off between equity and efficiency if they want price-cap regulation to remain stable for a long period of time. The actual trade-off will favor the more powerful side when the less powerful side decides to minimize the maximum gain of the more powerful side.[1]

There are strong indications that profit sharing and profit monitoring represent significant deviations from the ideal of price-cap regulation. That is, for whatever reasons, the regulators have decided to not make the commitment that they will not evaluate the monopolist's profit history. They also have decided to not make the

[1] John von Neumann and Oscar Morgenstern, *The Theory of Games and Economic Behavior* (Princeton, NJ: Princeton University Press, 1944).

commitment that they will not second guess the appropriateness of the actual profits earned by the monopolist. However, to be fair to regulators, it is true that the existence of ideal price-cap regulation depends on commitments that are unaffected by *ex post* outcomes. Binmore and Schelling have argued convincingly that it is exceedingly difficult to extract commitments of this type from anyone or any organization.[2]

AN APPROACH TO PRICE-CAP REGULATION OF TRANSMISSION SERVICES

Regulatory authorities often place themselves between a rock and a hard place when they try to implement price-cap regulation. On the one hand, they want to provide the monopolist with incentives to pursue permanent cost reductions. On the other hand, they know that they cannot extend a guarantee to this company that it always will benefit from its cost-reduction efforts. Another group of regulators may decide to capture the monopolist's permanent cost savings by returning to some form of profit-based regulation. Therefore, current regulators must know that a rational monopolist would be fearful of irreversible cost reductions.

These observations suggest that the regulators' most pressing problem, as they implement price-cap regulation, is finding a way to induce permanent cost reductions. We know that they cannot solve this problem by making commitments that have probabilities approaching one. Although an earlier group of regulators could commit to never returning to profit-based regulation, they cannot commit a later group of regulators to do the same thing. As a result, the current regulators cannot create a stable environment that permits the monopolist to keep more profits as it earns more profits. They cannot decide to never change the way they calculate the allowed rate of

[2] Ken Binmore, *Game Theory and the Social Contract Volume I: Playing Fair* (Cambridge, MA: The MIT Press, 1994). Also, see Thomas Schelling, *The Strategy of Conflict* (Cambridge, MA: Harvard University Press, 1960).

return for use in profit-sharing forms of price-cap regulation. They cannot vote for the permanent elimination of a cap on the amount of profits that the monopolist may earn in any time period. In fact, they cannot even preset, once and for all, a rate of return at which the monopolist is obligated to return 100 percent of the difference between this rate of return and the allowed rate of return. Essentially, current regulators cannot commit to the principle that they will never expropriate profits. Consequently, a positive probability always exists that a future configuration of regulators will return to rate-of-return regulation for some reason or another.

Obviously, their inability to make commitments raises a difficult question for current regulators that favor price-cap regulation. *How can they induce the monopolist to accept this form of regulation wholeheartedly*? We believe that it will be difficult to nail down the answer to this question. At present, our best response is to assure a range of profitability to the utility that counterbalances the regulators' credible threat that they may some day return to profit-based regulation. In the remainder of this section, we develop a form of price-cap regulation that contains this feature.

As we see it, price-cap regulation is unstable for two reasons. First, the monopolist does not have any legal recourse when regulators renege on their promises to allow it to increase its profits indefinitely. Second, the regulators want to avoid the political costs that are associated with excessive profits. Initially, we thought that these sources of regulatory instability would be eliminated if the public expected price declines from price-cap regulation. Our reasoning was that price decreases could be used to offset the critics' claim that price-cap regulation favors the monopolist over the consumer. With the critics' claims safely rebutted, the regulators could be less concerned about the political risks of excessive profits, while the monopolist could be less concerned that the regulators would revert to rate-of-return regulation. Therefore, we defined the payoff from price-cap regulation in terms of expected price increases and decreases. Expected price increases represented negative payoffs. Expected price decreases represented positive payoffs.

We surmised that forms of price-cap regulation with many expected price increases over the long term would be eliminated immediately by the regulators. Regulators simply cannot accept repeated price increases because of the political risks they imply. We felt that the remaining forms could be ranked by their averaged expected price declines. Obviously, regulators would choose the form with the largest averaged fall in prices over the long term. But, can the regulators make this choice without the assistance of the monopolist? The cost information that is held by the monopolist and unavailable to the regulators is the problem.

If the regulators believe that information asymmetries do not unduly influence their selection of a form of price-cap regulation, then they unilaterally can estimate the averaged expected price declines for the eligible forms from the data that is supplied by the monopolist. However, they have to worry about whether the monopolist likes or dislikes a given form of price-cap regulation when asymmetric cost information can unduly influence the selection process. The conventional wisdom is that the monopolist can use asymmetric information to exert undue influence. Therefore, we surmised that the regulators had to be concerned about the monopolist's feelings. It soon became apparent to us that the monopolist needed a form of price-cap regulation that would be around for awhile.

The actual average expected price decrease that the monopolist will achieve under a particular form of price-cap regulation will vary with changes in the probability that the regulators will revert to rate-of-return regulation. The monopolist knows that it will achieve larger expected price decreases for a given form of price-cap regulation when it believes that the regulators will not change their minds about the validity of an implemented form. Conversely, it knows that it will achieve smaller expected price decreases for a given form when it believes that the regulators will change their mind about its validity. There are two reasons for this behavior. First, the monopolist chooses a steady course of action for reducing its costs when it is confident that the regulators will not change their course of action. Second, it chooses a flexible course of action for reducing its costs when it is unsure about the regulators' future behavior.

Because the monopolist knows that the regulators' expected behavior influences its behavior, it cannot ignore how the regulators feel about different forms of price-cap regulation. Consequently, the rational monopolist needs to set about constructing a unique probability for the possibility that the regulators will change their collective mind about the validity of a particular form of price-cap regulation. There is one probability for each eligible form. Of course, the monopolist constructs these probabilities from information that summarizes how vigorously the regulators will support each eligible form of price-cap regulation in the face of criticism that profits are excessive. The problem is that the monopolist does not have access to the information that it needs to construct these probabilities. Generally, it knows only that the regulators can initiate a proceeding to revert to rate-of-return regulation. Although this information is sufficient to determine the initial incentive that the monopolist has to cut its costs, it is not sufficient to construct the probabilities that the regulators will change their collective mind about the validity of each eligible form of price-cap regulation. Therefore, the monopolist does not have as much as an inkling of how future regulatory behavior will change its cost-cutting behavior. Its only course of action is to wait and see what the regulators do when they are asked to support an already-implemented form of price-cap regulation.

We believe that a credible promise from the regulators, pertaining to the maximum level of profit that the monopolist can earn in a given period of time, will alleviate the uncertainty that is created by the monopolist's inability to predict changes in regulatory behavior. Although a credible promise is not a commitment in the sense of Binmore and Schelling, it is a promise with a high continuation probability. In other words, it is a discounted commitment, where the commitment loses credibility as the discount factor approaches zero. Clearly, a promise of this type structurally reduces the monopolist's need to know about the regulators' tendencies to support eligible forms of price-cap regulation. Hopefully, this effect is strong enough to make the monopolist's need to know about the regulators' future behavior a nonissue when it is deciding how strongly to cut its costs under each eligible form of price-cap regulation.

An invariant upper bound on profits for a limited period of time is a credible promise that pertains to the maximal rate of return that is associated with each eligible form of price-cap regulation. Because the maximal rate of return is that rate of return above which the monopolist is required to return all profits to its customers, we believe that the regulators will be less inclined to turn their backs rapidly on an implemented form of price-cap regulation. If this effect does indeed emerge, then the monopolist's need to know about the beliefs of regulators is clearly reduced when upper-bound invariance is imposed on price-cap regulation.

Credible profit sharing is created when the regulators join the criteria of expected price declines and upper-bound invariance. Undoubtedly, this form of price-cap regulation eliminates any incentives for the monopolist to earn above the politically acceptable rate of return because it would have to return the entire amount to its customers. Unquestionably, credible profit sharing encourages the monopolist to find the mixture of cost and price decreases that yield the maximal rate of return for the given period of time because it is confident that the sharing percentages will remain in effect even if it earns this rate of return. Because a rational monopolist will never choose to do worse than it can under its existing beliefs, we conclude that credible profit sharing is stable.

The regulators may embed the maximal rate of return in an annual or multiyear time period. We realize that annually resetting the maximal rate of return is less risky for the regulators because this practice minimizes the probability that the profits earned by the monopolist will be perceived as excessive by the general public. However, we also realize that annual approaches do not represent much of a credible promise on the part of the regulatory authorities. Although it is very likely that profit sharing will continue in effect from year to year, it also is very likely that the maximal rate of return will be continually readjusted to capture a portion of the monopolist's cost savings for its customers. As a result, annual approaches are likely to impair the monopolist's incentive to seek out and realize permanent cost reductions. However, political risks increase as this time period is lengthened. Therefore, it would be useful if regulators had a means to offset the ill-effects of an annually recalculated upper bound on profits.

We believe that this counterweight is found in the procedures for the post-implementation review of price-cap regulation. Often, price-cap regulation is implemented with a review clause that allows the regulators to revisit their decisions. Typically, the review date is “etched-in-stone” to mute the political backlash from the implementation of price-cap regulation. If political concerns are being addressed by the annual recalculation of the maximal rate of return, then the regulators have the leeway to consider a flexible review date as a means to keep down the monopolist's administrative costs. Clearly, the monopolist incurs administrative costs when it has to defend price-cap regulation from the critics' claim that it favors the monopolist over the consumer. Similarly, the regulators incur administrative costs when they have to mitigate the political costs that arise when the monopolist's profits are perceived to be too high by the public. It seems self-explanatory to us that it is not necessary for either the regulators or the monopolist to incur these costs when the implemented form of price-cap regulation is working adequately in the eyes of the public. Obviously, a flexible review date allows the regulators to evaluate the economic and social effects of price-cap regulation on a schedule that matches public concerns with efficient regulatory oversight. In particular, a flexible review date improves economic efficiency by reducing society's administrative costs and encouraging the monopolist to take the time to ensure that the public perceives that price-cap regulation is working smoothly.

CONCLUDING REMARKS

In this chapter, we have suggested a form of price-cap regulation that we believe is suitable for the regulation of the transmission monopoly. The suggested form requires the public's acceptance of flexible review dates and an annually recalculated maximal allowed rate of return. Continuously recalculating the rate of return helps to avoid political costs. The flexible review date helps to avoid administrative costs. In the next chapter, we discuss the efficient pricing of unbundled transmission services when they are supplied by a monopolist. This discussion lays the foundation for our effort to develop rational ties between the price-cap regulation of the transmission monopoly and the pricing of unbundled transmission services.

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CHAPTER 3

ALMOST EFFICIENT PRICES FOR TRANSMISSION SERVICES

INTRODUCTION

Efficient prices are preferred over inefficient prices for two reasons. They maximize the sum of consumer and producer surplus, and they induce the efficient allocation of resources.[1] Why is it important to maximize the sum of consumer and producer surplus? Producer surplus is economic value that is realized in the real world as profit, while consumer surplus is economic value that is realized by the buyer of a good or service when that buyer does not have to pay what he or she is willing to pay to consume the good or service.[2] Therefore, the sum of consumer and producer surplus is the total economic value that is created by the production and consumption of a good or service. Why is it important to allocate resources efficiently? The efficient allocation of resources achieves a Pareto optimum, and the achievement of a Pareto optimum means that no consumer or producer of the good or service in question can be made better off in terms of satisfaction or profits, respectively, without making some

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[1] The sum of consumer surplus and producer surplus is maximized in a perfectly competitive market for transmission services by setting prices equal to marginal costs when government intervention and externalities are not present. See Kenneth J. Arrow, "An Extension of the Basic Theorems of Classical Welfare Economics," in *Proceedings of the Second Berkeley Symposium on Mathematical Statistics and Probability*, Jerzy Neyman, ed. (Berkeley, CA: University of California Press, 1951), 507; Gerard Debreu, *The Theory of Value: An Axiomatic Analysis of Economic Equilibrium* (New Haven, CT: Yale University Press, 1959).

[2] Consumer surplus is measured by subtracting the amount that consumers actually paid to consume the equilibrium level of the good or service from what consumers would have been willing to pay collectively to consume the same level of the good or service. The measure of consumer surplus is a positive number when at least one consumer is willing to pay more to consume the good or service than the price that is set by the firm producing the good or service. Producer surplus is measured by simply subtracting what it actually costs the firm to produce the equilibrium level of the good or service from what the consumers actually paid to consume the same level of the good or service.

other consumer or producer of the good or service worse off.

The purpose of this chapter is to discuss what regulatory authorities can do to approach efficient prices for transmission services. The next three sections present models of the monopolistic market for transmission, the monopolistic transmission company, and the nonprice regulation of the monopolistic transmission company. These models are the foundation for the analysis of almost efficient prices for transmission services. The fourth section discusses the conditions under which regulatory authorities can prevent the cross-subsidization of transmission services, thereby moving us at least one step closer to efficient prices. The fifth section describes how regulatory authorities can implement compensatory prices for transmission services, thereby moving us another step closer to efficient prices. The next-to-last section examines the character of a specific upper limit on the compensatory prices for transmission services that represents yet another step toward efficient prices.

MODEL FOR THE REGULATION OF TRANSMISSION SERVICES

Federal regulators are assumed to have exclusive jurisdiction over transmission. This assumption has been made for the purpose of analytical convenience as much as anything else. Although not absolutely convincing, an argument in favor of the federal regulation of transmission is based on the observation that bilateral contracts between buyers and sellers of wholesale power would never exist if the buyers could not arrange for the delivery of this power to their distribution gateways, and if the sellers could not arrange for the delivery of their power to the transmission gateways.[3] Therefore, it seems reasonable that the same authority that regulates the sale of

[3] There is no proof or argument that establishes undeniably that transmission must be regulated by the FERC, just as there is no proof that transmission should be regulated by state authorities. Consequently, it is possible that the regulation of unbundled transmission services might be shared among state and federal authorities.

wholesale power also should regulate the sale of transmission-access and transmission services. Because federal authorities currently regulate the sale of wholesale power to rural cooperatives, municipally-owned utilities, and investor-owned utilities, it seems reasonable to extend their reach to transmission-access and transmission services.

If the reach of federal regulatory authorities is extended to the transmission market, then they would be responsible for assuring the efficiency and equity of the markets for wholesale power and unbundled transmission services. With respect to the market for wholesale power, the FERC has to decide whether there are pockets of market power that would cause it to intervene in the areas of pricing and production. If these federal authorities conclude that pockets of market power do not exist in the wholesale market, then they can deregulate this market, thereby letting market forces determine the prices for wholesale power. If the FERC decides that there are pockets of market power in the production of generation service that would cause a distortion in the operation of the wholesale power market, then it will have to decide on the appropriate regulatory format for this market.

With respect to the transmission market, the federal regulators have to assure the buyers and sellers of wholesale power that the utility-owned transmission company will not act on its incentive to sell different transmission services to different buyers. To provide this assurance, they have to promulgate rules governing the supply of transmission services that include the principles of open access and service comparability. These rules will spell out how the rural cooperatives and municipally-owned utilities will transport power to their gateways.[4]

Presumably, the transmission services that are provided to the nonutility

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[4] In principle, a buyer does not have to be in the "sale for resale" business to purchase unbundled generation services. Large-volume industrial customers and cooperatives of retail customers may want to purchase unbundled generation services if they also could purchase unbundled transmission, distribution-access, and distribution services. Of course, now we are describing retail competition. But, the point is that the unbundled transmission services that are purchased by wholesale customers under wholesale competition are the same unbundled transmission services that are purchased by retail customers under retail competition.

distribution companies will be the same as the transmission services that are provided to utility-owned distribution companies. That is, the federal regulatory authorities have to make sure that the rural cooperatives and municipally-owned utilities are not competitively disadvantaged because of the quality or structure of the transmission services that are sold to them.[5] If this assurance cannot be made, then the federal regulators have to ensure that the transmission services actually sold to rural cooperatives and municipally-owned utilities do not differ appreciably from the transmission services that are provided to the utility-owned distribution companies.

The FERC is not the only agency that can assure the rural cooperatives and municipally-owned utilities that they will be treated fairly by utility-owned transmission companies. If required to do so, state regulatory authorities could provide assurances to all buyers of unbundled transmission services that they will be treated equally during the time that they are transporting power to their distribution gateways. Of course, there may be some notable differences in a state-by-state comparison of transmission rules. However, the buyers and sellers of unbundled transmission services presumably can overcome these differences by incurring some coordination costs. Consequently, the assumed federal regulation of the transmission market has nothing whatsoever to do with the utility's ownership of generation companies or its control over the bottleneck facilities that create the subsystem of assets that comprises transmission-access and transmission services.[6] Instead, the federal regulation of transmission has been assumed because federal regulators are positioned nicely to promulgate unified rules that join together the unbundled generation and transmission markets consistently. In particular, they can promulgate unified rules for transmission services that ensure the

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[5] It is a common regulatory practice to adopt a standard of comparability that recognizes that physically identical interconnection is not always possible or economically feasible when a formerly monopolistic, regulated, and vertically-integrated company is in a transition to a different state of organization.

[6] This subsystem is a component of a larger system that connects generation companies to retail customers. The other components of the larger system are generation services, distribution-access services, distribution services, and retail customer interconnection. The larger system may be visualized as a network of shipping routes leading from a generator's port of exit to a retail customer's port of entry.

timely delivery of electric power that is purchased in the wholesale market, regardless of the physical location of the buyer and seller.[7]

Model of the Utility-Owned Transmission Company

In this model, the transmission company supplies unbundled transmission-access services to nonutility generators and utility-owned generation companies, and unbundled transmission services to rural cooperatives, municipally-owned utilities, investor-owned distribution companies, large-volume industrial customers, and cooperatives of retail customers. The transmission company is a monopolist, and as a result, its customers cannot go to other sources for the transmission-access and transmission services they require. Therefore, the transmission company has a conflict of interest when it is owned by the utility.

Traditionally, an electric power utility owned facilities that permitted it to generate, transmit, and distribute electricity to its retail customers, and to generate and transmit electricity to its wholesale customers. Its retail and wholesale customers did not buy the utility's generation, transmission, and distribution services separately. Instead, they purchased bundled wholesale or retail services. Obviously, wholesale power was cheaper than retail power because the utility did not have to incur any distribution costs. Now, as long as the utility continues to own transmission and distribution facilities, it has to sell unbundled transmission and distribution services to its competitors. Its wholesale competitors are the rural cooperatives and municipally-owned utilities that compete with the utility-owned distribution companies. Its generation competitors are the nonutility generators that compete with the utility-owned generation companies.

[7] The transmission service under discussion is the transportation of electric power through a utility-dominated transmission grid or a utility-owned transmission network to the distribution gateways of the buyers of wholesale electric power.

Competition on both sides of transmission and the regulation of the transmission market provide the utility with incentives to set prices for its transmission-access services that favor its generation companies and for transmission services that favor its distribution companies. Because the profitability of its transmission company usually is limited by regulation, the utility may as well make every effort to boost the competitiveness of its generation and distribution companies. A utility can do this, if it can find a way for its transmission company to cross-subsidize its generation and distribution companies.

Loosely speaking, cross-subsidization means that the prices for some services are set too high in order that the prices for other services can be set too low. Therefore, in a general sense, the utility must have the wherewithal to set the prices for its transmission-access and transmission services at excessively high levels, if these prices are to be the sources of cross-subsidies for generation and distribution prices. That is, the utility must feel confident that neither it nor its transmission company will be harmed by excessively high transmission prices.

In this model, the utility knows that its transmission company is a monopolist. The utility also knows that its transmission company incurs a lot of service-specific costs to produce transmission-access and transmission services. Furthermore, it knows that these costs are sunk in the short term because they would not disappear from the transmission company's books, even if no power was to flow over transmission towers, cables, and rights of way. Lastly, the utility knows that these sunk costs are attributable to its ownership of bottleneck transmission facilities.

On its own, a significant level of sunk costs raises a barrier to the entry and exit of a market.[8] New entrants do not want to incur these costs because they may not be successful in the market. Therefore, they are an entry barrier. Incumbents do not want to incur them because they remain to plague them after they exit a market. Therefore,

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[8] William J. Baumol, John C. Panzar, and Robert D. Willig, *Contestable Markets and the Theory of Industry Structure*, with contributions by Elizabeth E. Bailey, Dietrich Fisher, and Hermam C. Quirmback, rev. ed. (San Diego, CA: Harcourt Brace Jovanovich, 1988).

they are an exit barrier. The simultaneous presence of entry and exit barriers suggests strongly that another transmission company is not likely to challenge the incumbent, utility-owned transmission company.[9] Consequently, the utility-owned transmission company has the wherewithal to raise the prices of its transmission-access and transmission services.

MODEL OF THE MARKET FOR TRANSMISSION SERVICES

In theory, any market can be opened to competition. Perhaps, a new technology will destroy a natural monopoly.[10] For example, new network-management and information-processing techniques may progress to a point where it is possible to accommodate wide-spread competition among transmission companies. However, these techniques are not yet available. Moreover, it is very difficult for a new transmission company to obtain the permission that is necessary to build new transmission facilities. Therefore, in this model, the utility's transmission company is a natural monopolist.

Often, market demand conditions produce the outcome that the profit-maximizing level of output for a natural monopolist lies within the declining-cost region of its existing production technology. When this relationship exists between the monopolist's existing costs and existing production technology, it cannot remain financially viable by setting the prices for its services equal to their marginal costs.[11] Therefore, this monopolist must set prices for its services that lie above their marginal costs.

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[9] A utility-owned transmission service provider would not have to worry at all about market entry if the level of its sunk costs is high enough and the markets for transmission-access and transmission service are small enough.

[10] A natural monopoly exists when a single firm is the most efficient way to serve market demand.

[11] Marginal cost of a service is defined as the increase in the total cost of producing that service that is caused by a very small increase in the production of the service.

What does it mean when a natural monopolist must set its prices above its marginal costs to remain financially viable? It means that the most the monopolist can hope for in terms of efficiency is to achieve second-best economic efficiency. How does the monopolist achieve second-best economic efficiency? It finds the configuration of prices that yields no more than the (perfectly) competitive rate of return on its investment and minimizes the reduction in the (perfectly competitive) sum of its consumer and producer surplus, where this reduction in economic efficiency arises because the monopolist has to set its prices above its marginal costs.[12] These prices are derived analytically by employing mathematical techniques that produce nothing less than a generalized optimal solution to the problem of insufficient revenues.

A strong heart and a large pocketbook are necessary to do the mathematics that solve the problem of insufficient revenues. Data are required on a number of economic variables, including the schedules of the monopolist's marginal costs and its own- and cross-price elasticities of demand.[13] Although it would be convenient to do so, the analyst cannot ignore the cross-price elasticities of demand whenever the configuration of the services in question contains substitutes and complements.[14] In fact, Baumol and Sidak argue that the problem of insufficient revenues cannot be solved optimally because it is virtually impossible in their opinion to maintain the data sets that are needed to estimate the various elasticities of demand.[15] Consider just one aspect of

[12] Frank P. Ramsey, "A Contribution to the Theory of Taxation," *Economic Journal* 37 (1927): 47-61.

[13] Own-price elasticity of demand for a service is defined as the percentage change in the quantity demanded of the service that is caused by the percentage change in the price of the service when all other prices for all other services are held constant. Cross-price elasticity of demand for a service is defined as the percentage change in the quantity demanded of a particular service that is caused by a percentage change in the price of another service when all other prices for all other services are held constant.

[14] A service is a substitute for another service when the quantity demanded of the first service increases (decreases) after an increase (decrease) in the price of the second service. A service is a complement to another service when the quantity demanded of the first service increases (decreases) after a decrease (increase) in the price of the second service.

[15] Baumol and Sidak, *Local Telephony*, 40-41.

finding the appropriate values for own- and cross-price elasticities of demand. These elasticity values are influenced by the actions of regulated companies and the decisions of state and federal regulatory authorities. These values are reduced whenever the regulatory authorities or others erect entry barriers, and conversely, these values swell when entry barriers are removed and pricing flexibility is augmented. Other complications with respect to finding appropriate values for own- and cross-price elasticities of demand include inaccurate measurement, improper estimating techniques, and limited computing time. Consequently, in all probability, it is only by pure chance that the set of prices alleged to solve the revenue insufficiency problem is actually the set of prices that achieves second-best economic efficiency.

The preceding element of chance creates the very real possibility that the utility may engage in anticompetitive behavior. Perhaps, the utility might order its transmission company to set discriminatory prices for the transmission services that the latter sells to rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. For example, the utility-owned transmission company might be ordered to set prices that are below marginal costs for the transmission services that are used by utility-owned distribution companies if the transmission company can find ways to prevent the other users from purchasing these below-cost transmission services. Although open access and service comparability are meant to prevent price discrimination and service discrimination, these structural solutions to the problems of discrimination by a monopolist are not perfect. Technologies simply do not change fast enough to make open access and service comparability appear over night. This concern has led many analysts to search for a menu of pricing rules that holds out the hope that a monopolistic company will propose prices that are inconsistent with anticompetitive behavior.

In the next two sections, we discuss pricing rules that have been proposed by Baumol and Sidak. These rules are used to find subsidy-free and compensatory prices for the monopolist's transmission services. Rules that prevent predation are not considered in this report because the utility-owned transmission company is a natural monopolist in our model. Consequently, this company does not have any reason to exercise its market power to drive competitors out of the transmission market because there aren't any actual or potential competitors.

SUBSIDY-FREE PRICES FOR TRANSMISSION SERVICES

Simply speaking, Baumol and Sidak hold the position that cross-subsidization exists when the incremental revenue received from the sale of a particular service is insufficient to cover the incremental cost of producing that service, and still the company collects enough revenues from the sales of all of its other services to cover the total cost of producing all of its services.[16] In other words, cross-subsidization exists when a problem of service-specific insufficient net revenue is solved by improperly increasing the net revenue that is earned from the sales of all of the company's remaining services. Obviously, the incremental cost of the production of a service and the incremental revenue from the sale of a service are defined in the context of a company that produces more than one service. Therefore, to explain the existence of cross-subsidization, we consider a company that produces three services: A, B, and C.[17] Following Baumol and Sidak, the *average* incremental cost of service A is defined as:

$$[TC(a,b,c) - TC(0,b,c)]/a, \qquad (3.1)$$

[16] Ibid., 62.

[17] Ibid., 57.

where

a denotes the quantity produced of service A;

b denotes the quantity produced of service B;

c denotes the quantity produced of service C;

$TC(a,b,c)$ represents the total cost of the combined production of A, B, and C;

$TC(0,b,c)$ represents the total cost of the combined production of B and C.

Of course, with the appropriate substitutions, this definition also applies to the average incremental costs of services B and C.

Per the definition of total cost, $TC(a,b,c)$ includes the direct, indirect, and common costs that are associated with the combined production of services A, B, and C. Some portion of this total cost is a fixed cost, and the remainder of this total cost is made up of variable costs. Meanwhile, $TC(0,b,c)$ can be divided into the fixed and variable costs of the combined production of only services B and C. That is, $TC(0,b,c)$ does not include any of the service-specific variable and fixed costs that are associated with producing a units of service A when the company also produces b units of service B and c units of service C. Therefore, the numerator of equation 3.1, being merely the difference between $TC(a,b,c)$ and $TC(0,b,c)$, is the total service-specific costs that the company incurs to produce a units of service A when it already is producing b units of service B and c units of service C. In other words, the numerator of equation 3.1 is the *incremental cost* of service A, where this particular incremental cost is conditioned on the existing production levels of services B and C.

When the company in question minimizes costs, the definition of the incremental cost of service A identifies the minimum amount of service-specific variable and fixed costs that are needed to produce a units of service A when the company already is producing b units of service B and c units of service C. If, however, the company is not a cost minimizer, then the incremental cost of service A, as defined, clearly can represent more the minimum amount of service-specific variable and fixed costs that have to be incurred to produce *a* units of service A. This fact has to be kept in mind when the incremental cost of a service and the average incremental cost of a service are used in the following analysis.

Also following Baumol and Sidak, the average incremental revenue of service A is defined as:

$$[TR(a,b,c) - TR(0,b,c)]/a, \qquad (3.2)$$

where

a denotes the quantity sold of service A;
b denotes the quantity sold of service B;
c denotes the quantity sold of service C;
TR(*a*,*b*,*c*) represents the total revenue from the combined sales of A, B, and C;
TR(0,*b*,*c*) represents the total revenue from the combined sales of B and C.

The numerator of equation 3.2 is *incremental revenue* for service A, which is the amount of revenues that the company receives from the sale of *a* units of service A according to a price schedule $\mathbf{p}_A$ when it already is selling *b* units of service B and *c* units of service C according to price schedules $\mathbf{p}_B$ and $\mathbf{p}_C$.

Equation 3.2 has several features that should be discussed further. The average incremental revenue of service A is equal to the price, p_A, of service A only when the company sets a uniform price for service A.[18] If the company uses declining-block or time-of-day prices for service A, then the average incremental revenue of service A is the average of the summation of all the revenues received from all of the sales of service A to different customers with different usage levels or different time

[18] We would like to thank Dr. Larry Blank of the NRRI for making this observation and pointing out that it would be less confusing to assume uniform pricing for the individual services A, B, and C.

patterns of consumption. In the subsequent discussion, we assume that the company sets uniform prices, p_A, p_B, and p_C, for services A, B, and C.

We now use equations 3.1 and 3.2 to find subsidy-free prices for the combined production of services A, B, and C. We simplify this computational exercise by considering a set of examples that exhausts the substitute and complement relationships among these three services. In the first example, we assume that each service is neither a substitute for nor complement to the other two services. Consequently, changing the price relationship among these services does not shift the position of any of three market demand schedules, which means analytically that the price of any one of the three services does not affect the sales of the other two services. Therefore, the average incremental revenue of service A does not rise or fall when there are changes in the prices, p_B and p_C.

No Common Costs, Substitutes or Complements

It can be argued easily that average-incremental-cost pricing implies subsidy-free prices for services A, B, and C when common costs are not present. We begin by recalling that the incremental cost of service A includes the service-specific variable and fixed costs that the monopolist incurs to produce *a* units of A. We have assumed that the monopolist will set a uniform price, p_A, for service A, and we let p_A be equal to the average incremental cost of service A. Because service A is neither a substitute for nor a complement to the other two services by assumption, we know that neither the level of p_A nor changes in the level of p_A affect the consumption and production of services B and C. Surely, to find the incremental revenue that a monopolist earns by selling *a* units of service A when it already is selling *b* units of service B and *c* units of service C, we simply have to multiply the *a* sold units of service A by p_A, which is the uniform price of service A set equal to the average incremental cost of service A. By the definition of the incremental cost for service A, which is $TC(a,b,c) - TC(0,b,c)$, this incremental revenue completely covers all of the service-specific variable and fixed costs of producing *a* units of A.

Although the uniform price, p_A, keeps the monopolist whole with respect to the costs that it has incurred exclusively and specifically to produce *a* units of service A, given sales of *a* units of service A, it does not support any common costs that the monopolist may have incurred to produce services A, B, and C. If the monopolist did indeed incur some common costs to produce service A along with services B and C, then the monopolist's failure to recover any common costs as a result of the sales of service A would imply that the price p_A is not subsidy free. Why? The position that a subsidy-free price for service A should not provide any support for common costs is tantamount to claiming that the monopolist would be an economically viable company, if it produced *a* units of service A on a stand-alone basis, and then sold each unit of service at a uniform price of p_A. If indeed this is the case, then it must be true that the monopolist had to incur common costs only because it wanted to produce services B and C along with service A, and not because it wanted to produce service A along with services B and C.

A price equal to the average incremental cost of the service is subsidy free when the monopolist does not incur any common costs to produce that service, and the service is neither a substitute for nor a complement to any other service that is produced by the monopolist. Only under these conditions, is it proper for a subsidy-free price for service A to recover only the service-specific variable and fixed costs of producing *a* units of service A when the company already produces *b* units of service B and *c* units of service C. The same analysis applies to services B and C. That is, the uniform prices, p_B and p_C, if set equal to their respective average incremental costs, are subsidy free only if these services are neither substitutes nor complements, and the monopolist can be economically viable on a stand-alone basis by selling *b* units of service B at a price p_B, or *c* units of service C at a price p_C. Can subsidy-free prices be found when the monopolist does incur common costs to produce these three services and none of the services is a substitute or a complement? The next example shows that this outcome can be achieved when the market demand schedules for services A, B, and C are inelastic.

Common Costs and Inelastic Demands without Substitutes and Complements

We begin this analysis with the assumption that the prices p_A, p_B, and p_C for the services A, B, and C are equal to their average incremental costs. We know that these prices do not allow the monopolist to recover the total cost of producing *a* units of service A, *b* units of service B, and *c* units of service C when it has incurred common costs. Therefore, the monopolist wants to bring its total revenue in line with its total cost. We know that it can do this by raising its prices because the market demand schedule for each of these services is inelastic.

It is shown easily that the monopolist increases its *net revenue* by raising its prices. First of all, it incurs fewer variable costs because it produces fewer units of service. Furthermore, the inelastic market demand schedules guarantee that it earns more revenue. Obviously, the net effect of these changes is an increase in net revenue. It also is shown easily that the relationship is indeterminate between the average incremental costs after the price increases and the average incremental costs before the price increases. The monopolist's downward-sloping demand schedules guarantee only that it sells fewer units of its services after the price increases. Meanwhile, its cost schedules ensure only that it will incur fewer service-specific variable costs. Without additional information concerning the shapes of these schedules, we do not know whether the percentage decreases in the incremental costs of these services exceed or fall short of the percentage decreases in the quantities sold of these services. If the percentage decreases in the incremental costs are greater than the percentage decreases in the quantities sold, then the average incremental costs for these services, at the new production levels, *a′*, *b′*, and *c′*, are smaller than the average incremental costs before the price increases. If the percentage decreases in the incremental costs are less than the percentage decreases in the quantities sold of these services, then the subsequent average incremental costs are larger than the initial average incremental costs.

Notwithstanding the relationship between subsequent and initial average incremental costs, we need to determine whether the new prices are subsidy free. These prices are subsidy free when the subsequent average incremental costs are less than the initial average incremental costs. Why? The new prices are greater than the old prices; therefore, the new prices must be greater than the subsequent average incremental costs. Perhaps not as clearly, the new prices also are subsidy free when the subsequent average incremental costs are greater than the initial average incremental costs. Although these particular costs have increased, it still is true that any prices set equal to these costs would earn only enough revenues to cover the monopolist's service-specific fixed and variable costs. Because the new prices also support the recovery of the monopolist's common costs, these new prices must be greater than the average incremental costs after the price increases, even when the percentage decreases in the quantities sold of these services exceed the percentage decreases in the incremental costs of these services.

We have just argued that new and higher prices for services A, B, and C are consistent with subsidy-free pricing when the market demand schedules for these services are inelastic. Now, we establish that it is the degree of inelasticity that determines whether the monopolist has a reasonable chance of raising its prices enough to recover its common costs. This analysis is performed in two parts. We begin with perfect inelasticity, and then we move to imperfect inelasticity.

When the three market demand schedules are perfectly inelastic, there are no upper bounds on the revenue increases that the monopolist can achieve by increasing the initial prices, p_A, p_B, and p_C. Therefore, the monopolist undoubtedly can raise the additional revenue that it needs to cover its common costs. In addition, there is no doubt that the new prices are subsidy free. Even though the new prices are higher than the initial prices, perfect inelasticity ensures that the monopolist sells the same number of units of these services. Since the number of sold units remains the same, the levels of the service-specific variable and fixed costs do not change after the price increases. Consequently, the incremental costs and average incremental costs for these services do not change. However, the monopolist's incremental revenue from the sale of these services has increased. Hence, the new prices must be subsidy free.

The problem of finding subsidy-free prices is more complicated when the market-demand schedules for services A, B, and C are imperfectly inelastic. Why? The monopolist does not have an unlimited capability to raise its prices. Eventually, the demand for these services will migrate into the elastic range if their prices are raised high enough. Still, reasonable price increases should raise additional revenues because the services in question are neither substitutes nor complements. The question is: *Are these additional revenues enough to cover the monopolist's common costs*? One way to answer this question is to identify the sources of funds that are available to cover them.

When a monopolist increases its prices, it reduces its variable costs. Let us call this cost reduction, V. When it reasonably increases its prices, it increases its revenue. Let us call this additional revenue, R. Because the monopolist will earn more revenue after the price increases than it did before the price increases, it is able to apply the revenue that it previously used to support variable costs to the support of its common costs. Consequently, the sources of funds are V and R.

If we let Z equal the monopolist's common costs, then it must find prices, $p_{A'}$, $p_{B'}$, and $p_{C'}$ such that R + V = Z. Is it possible that R + V can be less than Z? The answer to this question is yes. Suppose that the price elasticities for the services A, B, and C are not very inelastic. This condition implies that the percentage decrease in the consumption of these services is slightly less than the percentage increases in the prices of these services. It also implies that the additional revenue, achieved through these price increases, will be relatively small. Consequently, the monopolist would have to cover its common costs primarily with avoided variable costs. However, to increase the amount of avoided variable costs, it would have to keep increasing the prices of services A, B, and C. Conceivably, the monopolist could run out of pricing room. More specifically, a set of prices, $p_{A'}$, $p_{B'}$, and $p_{C'}$ may not exist that produces enough additional revenue and avoided variable costs to cover the monopolist's common costs. Therefore, to ensure the complete recovery of its common costs, the monopolist's market demand schedules have to be sufficiently inelastic in the sense of being sufficiently close to perfect inelasticity.

The condition of sufficient inelasticity is similar to the inverse-elasticity rule that was developed by Baumol and Bradford.[19] Their rule achieves second-best economic efficiency when the monopolist produces services that are neither substitutes nor complements. The difference between the inverse-elasticity rule and the condition of sufficient inelasticity is that we do not require optimal departures from the efficient production of the monopolist's services. In others words, our condition does not require the monopolist to minimize the reduction in the sales of services A, B, and C.

Common Costs and Elastic Demands without Substitutes or Complements

The preceding analysis has established that price increases result in subsidy-free prices when the monopolist's market demand schedules are inelastic. What happens when the market demand schedules are elastic, and the services in question are neither substitutes nor complements? Can the monopolist find subsidy-free prices? In this example, we know that price increases cause decreases in revenue, costs, and quantities demanded. We also know that price decreases cause increases in revenue, costs, and quantities demanded. Therefore, we have to consider the rates of change of these variables to determine whether the monopolist can find subsidy-free prices for its services.

Price Increases for Services with Elastic Demands

[19] William J. Baumol and David F. Bradford, "Optimal Departures from Marginal Cost Pricing," *American Economic Review* 67 (1977): 350.

Let us first consider price increases. If the monopolist's revenue decreases faster than its costs, then it becomes less profitable. Consequently, in this instance, a rational monopolist would not try to recover its common costs by raising its prices. Now, assume that the monopolist's revenue decreases slower than its costs. Clearly, the monopolist's has improved its financial position, and consequently, it can recover some of its common costs. Therefore, let us assume that the monopolist recovers all of its common costs as a result of these price increases. But, are the new and higher prices subsidy free?

To answer the preceding question, we need to examine the assumption that the monopolist's revenue decreases slower than it costs. For this to happen, the percentage decreases in revenue have to fall short of the percentage decreases in variable costs. Such an outcome is indeed possible. Essentially, the monopolist has been overproducing given its existing production technologies because its variable costs are rising rapidly with increases in output.

Having crossed the threshold of feasibility, we now need to consider the importance of the relationship between quantities demanded and costs. Here we ask: *Does it matter whether there are increases or decreases in the monopolist's average incremental costs*? The answer is that it does not matter as long as the price increases are improving the monopolist's financial position. Why? If the percentage decreases in costs exceed the percentage decreases in the quantities demanded of these services, then the average incremental costs of these services also have decreased. Consequently, the new prices clearly are subsidy free because they are higher than the old prices. If the magnitudes of the preceding percentage decreases are reversed, then the monopolist experiences increases in its average incremental costs. However, as noted in a previous example, the new prices must be greater than the subsequent average incremental costs because they support the monopolist's common costs.

Price Decreases for Services with Elastic Demands

Next, let us consider price decreases. If the monopolist's revenue increases slower than its costs, then it become less profitable. Consequently, in this instance, a rational monopolist would not try to recover its common costs by lowering its prices. Now, assume that the monopolist's revenue increases faster than its costs. Clearly, the monopolist's has improved its financial position, and consequently, it can recover some of its common costs. Therefore, let us assume that the monopolist recovers all of its common costs as a result of these price decreases. But, are the new and lower prices subsidy free?

To answer the preceding question, we need to examine the assumption that the monopolist's revenue increases faster than its costs. For this to happen, the percentage increases in revenue have to exceed the percentage increases in variable costs. Such an outcome is indeed possible. Essentially, the monopolist is underproducing given its existing production technologies because its variable costs are rising slower than its revenue. Having crossed this threshold of feasibility, we now need to consider the relationship between costs and quantities demanded. Here, we ask once again: *Does it matter whether there are increases or decreases in the monopolist's average incremental costs*? The answer to this question again is no.

If the percentage increases in costs fall short of the percentage increases in the quantities demanded of these services, then the average incremental costs of these services fall also. When this happens, the new prices must be greater than the subsequent average incremental costs because they support the monopolist's common costs. But when the magnitudes of the preceding percentage increases are reversed, the monopolist experiences increases in its average incremental costs. Consequently, the new prices clearly are lower than the new average incremental costs. Now, the issue is: *Can prices that are below average incremental costs be subsidy free*?

Per Baumol and Sidak, we know that cross-subsidization exists when the monopolist still earns enough revenue to cover its total cost, even when some of its services are earning incremental revenue that is less than the incremental cost of these services. In the example that we are considering here, the new prices are less than the subsequent average incremental costs. This relationship has emerged because the percentage increases in costs exceed the percentage increases in the quantities demanded of these services. But, we know by the construction of the example that the monopolist is earning enough revenues to cover all of its costs, which include common costs. We also know that its service-by-service revenues are increasing faster than its service-by-service costs. These last two pieces of information imply that the monopolist's incremental revenues for these three services after the price declines are greater than its incremental costs for these services after the price declines because the new prices are supporting the recovery of its common costs. Therefore, cross-subsidization is not occurring, even though the new prices are not greater than or equal to the subsequent average incremental costs.

This analysis of common costs and elastic market demands has established that cross-subsidization does not have to exist even when all prices are set below the relevant average incremental costs of the respective services. This result suggests that the most useful notion of a subsidy-free price is a price such that the monopolist earns incremental revenues from the sales of its services that are equal to or greater than the incremental costs that the monopolist incurs to sell these particular levels of these services. Of course, the incremental revenues and the incremental costs under consideration are measured in the context of Baumol's and Sidak's definitions of average incremental cost and average incremental revenue. For example, the incremental revenue for service A is the total revenue that the monopolist earns from the sale of *a* units of service A when the monopolist already is selling *b* units of service B and *c* units of service C. Meanwhile, the incremental cost for service A is the sum of the service-specific variable and fixed costs that the monopolist incurs to produce *a* units of service A when it already is producing *b* units of service B and *c* units of service C.

In the final examples considered in this chapter, each of the three services are substitutes for or complements to another service. Consequently, the sales of any individual service are affected by the prices that are set for the remaining two services.

For example, the number of units sold of service A changes with changes in the prices of services B and C because the location of the market demand schedule for service A is altered when the prices of services B and C are changed. We assume a simple substitute-complement configuration for the three services A, B, and C. Service B is a substitute for service A, and it is a complement to service C. Services A and C are neither substitutes for nor complements to each other.

Common Costs and Inelastic Demands with Substitutes and Complements

In this example, we assume imperfectly inelastic market demand schedules for services A, B, and C. Once again, the starting point for the analysis is that the monopolist will not earn total revenue that is sufficient to cover its total cost of production when the prices for the services A, B, and C are equal to their average incremental costs. We let the initial prices be p_A, p_B, and p_C. Now, we increase the price of service A from p_A to $p_{A'}$. Imperfect inelasticity guarantees an increase in the monopolist's revenue and a decrease in its production. So, *a'* is less than *a*. The movement from p_A to a higher $p_{A'}$ causes an outward shift of the market demand schedule for service B because service B is a substitute for service A. Consequently, the monopolist's customers will demand more of service B at every price after the increase in the price of service A. Therefore, the monopolist's production and sales of service B will rise from *b* to a higher *b_* at the initial price for service B of p_B.[20] An increase in the production of service B implies an increase in the incremental cost of service B simply because the monopolist incurs more service-specific variable costs. *Can the monopolist expect to recover these additional variable costs if its regulatory*

[20] We did not presume an increase in the price of service B because we are dealing with a regulated monopoly. Perhaps, the regulatory authorities may prevent a price increase for service B, even though there has been an increase in the demand for that service. However, it is necessarily true that the quantity demanded of service B will increase as a result of the assumed increase in the price of service A.

authorities order it to keep the price for service B at p_B? The answer to this question is maybe yes, and maybe no.

The monopolist has increased its variable costs without any change in its service-specific fixed costs. An unchanged price for service B means that the monopolist continues to receive contributions toward fixed costs that can be applied against the new variable costs or converted into profits. If the average variable cost of each unit of the *additional* production of service B that is induced by the rise in the price of service A is less than or equal to the average variable cost of each unit of production before the increase in the price of service A, then the monopolist recovers the additional service-specific variable costs and then some. As a result, p_B clearly is a subsidy-free price. If, however, the average variable cost of each unit of the *additional* production of service B is greater than the average variable cost before the increase in the price of service A, then the monopolist may not recover the additional costs that it incurs to produce more of service B at price p_B. In particular, the monopolist does not recover its additional variable costs when these costs are greater than $p_B(b\_ - b)$.[21] In this case, p_B is not a subsidy-free price.

Next, we increase the price of service C from p_C to $p_{C'}$. Once again, imperfect inelasticity guarantees a revenue increase, a cost decrease, and an output decrease. So, c' is less than c. Additionally, the movement from p_C to a higher $p_{C'}$ causes a downward shift in the market demand schedule for service B because service B is a complement to service C. Therefore, the monopolist's customers will demand a lower quantity of service B at price p_B, after the price increases for services A and C, as compared to the *b_* units of service B that they previously demanded at p_B after the price increase for service A. Let *b#* be the quantity demanded of service B at price p_B after the increase in the prices of service A from p_A to $p_{A'}$ and service C from p_C to $p_{C'}$. *b#* may be less than *b_* and greater than *b*, or *b#* may be less than *b* and *b_*. If the incremental cost of service B at the production level of *b#* is less than or equal to the

[21] $(b\_ - b)$ is the additional production of service B, and $p_B(b\_ - b)$ is the additional revenues that the monopolist earns for the sale of the additional production of service B.

incremental revenue from the sale of service B at price p_B and production level *b#*, then p_B is a subsidy-free price. p_B is not a subsidy-free price when these conditions are not met.

The analysis is almost complete when p_B continues to be a subsidy-free price after increasing the prices of services A and B. If the new prices produce cost reductions and additional revenues that are sufficiently large to equate total revenue with total cost, then the monopolist has solved its revenue insufficiency problem without cross-subsidization. However, the analysis is far from over when p_B is not a subsidy-free price at the production level of *b#*. Because the market demand schedule for service B is inelastic, it is necessary to raise the price of this service from p_B to $p_{B'}$. The new price for service B implies that the monopolist sells only *b** units of service B, where *b** is less than *b#*. Also, the price increase to $p_{B'}$ implies that the monopolist will earn additional *net revenue* because the market demand schedule for service B is inelastic. But, in addition, the movement from p_B to a higher $p_{B'}$ causes an outward shift in the market demand schedule for service A and an inward shift in the market demand schedule for service C. As a result, there is another round of changes to the quantities demanded of services A and B. At price $p_{A'}$, the quantity demanded of service A increases from *a′* to *a#*, where *a#* may be less than, equal to, or greater than *a*. At the price $p_{C'}$, the quantity demanded of service C decreases to *c#*, where *c#* is less than *c′* and *c*. These new demand levels for services A and C cause changes in the incremental costs and incremental revenues for these services. If this third generation of incremental costs for services A and C still implies that $p_{A'}$ and $p_{C'}$ are subsidy free, then the monopolist has avoided cross-subsidizing its services as it adjusted its prices to recover its common costs. However, the upward price adjustments for services A and C must be continued if $p_{A'}$ or $p_{C'}$ is not subsidy free after an increase in the price of service B from p_B to a subsidy-free $p_{B'}$.

Common Costs and Elastic Demands with Substitutes and Complements

Now, we repeat the analysis for substitutes and complements under the assumption that the market demand schedules for services A, B, and C are imperfectly elastic. As before, we will consider price increases and price decreases.

Price Increases for Services with Elastic Demands

Let there be a price increase for service A from p_A to a higher $p_{A'}$. Imperfect elasticity guarantees a decrease in the monopolist's revenue and a decrease in its production. So, *a'* is less than *a*. If the decrease in the variable cost that is associated with the decrease in the production of service A is larger than the decrease in the revenue that is associated with the price increase, then the monopolist has recovered some of is common costs. Meanwhile, the price $p_{A'}$ is subsidy free. If, however, the decrease in variable cost is less than the decrease in revenue, then the monopolist finds it even more difficult to recover its common costs because the profitability of service A has declined. Furthermore, the price $p_{A'}$ is not subsidy free.

Next, we increase the price of service C from p_C to a higher $p_{C'}$. Once again, imperfect elasticity guarantees revenue and production decreases. So, *c′* is less than *c*. As with the increase in the price of service A, the new price $p_{C'}$ may result in the recovery of some of the monopolist's common costs, or it may make it more difficult for the monopolist to recover its common costs. The new prices may or may not be subsidy free, but they will cause outward and inward shifts of the market demand schedule for service B because service B is a substitute for service A and a complement for service C. Consequently, the monopolist's customers may demand more or less of service B at every price after the increases in the prices of services A and C. Therefore, the monopolist's production and sales of service B may rise from *b* to *b_* or fall to *b** at the initial price for service B of p_B. If the production level of service B falls to *b**, then the profitability of service B declines because some service-specific fixed costs are left unsupported. If the production level rises to *b_*, then service B's profitability may or may not improve depending on whether or not the monopolist can earn enough additional revenues to cover the additional variable costs that are associated with the additional production of service B.[22] Consequently, we are left with the following result. Although possible, it is uncertain whether the monopolist can recover its common costs through price increases alone when it produces substitutes and complements with elastic demands.

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[22] If the percentage increase in the quantity demanded of service B equals the percentage increase in the incremental cost of service B, then p_B is equal to the subsequent average incremental cost of producing *b_* units of service B. As a result, the monopolist earns enough revenues from the sale of service B to recover the service-specific variable and fixed costs that are associated with the production of *b_* units of service B. p_B also is subsidy free when the percentage increase in the quantity demanded of service B is greater than the percentage increase in the incremental cost of service B. In this case, p_B actually is larger than the subsequent average incremental cost for service B after the increase in the price of service A. Consequently, the monopolist earns enough revenues from the sale of service B to cover its service-specific variable and fixed costs of producing *b_* units of service B and to make a contribution toward the recovery of its common costs. But what if the percentage increase in the quantity demanded of service B is less than the percentage increase in the incremental cost of producing *b_* units of service B? Then p_B is less than the subsequent average incremental cost of service B after the increase in the price of service A. Consequently, the monopolist does not earn enough revenues from the sale of *b_* units of service B to cover the service-specific variable and fixed costs of producing *b_* units of service B. Therefore, p_B is not a subsidy-free price in this instance.

Price Decreases for Services with Elastic Demands

Now, we consider price decreases for services A and C from p_A to a lower $p_{A'}$ and p_C to a lower $p_{C'}$. Imperfect elasticity guarantees increases in the monopolist's gross revenue and production. So, *a'* is greater than *a*, and *c'* is greater than *c*. If the increases in the variable costs that are associated with the increases in the production of services A and B are smaller than the increases in the revenues that are associated with the price increases, then the monopolist has recovered some of its common costs. Meanwhile, the prices $p_{A'}$ and $p_{C'}$ are subsidy free. If, however, the increases in the variable costs are larger than the increases in revenues, then the monopolist finds it even more difficult to recover its common costs because the profitability of services A and C has declined. In addition, the prices $p_{A'}$ and $p_{C'}$ are not subsidy free. Because the prices $p_{A'}$ and $p_{C'}$ cause outward and inward shifts of the market demand schedule for service B because service B is a substitute for service A and a complement to service C, it is not clear whether the monopolist can recover its common costs.

The preceding analysis has shown that the problem of finding subsidy-free prices that recover common costs can be difficult to solve when the monopolist's market demand schedules are imperfectly elastic. However, under the appropriate conditions, the monopolist can solve this problem by using a mixture of price increases and price decreases. Suppose that it lowers the price for an elastic service A from p_A to a lower $p_{A''}$. Assume that the incremental revenue grows faster than the incremental cost. This result pushes the monopolist in the direction of achieving its objective of equating total revenues with total costs. Assume further that the new incremental revenue from the sales of service A at the new price $p_{A''}$ are equal to or greater than the new incremental cost for service A. In this instance, $p_{A''}$ is a subsidy-free price. Because service B is a substitute for service A, the lower $p_{A''}$ causes a decrease in the production of service B. Now, suppose that the monopolist increases the price for an elastic service B from p_B to a higher $p_{B''}$. Assume that the incremental revenue falls slower than the incremental cost. This outcome also pushes the monopolist in the direction of solving its problem of revenue insufficiency. Assume that the new incremental revenue from the reduced sales of service B at the new and higher price $p_{B''}$ is equal to or greater than the new incremental cost for service B. In this instance, $p_{B''}$ is a subsidy-free price. Finally, assume that the feedback effect on service A has the same effect on that service's incremental revenue and cost as the initial change in the price of service A from p_A to a lower $p_{A''}$. Then both subsidy-free prices have the effect of bringing the monopolist's total revenue closer to its total cost. This last example shows that it is vitally important for the regulatory authorities to get a handle on the incremental revenues and costs of the monopolist's services. This information is absolutely necessary for analytical purposes. Without it, the regulatory authorities cannot determine whether or not the monopolist has proposed prices that are subsidy free.

COMPENSATORY PRICES FOR TRANSMISSION SERVICES

Subsidy-free prices have a characteristic that many regulatory authorities may find troublesome. Depending on the *net revenue* needs of the monopolist and the elasticities of the services that it produces, these prices sometimes can be lower than the relevant average incremental costs, while other times they can be much higher. This fact usually alerts the regulatory authorities to the possibility that the monopolist might violate the regulators' concept of fairness when it sets prices for its services. Compensatory prices provide a baseline for judging whether a particular price for a particular service is fair.

Compensatory pricing is a concept that can be grasped by looking at examples. We have just finishing analyzing several examples of subsidy-free prices for a monopolist that incurs common costs to produce three services. We will use the same monopolist to analyze the compensatory prices for these services.

Although the monopolist under consideration produces all three services, other monopolists could produce any of these services on a stand-alone basis. That is, a monopolist could produce service A, another monopolist could produce service B, and so on. But this is not the only alternative organization of the production of services A, B, and C. A monopolist could produce service A, and another monopolist could produce services B and C. Or perhaps, a monopolist could produce service B, and another monopolist could produce services A and C, and so on. Therefore, any particular service in the group of services ABC can be produced in several different ways.

It is a straightforward matter to list all of the combinations that can be created from three services. They are: (1) A, (2) B, (3) C, (4) AB, (5) AC, (6) BC, and (7) ABC. These seven combinations imply five ways to produce the three services. The first way is the stand-alone production of each of the three services by three separate monopolists that produce one service apiece. The second way is the stand-alone production of service A by one monopolist and the production of services B and C by another monopolist. The third way is the stand-alone production of service B by one monopolist and the production of services A and C by another monopolist. The fourth way is the stand-alone production of service C by one monopolist and the production of services A and B by another monopolist. The fifth way is the production of services A, B, and C by one monopolist. These five ways of producing services A, B, and C, in turn, can be grouped into three categories. Category I contains the monopolists that produce the services A, B, and C on a stand-alone basis. Category II contains the monopolists that produce two of the three services. Category III contains the monopolist that produces all three services.

The category I monopolists, by definition, do not incur any common costs to produce their service because sharing and coordination, by definition, are not part of their production processes. For example, the senior management of a category I monopolist devotes itself entirely to the production of a single service. Meanwhile, the category II and III monopolists do incur common costs to produce their particular combinations of services because some in-house sharing and coordination of their assets and their personnel are part of their production processes.

We choose to simplify the analysis of these monopolists by assuming that the common costs that are associated with the production of services A and B by monopolist AB are in no way related to the common costs that are incurred to produce services B and C by monopolist BC, and so on. What this assumption means is that the common costs that a monopolist incurs to produce any combination of two or more of the services A, B, and C can be neatly divided into disjointed sets of costs. For example, suppose that the common costs consist exclusively of nine senior managers. These managers might be assigned among the four monopolists in the following way. Two of them would be employed by the monopolist that produces services A and B. Two more would be employed by the monopolist that produces the services A and C. Two of the remaining five senior managers would be employed by the monopolist that produces the services B and C. Finally, the last three managers would be employed by the monopolist that produces the services A, B, and C. Obviously, this assignment rule totally exhausts all nine of the senior managers.[23]

Table 3-1 provides a complete characterization of the cost relationships between the seven combinations of services. The service-specific variable costs for the stand-alone production of services A, B, and C are deemed to be $13.00, $38.00, and $24.00, respectively. The service-specific fixed costs are deemed to be $7.00, $9.00, and $6.00, respectively. The service-specific variable costs for the production of services A and B, A and C, and B and C are deemed to be $51.00, $37.00, and $43.00, respectively. The service-specific fixed costs for these combinations of services are deemed to be $16.00, $13.00, and $15.00, respectively. The service-specific variable

[23] This assignment rule is central to a demonstration that any common costs that are associated with the production of services and A and B are incremental to the production of that combination of services, and similarly for the production of services B and C, services A and C, and services A, B, and C.

TABLE 3-1

SUMMARY OF PRODUCTION COSTS

Service Combination	Variable Cost	Service-Specific Fixed Cost	Common Cost	Total Cost
A	13	7	0	20
B	38	9	0	47
C	24	6	0	30
AB	51	16	3	70
AC	37	13	14	64
BC	43	15	4	62
ABC	53	22	20	95

Source: Author's construct.

costs of producing services A, B, and C are deemed to be $53.00, and the service-specific fixed costs are deemed to be $22.00. As noted previously, no common costs are associated with the stand-alone production of services A, B, and C. The common costs for the production of services A and B, A and C, and B and C, are deemed to be $3.00, $14.00, and $4.00, respectively. Finally, the common costs for the production of services A, B, and C are deemed to be $20.00.

These cost relationships indicate that the monopolists that produce services A and B and services A and C do not realize any reductions in their service-specific variable and fixed costs as compared to the monopolists that produce services A, B, and C on a stand-alone basis. The monopolist that produces service A and B incurs

$51.00 of service-specific variable costs, and $51.00 is the sum of the service-specific variable costs that are incurred by the monopolists that produce these services on a stand-alone basis. The $37.00 of service-specific variable costs that are incurred by the monopolist that produces services A and C is equal to the sum of the service-specific variable costs that are incurred by the monopolists that produce these two services on a stand-alone basis.[24]

Nothing would be gained or lost if the monopolists that produce services A and C and services A and B did not incur any common costs. However, they do incur such costs. In particular, the monopolist that produces services A and B incurs common costs of $3.00, while the monopolist that produces services A and C incurs common costs of $14.00. Consequently, the effect of having a monopolist produce services A and B is to increase production costs by $3.00, while the effect of having a monopolist produce services A and C is to increase production costs by $14.00. Clearly then, nothing is gained and something is lost by having monopolists produce the combinations of services AB and AC.

This troubling outcome is not observed when a monopolist produces services B and C. Although this monopolist incurs $4.00 of common costs that are not incurred by the stand-alone monopolists, it has been able to reduce its service-specific variable costs by $19.00 as compared to the service-specific variable costs that are incurred by the monopolists producing services B and C on a stand-alone basis. These changes amount to a $15.00 net decrease in the production cost of the monopolist BC. A

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[24] It also is worth noting that the service-specific fixed costs for the monopolists producing services A and B, A and C, B and C, and A, B, and C are found by summing the pertinent service-specific fixed costs that are incurred by the monopolists that produce these three services on a stand-alone basis. For example, the service-specific fixed costs that are incurred by a monopolist to produce the services A and B are equal the sum of the service-specific fixed costs that are incurred to produce these two services separately.

similar, but not as distinctive outcome, is achieved by the monopolist that produces services A, B , and C. It has been able to reduce service-specific variable costs by $22.00 as compared to the stand-alone production of these services, but it had to incur common costs of $20.00 to achieve this result. Therefore, this particular monopolist only experiences a $2.00 net reduction in production costs as compared to the stand-alone production of these three services.

It is easy to see from Table 3-1 that the choices are (1) a monopolist that produces services B and C with service A produced by a stand-alone monopolist, or (2) the production of services A, B, and C by a single monopolist. Competition makes this choice by comparing the prices that would by charged by the different monopolists. We will make this choice in a similar fashion.

We begin by recalling that the appropriate way to determine whether a price for a service is subsidy free is to look at its incremental cost and revenue at this price. Table 3-2 shows the incremental costs of service A, service B, service C, services A and B, services A and C, and services B and C from the perspective of the monopolist that produces all three services. It is constructed in the fashion that is suggested by Baumol and Sidak. That is, the incremental cost of service A is calculated by subtracting the total cost of producing services B and C from the total cost of producing services A, B, and C. From Table 3-1, the total cost of producing services B and C is $62.00. From the same table, the total cost of producing services A, B, and C is $95.00. Therefore, the incremental cost of service A is $95.00 - $62.00 = $33.00. The incremental cost of service A and B is calculated by subtracting the total cost of producing service C from the total cost of producing services A, B, and C. The total cost of producing service C is $30.00, and the total cost of producing services A, B, and C is $95.00. Therefore, the incremental cost of service A and B is $95.00 - $30.00 = $65.00. The other entries in the table have been calculated using the same rules.

Table 3-3 shows the incremental costs of service A and service B from the perspective of a monopolist that produces these services. The incremental cost of

TABLE 3-2

INCREMENTAL COST OF COMBINATIONS OF SERVICES
(From the perspective of a monopolist producing services A, B, and C)

Service Combination	Total Cost	Incremental Cost
A	20	33
B	47	31
C	30	25
AB	70	65
AC	64	48
BC	62	75
ABC	95	95

Source: Author's construct.

TABLE 3-3

INCREMENTAL COST OF COMBINATIONS OF SERVICES
(From the perspective of a monopolist producing services A and B)

Service Combination	Total Cost	Incremental Cost
A	20	23
B	47	50
AB	70	70

Source: Author's construct.

service A is calculated by subtracting the total cost of producing service B from the total cost of producing services A and B. The incremental cost of service B is calculated by subtracting the total cost of producing service A from the total cost of producing services A and B.

Table 3-4 shows the incremental costs of service A and service C from the perspective of a monopolist that produces these services. The incremental cost of service A is calculated by subtracting the total cost of producing service C from the total cost of producing services A and C. The incremental cost of service C is calculated by subtracting the total cost of producing service A from the total cost of producing services A and C.

TABLE 3-4

INCREMENTAL COST OF COMBINATIONS OF SERVICES
(From the perspective of a monopolist producing services A and C)

Service Combination	Total Cost	Incremental Cost
A	20	34
C	30	44
AC	64	64

Source: Author's construct.

Tables 3-2 through 3-4 make it clear that a monopolist that produces only service A can underprice any monopolist that produces a combination of services that includes service A. The reason is that the incremental costs of service A all are greater than the stand-alone cost of this service. Table 3-5 shows the incremental costs of service B and service C from the perspective of a monopolist that produces these services. The incremental cost of service B is calculated by subtracting the total cost of producing service C from the total cost of producing services B and C. The incremental cost of service C is calculated by subtracting the total cost of producing service B from the total cost of producing services B and C.

Tables 3-2 and 3-5 show that a monopolist that produces only service B cannot compete with a monopolist that produces services A, B, and C or a monopolist that produces services B and C. Table 3-3, on the other hand, shows that a monopolist that produces service B on a stand-alone basis can compete with a monopolist that produces services A and B. The reason is that the incremental cost of service B for a

TABLE 3-5

INCREMENTAL COST OF COMBINATIONS OF SERVICES
(From the perspective of a monopolist producing services B and C)

Service Combination	Total Cost	Incremental Cost
B	47	32
C	30	15
BC	62	62

Source: Author’s construct.

monopolist producing these two service is greater than the stand-alone cost of service B. In addition, Tables 3-2 and 3-5 indicate that service C cannot be produced on a stand-alone basis. A monopolist that produces all three services or a monopolist that produces services B and C can set lower prices than the monopolist that produces only service C.

In total, Tables 3-2 through 3-5 demonstrate that the optimal industrial organization for the production of services A, B, and C is to have one monopolist produce service A and another monopolist produce services B and C. The total industry cost in this case is $82.00 as compared to a total industry cost of $95.00 if these three services were produced by a single monopolist.

Although the optimal industrial organization for the production of services A, B, and C is two monopolists, it is possible that an incumbent monopolist might try to retain its market position by setting entry-deterring prices. This possibility is examined in the next subsection in the context of a single monopolist that can produce all three services at a total cost of $95.00.

Impossibility of Entry-Deterring Prices

In this subsection we demonstrate that the monopolist under consideration cannot deter the entry of a single-service firm that produces service A and a two-service firm that produces services B and C. Let the three-service monopolist set prices that are equal to the average incremental cost of each service. Let these prices be $.33 for service A, $.31 for service B, and $.25 for service C. These prices are based on market demand schedules that permit this monopolist to sell 100 units of each service. Table 3-6 shows the monopolist suffers a revenue deficit of $6.00 when its prices are equal to its average incremental costs. This deficit is eliminated by raising one or more of the prices shown in the table.

Table 3-7 shows a price mark-up that achieves the monopolist's objective of eliminating the $6.00 revenue deficit. The mark-up is $0.06 added to the average

TABLE 3-6

REVENUES FROM AVERAGE INCREMENTAL COST PRICES

Service	Demand Level	Price	Revenue	Total Cost
A	100	0.330	33.00	N/A
B	100	0.310	31.00	N/A
C	100	0.250	25.00	N/A
Sum	300	N/A	89.00	95.00

Source: Author's construct.

TABLE 3-7

MARK-UP PROVIDING FOR THE FULL RECOVERY OF COSTS

Service	Demand	Mark-Up	Marked Price	Revenue	Total Cost
A	100	0.000	0.330	33.00	N/A
B	100	0.060	0.370	37.00	N/A
C	100	0.000	0.250	25.00	N/A
Sum	300	N/A	N/A	95.00	95.00

Source: Author's construct.

incremental cost of service B. Of course, we assumed that demand for service B is perfectly inelastic because the quantity demanded of service B is not altered in Table 3-7.[25] However, the price of $.33 for service A is far to high because a monopolist producing only this service could set a price of $.20 and recover its total cost of production.

Table 3-8 shows what happens when the price of service A is lowered to $.20 so that the three-service monopolist can be competitive with the monopolist that is producing and selling only service A. Although the three-service monopolist can compete with the one-service monopolist with respect to the sale of service A, it also suffers a revenue deficit of $13.00, which is $7.00 greater than the revenue deficit that this monopolist started with. To eliminate this new deficit, the three-service monopolist has to raise the prices for services B and C.

TABLE 3-8
MARK-DOWN REQUIRED FOR COMPETITIVENESS

Service	Demand	Mark-Down	Marked Price	Revenue	Total Cost
A	100	0.130	0.200	20.00	N/A
B	100	0.000	0.370	37.00	N/A
C	100	0.000	0.250	25.00	N/A
Sum	105	N/A	N/A	82.00	95.00

Source: Author’s construct.

Table 3-5 implies that the price of service C can be raised from $.25 to $.30.

[25] If the demand for a service is merely inelastic, then a price increase involves a decrease in the quantity demanded of the service, as well as an increase in the monopolist's revenues. Because a decrease in the quantity demanded of the service implies that the monopolist will incur fewer variable costs in the short run, it is clearly true in this instance that the monopolist now would be experiencing a revenue surplus. Therefore, this monopolist would have to move its price for service B downward from $0.37, but not as low as $0.31. It is this iterative procedure that we wished to avoid by assuming that the demand for service B is perfectly inelastic.

This price change produces $5.00 of additional revenue for the three-service monopolist. However, there still is an $8.00 revenue shortfall. Consequently, this monopolist has to increase the price of service B from $.37 to $.45. However, the fate of the three-service monopolist is sealed after these price changes. A monopolist that produces services B and C does so at a total cost of $62.00. As a result, it can set prices of $.29 for service C and $.33 for service B. Clearly the three-service monopolist cannot compete with these prices and still set a price of $.20 for service A. Therefore, it cannot deter the entry of a single-service firm that produces service A and a two-service firm that produces services B and C. In the next subsection, we examine how the regulatory authorities can set compensatory prices for these three services.

Calculation of Compensatory Prices

In this subsection, we assume that the incumbent three-service monopolist chooses to spin off the production of service A to a fully separate subsidiary that uses the same production technology as the competing single-service firm. We also assume that the monopolist writes off all of the service-specific fixed costs of the old technology that was used to produce service A along with services B and C. We further assume that the incumbent monopolist lowers its total cost of producing services B and C to the level of the total cost of production that the two-service firm would have incurred to produce these services. Finally, we assume that the monopolist's good reputation prevents the single-service firm from winning over any customers. As a result of these assumptions, there still is only one company in the market.

Compensatory pricing rests on the foundation that price floors prevent cross-subsidization and price ceilings prevent the exploitation of the monopolist's customers. When the monopolist produces more than one service, price floors are determined by the combinatorial form of the cross-subsidization test as proposed by Gerald

Faulhaber.[26] Faulhaber's test requires that the prices of any combination of services must satisfy two criteria. First, the price of each service in the combination must equal or exceed its average incremental cost. Second, the prices of all services in the combination of services under consideration must yield revenue that is equal to or greater than the incremental cost of the combination. The combinatorial test form for price ceilings is less demanding than the combinatorial test form for price floors. The former requires only that the prices of each combination of the monopolist's services cannot cause the monopolist to receive revenue from the sale of that combination that exceeds the stand-alone cost of that combination of services.[27]

We are trying to find compensatory prices for a monopolist with the following revenue-cost structure for the price floors. The revenues from the sales of services A, B, and C are greater than or equal to their respective incremental costs. The revenue from the sale of services B and C in combination is greater than or equal to its incremental cost. We can find the minimum prices for services A, B, and C by dropping the inequalities and writing the following system of equations. Unfortunately, the information shown in Tables 3-2 and 3-5 indicates that this system of equations does not have a solution. Although the monopolist can satisfy equation 3.3 through its spin off of

$$R(A) = IC(A) \tag{3.3}$$

$$R(B) = IC(B) \tag{3.4}$$

$$R(C) = IC(C) \tag{3.5}$$

$$R(B) + R(C) = IC(BC) \tag{3.6}$$

[26] Gerald Faulhaber, "Cross-Subsidization: Pricing in Public Enterprise," *American Economic Review* 65 (1975): 966.

[27] Baumol and Sidak, *Local Telephony*, 78.

the production of service A, it cannot satisfy equations 3.4 through 3.6. Equation 3.4 implies that the revenue from the sale of service B cannot exceed $32.00. Equation 3.5 implies that the revenue from the sale of service C cannot exceed $15.00. Equation 3.6 implies that the revenues from the sales of services B and C have to equal $62.00. Clearly, there is a revenue insufficiency. If subject to the restrictions implied by equation 3.4 through 3.6, the monopolist would experience a revenue shortfall of $15.00.

The system of equalities and inequalities, immediately below, can be solved consistently with the data shown in Tables 3-2 and 3-5. Equation 3.7 can be satisfied because the monopolist has spun off the production of service A to an efficient stand-alone subsidiary. Equation 3.10 can be satisfied because there exists prices p_B and p_C that can satisfy the inequalities in equations 3.8 and 3.9 consistently with equation 3.10. Consider the data in Table 3-8. p_B is set equal to $.37, and p_C is set equal to $.25. Because the monopolist sells 100 units of service B and 100 units of service C at these prices, it earns exactly $62.00 of revenue.

$$R(A) = IC(A) \quad (3.7)$$

$$R(B) > IC(B) \quad (3.8)$$

$$R(C) > IC(C) \quad (3.9)$$

$$R(B) + R(C) = IC(BC) \quad (3.10)$$

Let us now test these prices for the absence or presence of cross-subsidization. The test is that the incremental revenue that is earned from the sale of each service must be greater than or equal to the incremental cost that is incurred to produce each service, and the incremental revenue that is earned from the sale of each combination of services must be greater than or equal to the incremental cost that is incurred to produce each combination of services. Clearly, the incremental revenue that is earned from the sale of 100 units of service A is equal to the incremental costs that is incurred to produce 100 units of this service. The incremental cost of service A, defined as

$TC_A(100) - TC_A(0)$, equals \$20.00. The incremental revenue for service A, defined as $TR_A(100) - TR_A(0)$, equals \$20.00 when the price p_A equals \$.20. Table 3-9 shows that the other relevant tests also are passed.

TABLE 3-9

TEST FOR CROSS-SUBSIDIZATION

Service	Revenue	Incremental Revenue	Incremental Cost
B	37.00	37.00	32.00
C	25.00	25.00	15.00
BC	62.00	62.00	62.00

Source: Author’s construct.

The next step is to calculate the upper bounds for the compensatory prices for services A, B, and C when they are produced by two fully separate subsidiaries that are owned by the incumbent monopolist. Baumol and Sidak propose that these upper bounds be derived from the stand-alone costs of all relevant combinations of services A, B, and C.[28] Stand-alone costs are the basis for these calculations partly because these costs can be identified for any combination of services as long as there are

[28] Baumol and Sidak, *Local Telephony*, 78-83.

actual total cost data on the full set of services that is actually produced by the monopolist. Therefore, we are examining upper limits on the compensatory prices for a subsidiary of the monopolist that produces only service A and another subsidiary that produces services A and B.

Calculation of Upper Limits for Compensatory Prices

To find the upper limit of the compensatory price for service A, we only have to convince ourselves that the revenue that is earned from the sale of this service does not exceed its stand-alone cost. It is only slightly more difficult to find the upper limits of the compensatory prices for services B and C. We have to convince ourselves that the revenue that is earned from the sale of service B does not exceed its stand-alone cost, the revenue that is earned from the sale of service C does not exceed its stand-alone costs, and the revenue that is earned from the sale of services B and C does not exceed the stand-alone cost of this combination of services.

The stand-alone cost of service A is the total cost of each nonempty subset of the set {A}. Because the set {A} contains only one element, it has only two subsets. The first is the empty set, which is of no concern to us. The second is the set that includes only service A. Therefore, the stand-alone cost for service A is the total cost of producing only service A. A total cost of $20.00 is incurred by the monopolist's subsidiary to produce 100 units of service A. Consequently, the stand-alone cost of producing 100 units of service A is $20.00. Recalling that the price p_A is $.20 per unit of service A, it follows that this price is the upper limit of the price for service A because the monopolist's subsidiary earns $20.00 of revenue from the sale of 100 units of this service.

A little more work is required to calculate the stand-alone costs of services B and C. The set {B,C} contains two elements, and it can be divided into four subsets. The first is the empty set, which once again is of no concern to us. The second is {B}. The third is {C}. The fourth is {B,C}. The stand-alone costs of {B} and {C} are calculated using:

$$SAC(B) = TC(B,C) - IC(C) \quad (3.11)$$

$$SAC(C) = TC(B,C) - IC(B) \quad (3.12)$$

The solution to equation 3.11 is: SAC(B) = $62.00 - $15.00 = $47.00. This is the stand-alone cost for service B. The solution to equation 3.12 is: SAC(C) = $62.00 - $32.00 = $30.00. This is the stand-alone cost for the service C. Clearly, the set of compensatory prices such that p_B equals $.37 and p_C equals $.25 satisfies these upper-limit tests when the monopolist's second subsidiary produces 100 units of service B and 100 units of service C. In fact, the upper limit for the compensatory price of service A is $.47 per unit with the upper limit for the compensatory price of service B being $.30 per unit. Obviously, a rather large set of price configurations is consistent with the optimal organization of this market.

CONCLUDING REMARKS

On the basis of the analyses in this chapter, it will not be easy for a utility to use its transmission company to cross-subsidize its distribution companies as they compete with rural cooperatives and municipalities for service territories. First, the utility has to convince the regulatory authorities that the existing network design prevents its transmission company from offering the same transmission services to rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. If the utility is not successful in this endeavor, then its transmission company cannot divide its transmission services into those services that are used by the utility-owned distribution companies and those services that are used by rural cooperatives and municipally-owned utilities. If the transmission company cannot prevent the rural cooperatives and municipally-owned utilities from buying the services that are purchased by the utility-owned distribution companies, then it cannot set high prices for the transmission services that are used by the rural cooperatives and municipally-owned utilities and subsidized prices for the services that are used by the utility-owned distribution companies. As a result, the cross-subsidization of the utility-owned distribution companies cannot be sustained because the rural cooperative and municipally-owned utilities can avoid paying the subsidy.

Second, the utility-owned transmission company has to propose transmission prices with the following characteristics. The incremental revenue from the sale of a transmission service to a utility-owned distribution company is less than the incremental cost of producing that transmission service, while the incremental revenue from the sale of a transmission service to a rural cooperative or municipally-owned utility is greater than the incremental cost of producing that transmission service. In addition, the prices of the services sold to the rural cooperatives and municipally-owned utilities have to exceed the average incremental costs of these transmission services by amounts that are sufficiently large to cover all of the transmission company's common costs and provide a subsidy to the utility-owned distribution companies. Therefore, the utility has to do more than shift some service-specific fixed and variable distribution costs to the transmission services that are purchased by the rural cooperatives and municipally-owned utilities. It also has to shift all of the transmission company's common costs to these services.

It was not difficult to find compensatory prices for the three-service example that was analyzed in this chapter. These prices for services A, B, and C did not result in a revenue surplus, which implies that they are consistent with efficient prices because total revenue is equal to total cost. Still, it is apparent that the efficiency of compensatory prices really is dependent on the efficiency of the market. In our example, we know that the market for service A is efficient because the incumbent monopolist has spun off the production of this service to a subsidiary that uses the best available technology. That is, the monopolist's subsidiary is producing 100 units of service A at the lowest possible total cost, which implies that this subsidiary earns the normal rate of return on its new investments. Therefore, the revenue that this subsidiary earns from the sale of service A is simultaneously the minimum amount of revenue that it can receive from the sale of 100 units of service A and the maximum amount of revenue that it can realize from the sale of 100 units of service A.

We have just discussed what is required for compensatory prices to be efficient. Total revenue from the sale of the given amount of the service has to equal total cost of producing the given amount of the service. This total cost has to be the minimum total cost for the production of the given amount of the service. If the market for the service is in any way inefficient, then compensatory prices cannot be obtained. What does it mean for the transmission market to be inefficient. It means that the utility-owned transmission company does not have to minimize its costs or earn only a normal rate of return on its investment. Instead, this company can earn a supranormal rate of return or choose to not minimize its costs. In either instance, the incremental revenue for service A represents more than the minimum amount of revenue that this company has to receive in order to be economically viable.

Because the utility-owned transmission company sells its services in an inefficient market, it is capable of supporting unnecessary expenses and excess investments. In turn, this capability puts the transmission company in the position to support a utility-inspired shift of generation costs to the transmission market. After all, shifted generation expenses are unnecessary expenses from the perspective of the transmission company. Similarly, shifted generation assets are excess investments. Therefore, the utility can use its transmission company as a source for the cross-subsidization of its generation companies. However, an effort to find compensatory prices is not the culprit. The culprit is the inherent inefficiency of the transmission market.

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CHAPTER 4

EFFICIENT COMPONENT PRICE FOR TRANSMISSION SERVICE *Z*

INTRODUCTION

In the preceding chapter, we examined the issues that crop up when the utility-owned transmission company and its regulators attempt to find almost efficient prices for transmission services. We found that such prices have to be subsidy free and compensatory. In this chapter, we examine a specific pricing rule for calculating a subsidy-free and compensatory price for transmission service *Z*.

In an effort to simplify this exposition, we assume that a utility-owned transmission company is a monopolistic producer that supplies a single standardized transmission service to rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. Because the transmission company produces a single service, Faulhaber's cross-subsidization tests do not have to be called upon to ensure compensatory prices. Furthermore, the stand-alone cost of transmission service *Z* is simply the total cost of producing this service.

To be consistent with the existing environment, we assume that the utility-owned transmission company is subject to rate-of-return regulation. We assume that this monopolistic company is not able to set an efficient price for transmission service *Z* because it is not minimizing its operating costs or earning a competitive rate of return on its investment. If the utility-owned transmission company is not efficient, then what is the structure of its inefficiency? We assume that this monopolist is earning a fair rate of return that may be above or below the competitive rate of return. We also assume that it incurs justifiable costs that are above efficient levels. In other words, we assume that the utility-owned transmission company is conducting its business within the usual limits of rate-of-return regulation.

What can the regulatory authorities do to help set an efficient price for transmission service *Z*? Baumol and Sidak suggest *efficient component pricing*.[1] The purpose of this chapter is to examine the elements and structure of this pricing proposal. The next three sections set the stage for this examination. The first section presents a model of electricity production and delivery, wherein all competitive activities occur within the market for wholesale power. The second section describes transmission service *Z* as it is supplied to rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. The third section examines the responsibilities of these wholesale customers when it comes to arranging for the transportation of power from generation sites to distribution gateways.

The next five sections contain the analysis of an efficient component price for transmission service *Z*. The first discusses the context of an efficient component price for this service. The second shapes a plan of attack for setting an efficient component price. The third describes the construction of an efficient component price. The fourth explains the second-best status of this price. The last of these sections goes into the rationality of an efficient component price for transmission service *Z*, showing that such a price is consistent with balancing the interests of the utility's customers and stockholders.

MODEL OF ELECTRICITY PRODUCTION AND DELIVERY

Rural cooperatives, municipally-owned utilities, and utility-owned distribution companies are assumed to purchase transmission service *Z* from a monopolistic utility-owned transmission company. The utility-owned generation companies and nonutility generators are competing to sell electric power to these wholesale customers. When either a utility-owned generation company or a nonutility generator wins a contest, it

[1] Baumol and Sidak, *Local Telephony*, 95-97.

leases lines from the utility-owned transmission company for the purpose of interconnection. Either type of generator pays transmission-access charges to the utility-owned transmission company. However, neither the utility-owned generation company nor the nonutility generator pays anything to the transmission company when it does not win the contest. That is, the price of transmission-access service does not include the payment of a lump-sum fee to the utility-owned transmission company by any type of generation company.

Some of the utility-owned generation companies and some of the nonutility generators have the option to sell electric power to wholesale customers that are connected to different utility-owned transmission companies. Consequently, some generation companies are in the position to interconnect with more than one transmission company. This situation is depicted in Figure 4-1. The wholesale customer under consideration is located at point C. Two generation companies are located equal distances from point C on either side. The location of the utility-owned generation company is labeled A, and the location of the nonutility generator is labeled B. The tie line AD connects the utility-owned generation company to the utility-owned transmission company, and the tie line BD connects the nonutility generator to the utility-owned transmission company. Consequently, there are two different interfaces. We assume that each interface is equidistant from its respective generation company. These points of interconnection are labeled D. The tie lines represent the transmission-access service that is purchased by the generation companies from the utility-owned transmission company. Each generation company can sell electric power to the wholesale customer that is located at point C. However, only the utility-owned generation company can sell electric power to the wholesale customer that is located at point E, and only the nonutility generator can sell its electric power to the wholesale customer that is located at point F. Neither of these alternative wholesale customers is connected to the transmission network that is shown in Figure 4-1. This figure makes it clear that the tie lines and transmission routes are the property of the utility-owned transmission company. It also makes it clear that any competition that takes place is between the nonutility generator and the utility-owned generation company.

FIGURE 4-1. *ELECTRICITY PRODUCTION AND DISTRIBUTION.*

DESCRIPTION OF TRANSMISSION SERVICE *Z*

The utility-owned transmission company is assumed to produce a standardized transmission service *Z*. This service is sold to the utility-owned distribution company that is located at point C in Figure 4-1. We operationalize this assumption by requiring the transmission company to use the same type of transmission facilities and the same type of tie lines to bring electric power from the gateways of the generation companies to the gateway of the utility-owned distribution company. We also require that the utility-owned distribution company needs the same amount of conditioning regardless of its source of generation. In addition, we require that line losses be identical regardless of the source of generation, which is not unreasonable because each generation company is assumed to be the same distance from the utility-owned distribution company. Finally, we require that the transmission-access and the transmission-service costs be the same because we assume that the terrain is identical on both sides of the utility-owned distribution company that is located at point C in Figure 4-1. It is *as if* each generation company, regardless of its type, is sending its electric power over the same routes. Consequently, each unit of electric power carried from points A and B to point C in Figure 4-1 has the *same* average incremental costs of transmission access and transmission regardless of the company that generated it.

Therefore, we envision standardized transmission as having two components. The first component is a point-to-point access route that is used to transport electric power from points A and B to their respective points D. The second component is the subsequent transportation of the electric power from points D to point C over the *network routes* that are labeled $\mathbf{N_1}$ and $\mathbf{N_2}$ in Figure 4-1. We define transmission service *Z* as the transportation of electric power over network routes.

GENERATION COMPANY AND WHOLESALE CUSTOMER RESPONSIBILITY

Wholesale customers are responsible for buying electric power at competitive rates. They may purchase their power at an auction, or through private negotiations between themselves and generation companies. The resulting contracts may be long-term or short-term agreements, where the short-term agreements imply that there is no need to be loyal to any generation company. In the context of Figure 4-1, the rural cooperatives, municipally-owned utilities, and utility-owned distribution companies are responsible for the purchase of a transmission service that takes their power from points D to point C. Meanwhile, generation companies are responsible for the purchase of transmission-access service that takes their power from points A and B to points D. Finally, the utility-owned transmission company is responsible for the actual transmission of power from point A to point C and from point B to point C.

THE THREE PIECES OF AN EFFICIENT COMPONENT PRICE

It is useful to break an efficient component price for transmission service *Z* down into its three pieces. The first piece is the variable cost that the transmission company incurs after it begins to produce transmission service *Z*. This cost tends to rise when the production level of transmission service *Z* rises, and it tends to fall when the production level for this service falls. The second piece is the service-specific fixed cost that the transmission company incurs before it begins to produce transmission service *Z*. This cost is associated with the plant and equipment that the transmission company purchases to allow it to produce transmission service *Z* at more than one production level. However, the fixed nature of this cost implies that the transmission company is restricted to producing a range of output levels for transmission service *Z* after it has incurred them. Consequently, the service-specific fixed cost does not vary in the short run as the production level of transmission service *Z* fluctuates upwards and downwards within preset boundaries. The third piece is the lost profits that the utility-owned transmission company or the utility experiences when it produces transmission service *Z*.

Lost profits may or may not exist in the context of the sale of transmission service *Z* to an unrestricted class of wholesale customers. The availability of an unbundled transmission service creates the potential for lost profits at the utility level to the extent that a particular municipality is induced to switch over from a utility-owned distribution company to its own utility. However, the municipality most likely would buy the existing distribution network from the utility, and this purchase could be structured to keep the utility whole. As a result, the utility would not experience any lost profits. In addition, the availability of transmission service *Z* might induce an existing rural cooperative or municipally-owned utility to switch to a nonutility generator. This action would cause the utility-owned generation company to lose sales and some profits. However, it appears that these profits are lost because of the existence of nonutility generators and not because of the availability of an unbundled transmission service. It is clear that a wholesale customer could use transmission service *Z* even if there were no nonutility generators. The only required institutional change is the replacement of the wholesale tariff with bilateral contracts between the wholesale customers and the utility's generation companies. Consequently, we conclude that the availability of transmission service *Z* does not cause the utility to lose any profits because wholesale customers electing bilateral contracting would have to purchase this transmission service from the monopolistic, utility-owned transmission company regardless of how they obtained their power from the utility-owned generation companies and nonutility generators.

Plan of Attack for the Construction of an Efficient Component Price

The three pieces of an efficient component price suggest a plan of attack for its construction. Following Baumol and Sidak, we can imagine that the regulatory authorities can induce a monopolistic transmission company to propose a price for transmission service *Z* that is related closely to the level of the production cost that an unregulated monopolist would have to achieve to remain economically viable *if* the transmission market was perfectly contestable.[2] The principle behind this plan is: What the utility-owned transmission company does not have to do because the transmission market is not perfectly contestable, the regulatory authorities can make it do by ordering the transmission company to set a compensatory price for transmission service *Z*.

Baumol's and Sidak's plan of attack for constructing an efficient component price is easy to follow in our model because the utility-owned transmission company produces only transmission service *Z*. The analyses in Chapter 3 indicate that the average incremental cost of this transmission service equals its per-unit stand-alone cost at any production level because no sharing and coordination of assets are required to produce it at any given level. Furthermore, it is easy to see that this equality continues to be in effect regardless of the productive efficiency of the transmission company. Suppose that a cost-minimizing transmission company produces 100 units of transmission service *Z* at a total cost of $10.00. Recalling the standard definition of average incremental cost, $AIC_Z(100) = \{[TC_Z(100) - TC_Z(0)]/100\}$, it is clear that the average incremental cost of 100 units of transmission service *Z* is $.10 per unit. Recalling the standard definition of stand-alone cost, $SAC_Z(100) = TC_Z(100)$, it is clear that the per-unit stand-alone cost of 100 units of transmission service *Z* is $.10 per unit. Now, suppose that a cost-inflating transmission company produces 100 units of

[2] Baumol and Sidak, *Local Telephony*, 99. A perfectly contestable market has two of the four important characteristics of a perfectly competitive market. It achieves first-best economic efficiency when total revenue equals total cost at prices equal to marginal costs, and it maximizes the sum of producer and consumer surplus. However, a perfectly contestable market achieves these results without actual competition and without the firms in the market being so small that their individual actions cannot influence the market price. Consequently, the market that is associated with a natural monopoly can be a perfectly contestable market. In addition, the threat of competition can be just as effective in terms of achieving economic efficiency as actual competition when the market is perfectly contestable.

transmission service *Z* at a total cost of $15.00. Using the same standard definitions of stand-alone cost and average incremental cost, it follows that the per-unit stand-alone cost and the average incremental cost of 100 units of transmission service *Z* are equal at $.15 per unit. Consequently, it does not matter whether the monopolistic transmission company is a cost minimizer or a cost inflator. The per-unit stand-alone cost and the average incremental cost for a single-service utility-owned transmission company always are equal when they are viewed in the proper context.

The unique relationship between the average incremental cost and the per-unit stand-alone cost of a single-service transmission company indicates that the regulatory authorities do not have to accept or reject the pricing rule that any price between these two cost measures is permissible as long as the transmission company's total revenue equals its total cost. There can be only one price that produces enough revenue to achieve the recovery of the total cost that the transmission company incurs to produce the existing level of transmission service *Z*. However, the regulatory authorities do have to worry about the components of the total cost of producing this service when they seek to construct an efficient component price. In particular, they have worries at three levels. First, they have to identify the variable cost, the service-specific fixed cost, and the lost profits that the transmission company incurs by producing transmission service *Z*. Second, they have to assure themselves that the variable cost and service-specific fixed cost have been incurred efficiently. Third, they have to convince themselves that the transmission company's lost profits are not supranormal profits.

We already have concluded in Chapter 3 that the utility-owned transmission company does not incur any lost profits when it sells transmission service *Z* to its wholesale customers. We already have noted that the transmission market is not perfectly contestable, which implies that the utility-owned transmission company is not subject to any external market forces that would cause it to bring its costs down to competitive levels. We have assumed rate-of-return regulation, which implies that the utility-owned transmission company is not maximizing unregulated profits and not minimizing its production costs. Therefore, the regulatory authorities have cause to be suspicious about the actual levels of this company's variable costs and service-specific fixed costs.

The odds are in favor of the outcome that the utility-owned transmission company's actual total cost is greater than its efficient total cost of production. This inefficiency can arise from a variety of sources. First, the existing relationship between the transmission company's allowed rate of return and its cost of capital may cause it to use too much capital and too little labor, or too much labor and too little capital to produce the existing level of transmission service *Z*. Second, the cost-plus nature of rate-of-return regulation may induce this company to incur too many variable and service-specific fixed costs to produce the existing level of transmission service *Z*. Third, its earned rate of return may be above its cost of capital and also the rate of return that it would earn *if* it competed in a perfectly contestable transmission market.

When the regulatory authorities abide by the principles of rate-of-return regulation, they have only a limited ability to mitigate these forms of productive inefficiency. Of course, they can use audits and exercise moral persuasion to cause the utility-owned transmission company to incur its production costs efficiently. But, neither of these practices is sufficiently powerful to overcome the information advantages that the transmission company has over its regulators. Simply put, this company knows its production costs better than the regulators. Furthermore, information asymmetries are particularly powerful in the contest between the regulators and the transmission company that determines the fair rate of return for its transmission assets. Although the regulators may achieve some degree of success in terms of equating the fair rate of return under rate-of-return regulation with the rate of return that the utility-owned transmission company would earn in a perfectly contestable market, there always is the risk that they will overestimate or underestimate the perfectly contestable rate of return because of the counterfactual nature of the underlying analysis.

None of these difficulties with respect to the construction of an efficient component price for transmission service *Z* dismisses the requirements that this price should be subsidy free and compensatory. It is not particularly difficult to demonstrate either requirement when the utility-owned transmission company produces only transmission service *Z*. We begin by recalling that an efficient component price for this transmission service has to yield enough revenue to cover the total competitive cost of producing the given level of this service and any lost profits that might go along with this production level. We have argued that the utility does not lose any profits when it produces transmission service *Z* and sells it to rural cooperatives and municipally-owned utilities. Therefore, an efficient component price for this transmission service only has to generate enough revenue to cover the total competitive cost of production. Let us assume that the regulators know the total competitive cost of producing every reasonable level of transmission service *Z*. We now examine whether we can find a subsidy-free price for this service. We know that a subsidy-free price for transmission service *Z* has the characteristic that the transmission company must receive enough revenue from the sale of this service to at least cover the incremental cost of producing the given level of this transmission service. As a result of our analysis of the relationship between the average incremental cost and per-unit stand-alone cost of transmission service *Z*, we have established that either price for transmission service *Z* will indeed yield enough revenue to cover the incremental cost of producing the existing level of this service. Consequently, we just have shown that a subsidy-free price for transmission service *Z* is obtained by the price equal to the average incremental cost of this service.

To show that a price for transmission service *Z*, which is equal to its average incremental cost, is compensatory, we have to demonstrate that it yields enough revenue to cover the utility-owned transmission company's total competitive cost of production. We know from the definition of incremental cost of production that this cost measure equals the transmission company's total competitive cost of production when this company produces only one transmission service. We know that this company produces only transmission service *Z*. Consequently, we know that the price for transmission service *Z* is compensatory when it equals the average incremental cost of this service.

Our last task is to show that a price for transmission service *Z* that equals its average incremental cost also is an efficient component price for this service. To do this, we only need to recall that the utility-owned transmission company and the utility do not lose any profits when the former sells this service to rural cooperatives and municipally-owned utilities. Therefore, per the definition of an efficient component price for transmission service *Z*, the transmission company only has to choose a price for this service that yields enough revenue to cover its total competitive cost of production. We have shown that a price equal to the average incremental cost of transmission service *Z* has this characteristic. Consequently, the efficient component price for this particular transmission service equals its average incremental cost. In other words, we have established that an efficient component price for transmission service *Z* allows the utility-owned transmission company to earn a competitive rate of return on its assets and to recover all of its efficiently-incurred production costs.

EFFICIENCY CHARACTERISTICS OF AN EFFICIENT COMPONENT PRICE FOR TRANSMISSION SERVICE *Z*

The efficient component price for transmission service *Z*, that is, a price equal to its average incremental cost, is an optimal price when it is the first-best price. A first-best price for this service has four characteristics. First, it equals the service's marginal cost at the profit-maximizing level of production in an unregulated market. Second, the service's average cost of production is minimized at the same profit-maximizing level of output. Third, its total cost includes only the normal (i.e., perfectly competitive) rate of return on transmission investment. Fourth, total cost equals total revenue. The existence of these characteristics would be assured if the market for transmission service *Z* was perfectly contestable, and the utility-owned transmission company was able to produce an output level that is greater than or equal to the output level that is associated with the transmission company's minimum average cost of production. However, we suspect that the transmission market never will be perfectly contestable. Also, we suspect that market conditions will force the utility-owned transmission company to produce an output level that is less than the output level that is associated with this company's minimum average cost. Therefore, we suspect that an efficient component price for transmission service *Z* never will be an optimal price.

If we do not have an optimal price, then what kind of price do we have when we construct an efficient component price for transmission service *Z*? We have a price that minimizes the decline in the sum of consumer and producer surplus when transmission service *Z* is sold in a perfectly contestable market. The sum of consumer and producer surplus, that is, economic efficiency, declines as the utility-owned transmission company approaches economic viability because this company produces on the downward-sloping portion of its average cost schedule. Therefore, to remain financially viable, this transmission company, like any other company, has to set a price for transmission service *Z* that is greater than marginal cost. What are the implications of a price that is greater than marginal cost? First and foremost, this price is not a first-best price. Second, this price usually is not associated with monopoly profits because this company competes in a perfectly contestable market. Figure 4-2 describes the expected behavior of a utility-owned transmission company in a perfectly contestable market.

This company cannot set the price for transmission service *Z* at its marginal cost because it will not recover its efficiently incurred production costs and earn the efficient rate of return on its transmission assets. Instead, to have a chance of being economically viable, this company has to set a price for its transmission service that is something greater than marginal cost, mc_b, where mc_b is the marginal cost of producing q_b units of transmission service *Z*.

What are the implications of a price p_r that is equal to ac_b, where ac_b is the average cost of producing q_b units of transmission service *Z*? It is apparent from the figure that p_r is greater than the marginal cost that is associated with the production of

q_b units of transmission service *Z*. It also is apparent from the figure that rural cooperatives, municipally-owned utilities, and utility-owned distribution companies will not demand q_b units of transmission service *Z* at a price of p_r. Instead, they will demand q_r units of this service. However, the figure also shows that the average cost of q_r units of transmission service *Z* is greater than p_r. As a result, the utility-owned transmission company is not financially viable at this production level and price. In fact, this company does not achieve financial viability until it produces q units of transmission service *Z* and sets a price that is equal to p.

It is easy to demonstrate that p minimizes the decline of the sum of the consumer and producer surplus that results when this efficient utility-owned transmission company has to set a price for its transmission service that exceeds marginal cost. First, consider a price that is greater than p. This price causes this transmission company to produce fewer than q units of transmission service *Z*. Higher price and lower production are a prescription for a reduction in the sum of consumer and producer surplus that would be achieved by a declining-cost utility-owned transmission company that competes in a perfectly contestable transmission market. Consequently, consumers and society are worse off at a price that is greater than p. Second, consider a price that is less than p. This price causes this efficient transmission company to produce more than q units of transmission service *Z*. Consumers definitely are better off at this price than they are at p; however, the efficient transmission company no longer is financially viable. As a result, a price that is less than p cannot remain in effect for any prolonged length of time. Consequently, we have shown that p minimizes the decline of the sum of consumer and producer surplus, *if* the utility-owned transmission company competes in a perfectly contestable market.   Therefore, p is the second-best price for this efficient transmission company.

FIGURE 4-2*. ALMOST SECOND-BEST PRICE.*

Now, we need to show that the efficient component price for transmission service *Z* is equal to p when this service is produced by an efficient, declining-cost company. This is not difficult to do. The per-unit stand-alone cost of producing q units of transmission service *Z* is equal to the sum of variable costs and service-specific fixed costs divided by q. By definition, the average incremental cost of transmission service *Z* at production level q is equal to the same number. These two facts establish that the average incremental cost of transmission service *Z* at q is equal to the per-unit stand-alone cost of transmission service *Z* at q. Furthermore, the efficient component price for transmission service *Z* at q is the sum of its variable and service-specific fixed costs divided by q because this efficient utility-owned transmission company does not lose any profits by selling this service to rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. Therefore, the efficient component price for transmission service *Z* at q is equal to the per-unit stand-alone cost and the average incremental cost of this service at q. Consequently, the efficient component price for transmission service *Z* at q ensures that the efficient utility-owned transmission company is compensated fully for the production of transmission service *Z*. Previously, we have shown that p represents full compensation for the production of q units of transmission service *Z*. These two facts complete the demonstration that the efficient component price for transmission service *Z* at q is equal to p.

Unfortunately, an actual utility-owned transmission company is not likely to incur its actual production costs efficiently. Also unfortunately, this company is not likely to earn the efficient rate of return on its transmission assets. Therefore, there is little chance that regulators will ever see an efficient component price for transmission service *Z*. The price that they might see is a price that approximates the efficient component price for this service. This almost efficient component price will permit the transmission company to earn a fair rate of return on its rate base and to recover its reasonable production costs. In sum, the fair rate of return and the reasonable production costs are likely to be greater than the sum of an efficient return on transmission assets and efficient production costs. Consequently, the almost efficient component price for transmission service Z at q units of production does not measure up to the standard of a second-best price.

RATIONALITY OF AN ALMOST EFFICIENT COMPONENT PRICE FOR TRANSMISSION SERVICE *Z*

Whatever its actual cost characteristics, a utility-owned transmission company could not remain in business if it did not sell transmission service *Z* to wholesale customers. Therefore, it is a matter of survival that makes it rational for this company to make these sales. The only point of contention is the price that it wants to set for this transmission service. We know the conditions under which a rational utility-owned transmission company would select an almost efficient component price for transmission service *Z*. Even though this transmission company does not compete in a perfectly contestable market, it would select an almost efficient component price when it wants to minimize the threat of entry into its currently monopolistic transmission market. We also know why regulators favoring competition in the wholesale market want an almost efficient component price for transmission service *Z*. This price is the best-available tool for preventing an actual utility-owned transmission company from exercising its market power over rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. In particular, it places all wholesale customers on an equal footing in the eyes of the generation companies because no generation costs are recovered in this price. Furthermore, it ensures that the buyers of wholesale power will differentiate themselves in their retail markets through the costs of their portfolios of generation services. The first characteristic of an almost efficient component price for transmission service *Z* promotes the sale of this service, while the second characteristic induces the wholesale customers to seek the lowest-cost suppliers of generation services.

Concluding Remarks

In our model, an almost efficient component price for transmission service *Z* is an equalizer for the distribution market. Each rural cooperative, municipally-owned utility, and utility-owned local distribution company pays the same price for the same transmission service. Therefore, any retail price differences are attributable to their skill in purchasing power in the wholesale market and their efficiency when it comes to distributing that power.

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CHAPTER 5

EFFECTS OF DEVIATIONS FROM ALMOST EFFICIENT COMPONENT PRICES

INTRODUCTION

Baumol and Sidak argue that efficient component pricing is a way to protect against anticompetitive behavior.[1] Their position is that an efficient component price eliminates market power in the regulated market and promotes competition in the unregulated market. Since we are concerned about market power in the market for unbundled transmission services, we analyzed the characteristics of an efficient component price in a market where there is only one supplier and one transmission service. Not surprisingly, our analysis led us to Baumol's and Sidak's observation that an efficient component price is an ideal and cannot be realized in actual markets. Next, we examined the cost basis of an almost efficient component price to see how it departs from the cost basis of an efficient component price. We found that an almost efficient component price has a higher cost basis. However, we also found that an almost efficient component price is not subsidized and is not a source of subsidization. Now, we investigate the effects of deviations from an almost efficient component price for transmission service *Z*.

The next section explains the effects that are caused by prices that are above and below an almost efficient component price. The next section describes the instability that is inherent in a below-cost price for transmission service *Z*. The following section illustrates that above-cost prices for this transmission service will lead to the opening of the transmission market to competition. The section after that

[1] Baumol and Sidak, *Local Telephony*, 101-107.

examines the transition to above-cost prices for distribution-access services. The subsequent section investigates the potential for the utility to cross-subsidize its generation companies through above-cost prices for distribution-access services. The next-to-last section discusses why almost efficient component prices for transmission and distribution-access services will not be set voluntarily by the utility.

ABOVE-COST AND BELOW-COST PRICING OF TRANSMISSION SERVICE

The price of transmission service *Z* can be driven to an inefficiently high level for a variety of reasons. Perhaps, the regulatory authorities have decided to roll the recovery of stranded generation costs into this price. Maybe, the utility will try to shift some generation costs into it. Possibly, utility-financed assistance programs will be paid for out of the revenue that is produced from an above-cost price for this transmission service. For example, the utility may support a low-income assistance program, research on pollution abatement, deployment of renewable resources, and subsidization of demand-side management technologies.

Numerous troubling effects arise from an above-cost price for transmission service *Z*. The first and most obvious effect is the increase in the delivered cost of wholesale power because an above-cost transmission service price is combined with an almost efficient component price for transmission-access service and a competitive price for wholesale power. This higher cost of delivered wholesale power, in turn, serves to drive up the cost of delivered retail power. If the higher cost of delivered retail power is flowed through to the prices for retail services, then an echo of the first effect is an increase in the prices of retail services.

Retail services are purchased by many different classes of customers. Some of these classes have elastic market demand schedules, while other customer classes have inelastic demand schedules. Let's see how increased retail prices play out for consumers with elastic demands. As these consumers cut back on their purchases of retail services, the utility loses revenue and sheds some variable costs of generation, transmission, and distribution. When these avoided costs are less than the lost revenue, the utility suffers lost profit. The potential of reduced profitability leads to the second effect of an above-cost price for transmission service *Z*. In response to the possibility of becoming less profitable, the utility tries to flow the higher delivered cost of retail services through to retail customers with inelastic market demand schedules.

Generally, the regulatory authorities are not happy about price increases for retail services with inelastic demand schedules. Typically, these services are purchased by consumers that do not have effective ways to fight back. Consequently, the regulators may encourage the utility-owned distribution companies to look for better deals in the generation market. Therefore, the third effect of an above-cost price for transmission service *Z* is the creation of a market dynamic that might force down the price of wholesale power. However, this potential effect has a possible echo. Nonutility generators and utility-owned generation companies alike will be affected adversely financially if they cannot offset the reduced prices for wholesale power by decreasing their production costs.[2] Because not every generation company will be able to achieve the required level of cost reductions to offset the lower prices that the wholesale customers are willing to pay for wholesale power, the profitability of some generation companies may be lowered to a level that forces them from the market.

Many of the companies that potentially may be forced out of the generation market would be economically viable if an almost efficient component price had been set for transmission service *Z*. Therefore, the fourth effect of an above-cost price for this transmission service is the possibility that the quantity supplied of wholesale power is depressed without much hope of rebounding until the price of transmission service *Z*

[2] For the following reason, the decreasing prices of generation services do not result in increases in the quantities demanded of these services. From the perspective of wholesale customers, the decreases in the prices of generation services are offset exactly by the increase in the price of transmission service *Z*. Consequently, the prices of the retail services are unchanged, which implies no change in the quantities demanded of retail services. If there are no changes in the quantities demanded of retail services, then there cannot realistically be any changes in the quantities demanded of wholesale generation services.

is lowered. Consequently, there potentially could be a shortage of wholesale power. It would emerge when investors do not want to channel money into the production of wholesale power because market returns are not in line with the risks.

The below-cost pricing of transmission service *Z* also is disturbing. Consider its first effect. The utility-owned transmission company will cut back its investment in transmission facilities. Simply put, investors do not want to send money to the transmission market when the return on this investment is expected to be low because of the below-cost price for transmission service *Z*. This investor behavior cannot be altered by regulatory actions that strongly encourage the utility-owned transmission company to invest in transmission facilities. Despite these actions, investors tend to avoid any market that has returns that are not commensurate with its risks.

Although a below-cost price for transmission service *Z* drives down retail prices, it simultaneously causes the overconsumption of transmission and retail services. Therefore, the second effect of below-cost pricing is that improper pressure is placed on the wholesale customers to upgrade their distribution networks and the utility-owned transmission company to upgrade its transmission network. This pressure may wipe out some of the decreases in retail prices that are caused by the below-cost price for transmission service. Although the transmission company will not respond to this pressure because the investors are unwilling to provide it with the funds to build the new transmission facilities, it is possible that the wholesale customers will respond to it. Clearly, the average cost of the distribution component of a bundled retail service increases when the average cost of new distribution facilities exceeds the average cost of existing distribution facilities. This echo of a below-cost price causes retail prices to be pushed upward. These higher prices, in turn, will push down the consumption of transmission and retail services. However, the average cost of the distribution component of a bundled retail service decreases when the average cost of new distribution facilities is less than the average cost of existing facilities. In this instance, the prices of retail services will fall even farther with the result of additional increases in the quantities demanded of generation, transmission, and retail services.

Obviously, the below-cost pricing of transmission service *Z* not only causes the deployment of too many distribution facilities, it also creates market-entry opportunities for generation companies. No doubt, some of these new entrants will be inefficient. Consequently, their continued market existence will depend on the continued deflation of the price for transmission service *Z*. Therefore, the fourth effect of a below-cost price for transmission service *Z* is inefficient generation companies that represent foregone opportunities for society. Of course, retail customers are happy in the short term because the retail services that they purchase are available at depressed prices. The myopic wholesale customers are happy in the very short term because they see only that there are more options to choose from when it comes to the purchase of power in the wholesale market. However, the happiness of the wholesale and retail customers is a fleeting phenomenon for the following reasons. Recall that the first effect of a below-cost price for transmission service *Z* is inadequate or insufficient transmission facilities. We know that unreliable transmission facilities cause the retail customers to suffer power outages and other electric problems. We also know that the wholesale customers feel the pain in their financial reports and their regulatory reviews when their retail customers suffer inconveniences and crises.

INSTABILITY OF A BELOW-COST TRANSMISSION PRICE

Although it is common regulatory behavior to try to price essential services below cost, we believe that the dynamics of the generation market will force the regulators to let the price of transmission service *Z* rise. One of the effects of keeping the price for transmission price *Z* at an artificially low level is to increase the number of nonutility generators that compete with utility-owned generation companies. More competitors will push the utility-owned generation companies to accelerate the depreciation of their assets. More competitors and accelerated depreciation will cause these companies to lose more customers and sales than they would have lost if the price for transmission service *Z* was set at the almost efficient component price. The profitability of the utility-owned generation companies suffers when the costs avoided by not serving wholesale customers and not selling wholesale power are less than the lost revenue. In addition, these unnecessary customer and sales losses may be associated with a higher level of stranded generation costs than that which would have occurred otherwise. Unnecessary stranded generation costs and unnecessary reduction in the profitability of the utility-owned generation companies will send a round of jitters through the investor community. These jitters will push the price of the utility's stock downward and its costs of raising capital upward. All other things equal, these changes in the utility's financial circumstances suggest price increases for unbundled transmission services.

OPENING OF THE TRANSMISSION MARKET TO COMPETITION

Per the discussion in the preceding section, we believe that the price of transmission service *Z* necessarily will rise over time to the almost efficient level. If the price increases stop when the almost efficient component price is reached, then the regulatory authorities will have eliminated the inefficiency in the generation, transmission, and distribution markets. However, we do not believe that the price increases for transmission service *Z* will stop when the almost efficient component price is reached. Instead, we expect that the pressure to continue utility-financed assistance programs will push the regulators to the above-cost pricing of this transmission service.

An above-cost price for transmission service *Z* will create market-entry opportunities for alternative transmission companies if it is in place long enough and if it is high enough. We suspect that rural cooperatives and municipally-owned utilities will be the first wholesale customers to be contacted by the alternative transmission companies. Eventually, these contacts will come to some end. We believe that this end will be the artificial opening of the transmission market to competition. As a result, the regulatory authorities will have to fashion a response to a decrease in the customer base of the utility-owned transmission company. This response will address this transmission company's reasonable opportunity to recover its approved revenue requirement. Most likely, its contents will be to encourage the transmission company to become more cost conscious.

A more cost-conscious utility-owned transmission company presents the regulatory authorities with a difficult issue. This company will suggest that it could lower its costs if it did not have to honor an obligation to serve all wholesale customers. Its position simply will be that these customers have access to other transmission services. When this argument is first presented to the regulatory authorities, it will be knocked down as it has been in the past. But then, the utility will ask for more pricing flexibility to push back the inroads that are being made by the alternative transmission companies.

More pricing flexibility allows the utility-owned transmission company to account for the distance sensitivity of transmission service *Z*. If this course of action is taken, then the wholesale customers that are farther away from the utility's transmission network are apt to contribute less toward the support of the utility-financed assistance programs than those wholesale customers that are located closer to the utility's transmission facilities. The reason is that a distance-sensitive price for transmission service *Z* raises the costs of those wholesale customers that are located farther away from the transmission gateway, while it lowers the costs of the wholesale customers that are closer to the transmission gateway. This particular restructuring of the wholesalers' costs makes it more likely that the far-away wholesale customers will elect self generation. Consequently, it would be more risky to use them as a source of support for the utility's assistance programs because they might be pushed into leaving the utility's transmission network.

Because the utility-owned distribution companies, on average, may be closer to the utility's transmission gateways than the rural cooperatives and municipally-owned utilities, it may be that the utility-owned distribution companies will pay the lion's share of the utility-financed assistance programs. Such an outcome would create problems for the state regulatory authorities as the utility-owned distribution companies attempt to pass these costs forward to the prices for retail services. This observation suggests that a particular utility may conclude that a distance-sensitive transmission price is not in its best interests. It also suggests that the utility will guard its transmission turf jealously, after the transmission market is opened artificially to competition.

TRANSITION TO THE ABOVE-COST PRICING OF DISTRIBUTION-ACCESS SERVICE

Market-entry opportunities for alternate transmission companies place a ceiling on the above-cost price for transmission service *Z*. When this price ceiling is reached, the utility-owned transmission company has wiped out those stranded generation costs and lost generation profits that should not have been there in the first place. That is, the maximum above-cost price for this transmission service has reduced the inefficiently high demand for wholesale power to an inefficiently low demand for wholesale power. Consequently, the inefficient generation companies have been driven from the market. In addition, the above-cost price for transmission service *Z* provides revenue that can be applied to the recovery of stranded generation costs and lost generation profits that are created by new generation technologies and the removal of entry barriers. These losses may be termed market-based losses. However, let's suppose that all of these market-based losses are recovered in the *almost efficient component price for transmission-access service*.[3] Consequently, we can imagine that the additional revenue from the above-cost price for transmission service *Z* is used to finance environmental, low-income, and demand-side management assistance

[3] Because the generation companies purchase transmission-access service, this method of recovering market-based losses further thins the ranks of the generation companies. In particular, the higher-cost generation companies are driven from the market. Therefore, the average number of generators is reduced from what it would be if stranded generation costs and lost profits were written off by the utility.

programs.

Although the utility is supporting its assistance programs by setting an inefficient price for transmission service *Z*, it is reasonable to assume that it does not want to increase the costs of its distribution companies. High-cost utility-owned distribution companies might make municipalization or rural cooperatives more attractive to some communities. Therefore, the utility chooses to restructure the above-cost price for transmission service *Z* along distance-sensitive lines. On average, we believe that this restructuring will cause an increase in the costs of rural cooperatives and municipally-owned utilities and a decrease in the costs of the utility-owned distribution companies. As a result, the rural cooperatives and municipally-owned utilities become better targets for the marketing efforts of alternative transmission companies. However, an economically viable alternative transmission company implies stranded transmission costs and lost transmission profits. These new adverse financial effects indicate that the utility's effort to keep down the costs of its distribution companies relative to the costs of rural cooperatives and municipally-owned utilities have backfired and created another cost recovery problem that serves to exhaust the transmission market as the source of support for the utility’s assistance programs. Therefore, the utility has to look elsewhere for funds, if it wants to continue its support of the full set of assistance programs. The utility cannot look to the generation market. Consequently, it has to look to the distribution market.

The utility can raise the prices for its bundled retail services to obtain the revenue to support the assistance programs that no longer can be paid for with revenue from the transmission market and cost savings from the wholesale power market. However, retail price increases are sure to spur the introduction of retail competition. So, let's assume that the retail price increases cause the state regulatory authorities to approve retail competition. Large-volume industrial customers and cooperatives of retail customers are expected to be the first retail competitors. These users will require unbundled distribution-access and distribution services to complete the delivery of the power that they have purchased in the wholesale market.

Unbundled distribution-access and distribution services are new sources of revenue for the utility. After the emergence of retail competition, the utility can raise the price of distribution-access service above its almost efficient component price to support the assistance programs that previously had been supported by higher prices for bundled retail services. Because distribution-access service is purchased by consumers who buy wholesale power, an above-cost price for distribution-access service increases the delivered cost of wholesale power to these formerly retail customers. Therefore, the above-cost pricing of distribution-access service for the purpose of supporting utility-financed assistance programs improves the competitive position of bundled retail services.

CROSS-SUBSIDIZATION THROUGH THE ABOVE-COST PRICING OF DISTRIBUTION-ACCESS SERVICE

Up until now, the bottleneck characteristic of the distribution network has been used to extract funds to support assistance programs that cannot be supported by the transmission market. Let's suppose the utility-owed distribution company can support its share of the utility's assistance programs without creating market-entry opportunities for an alternative distribution company. Now, let's assume that there still is room between the existing above-cost price for distribution-access service and the maximum price for this service. This assumption raises the question: *Does the utility have any reason to raise the price of distribution-access to its maximum*? The answer to the above question is yes, when the utility has to cross-subsidize its generation companies.

The utility's need to cross-subsidize its generation companies surfaces when the competitive price for wholesale power does not permit the utility-owned generation companies to cover their total production costs and earn an acceptable rate of return on their assets. Therefore, the need to cross-subsidize materializes when the competitive price for wholesale power is lower than the average costs of the utility-owned generation companies. This need becomes pressing when the utility's average cost of wholesale power exceeds the nonutility generators' average costs. Under these assumptions, the utility-owned generation companies are losing money on each sale of wholesale power and losing customers to nonutility generators.

It should not surprise anyone that utility-owned generation companies, finding themselves in the above situation, will attempt to lower their average costs over time. It also should not surprise anyone that the utility-owned generation companies are not able to lower their average costs immediately to levels that would make them competitive with the nonutility generators. Consequently, these companies are in need of some short-term help. Obviously, the utility-owned distribution company is in the position to provide it. We only have to recall that this company has the room to raise the price of its distribution-access service.

Most cross-subsidization stories of this type are attacked by demonstrating that it is irrational for the parent to cross-subsidize its subsidiary for an indefinite period of time. The easiest way to show this form of irrationality is to prove that the present value of the parent's stream of profits with cross-subsidization is less than the present value of the parent's stream of profits without cross-subsidization. However, at least initially, this plan of attack cannot be used because it is unclear what the relationship will be between the pertinent present values. After all, we are not talking about hopelessly inefficient utility-owned generation companies. Consequently, there always is the possibility that they can cut their costs by amounts that eventually would make them competitive with nonutility generators.

Utility-owned generation companies in need of cross-subsidization face the following situation. They want to earn rates of return on their assets that are acceptable to investors, but market conditions require that they minimize their losses as they try to reposition themselves in the wholesale market. To reposition themselves, these companies have to raise capital to invest in more cost-efficient generation technologies. When confronted with this situation, it is reasonable for the utility to cross-subsidize its generation companies by setting above-cost prices for distribution-access services. However, the utility has to convince the state regulators that high prices for these services are a legitimate exercise of their authority.

Clever cost accounting that is grounded in information asymmetries is the means that the utility can use to justify an above-cost price for distribution-access service. It knows its costs more accurately than the regulators. It alone knows the amount of generation costs that it must shift to its distribution companies to give the appearance that its generation companies are close to being competitive with the nonutility generators. Recall that the utility needs to leave this impression with the investors because it wants to raise capital from them. No doubt should exist that the utility can shift costs between the generation and distribution markets. We only need to reflect upon the existing information asymmetries to realize that no amount of structural or nonstructural safeguards can overcome them. The only doubt is whether the utility can shift *enough* generation costs to convince its investors to give it the capital it needs on terms that it can afford. A failure to raise the needed capital means that the present value of the utility's stream of profits with cross-subsidization will be less than the present value of its stream of profits without cross-subsidization.

The utility has to believe in more than its ability to shift cost to pursue the strategy of cross-subsidizing its generation companies. It also has to believe that its generation companies can cut their costs to levels that will allow them to earn competitive rates of return sometime in the near future. Additionally, it has to believe that the present value of the stream of competitive profits that is expected to be earned *after* the end of the cross-subsidization period will be at least equal to the present value of the stream of losses *during* the cross-subsidization period. It does not matter that the utility-owned generation companies are not able to cover all of their costs in each year. All that matters is that these companies eventually will become profitable enough to make cross-subsidization worthwhile to the utility. If any of these conditions is not met, then this cross-subsidization story falls apart. It would be patently irrational for the utility to order the cross-subsidization of its generation companies because it would never benefit from such a program. Therefore, the focal points of our cross-subsidization story are successful cost shifting, successful cost cutting, and an excess of future gains over present losses in present value terms.

This cross-subsidization story has a dynamic that some readers may find interesting. First, we argued that the utility would charge above-cost prices for its transmission services because it had to support assistance programs. Then we argued that this price would open the transmission market to competition if it was high enough and in place for a long enough period of time. Next we argued that competition in the transmission market would cause the utility to switch to distance-sensitive transmission prices because it wanted to lower the costs of its distribution companies. After that, we argued that distance-sensitive transmission prices would cause the utility's distribution companies to take on the lion's share of the support for the utility's assistance programs. Then we argued that these restructured prices created stranded transmission costs because they improved the economic viability of alternate transmission companies. We argued next that stranded transmission costs meant that the utility could not finance all of its assistance programs with revenue from the transmission market. Then we argued that the utility would increase the prices of its bundled retail services to obtain the revenue that it needed to support its assistance programs. After that, we argued that the higher prices for bundled retail services would cause the institutionalization of retail competition and the deployment of distribution-access and distribution services. We argued that the utility would set above-cost prices for distribution-access service to cross-subsidize its generation companies. Finally, we argued that the utility would push down the previously increased prices for bundled retail services by transferring some of the costs of supporting assistance programs to the distribution-access services. However, these retail prices cannot be pushed down to the levels where they were before the opening of the transmission market to competition. Therefore, it is far from certain that every state regulatory authority always will perceive wholesale and retail competition as good things.

ALMOST EFFICIENT COMPONENT PRICES DO NOT JUST HAPPEN

What if the regulators did not choose to approve of utility-financed assistance programs? What if the utility did not try to use a distance-sensitive price for transmission service to place its distribution company in a favorable position relative to rural cooperatives and municipally-owned utilities? What if the regulators could prevent the utility from shifting generation costs to the distribution market? Would the utility voluntarily set efficient component prices for transmission and distribution-access services? The answer to the final question is found in the process for calculating almost efficient component prices.

Practically speaking, almost efficient component prices for a stand-alone transmission service and a stand-alone distribution-access service are calculated by finding reasonable estimates of the sum of the variable, fixed, and opportunity costs that are incurred to produce specific levels of these services in the given transmission and distribution markets. Let's assume that the utility can perform the required analyses. After calculating these prices, the utility has to decide if it is in its best interests to charge them. We have assumed that the utility believes that its generation companies can compete profitably in the wholesale power market if they are given enough time to lower their average costs. We know that the regulatory authorities cannot measure costs or determine the competitive rates of return with the required degree of accuracy because of information asymmetries. Given these circumstances, the utility works against its own best interests when it sets almost efficient component prices. Instead, it should select prices for transmission and distribution-access services that are above its almost efficient component prices to cross-subsidize its generation companies. We are confident that the regulatory authorities cannot completely prevent this activity under any form of regulation. Consequently, we conclude that almost efficient component prices will not be proposed voluntarily by the utility.

CONCLUDING REMARKS

Rate-of-return regulation is the only tested way for regulatory authorities to enforce the principles of almost efficient component pricing. However, the costs of this form of regulation may become prohibitive after the utility-owned generation companies have become competitive with the nonutility generators. This problem can be alleviated by the substitution of price-cap for rate-of-return regulation. The fact that the transmission and distribution markets are not workably contestable can be finessed by the regulatory authorities. They can alert the utility that it will be rewarded consistently for cost reductions, but only if its subsidiaries reduce their prices for transmission, distribution-access, and bundled retail services. This *ad hoc* condition on price-cap regulation should be relaxed only when the transmission and distribution markets become competitive.

Furthermore, service comparability and open access standards do not alleviate the concern that the utility will cross-subsidize its generation companies. These standards do no more than guarantee that wholesale customers have the same opportunity to contract with any generation company. They do not prevent the utility-owned transmission and distribution companies from setting above-cost prices for transmission and distribution-access services.

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CHAPTER 6

OPPORTUNISTIC BYPASS OF THE UTILITY'S TRANSMISSION SERVICES

INTRODUCTION

Bypass is either a competitive or opportunistic activity. It is competitive when the price of the bypass service is efficient. In this instance, the bypasser just gets a better deal elsewhere. It is opportunistic when the price of the bypassed service is inefficient. In this case, the bypasser trades on the misfortune or ignorance of the bypassed company. We are concerned in this chapter with opportunistic bypass because it is the only type of bypass that is consistent with our pricing story.

The opportunistic bypass of the utility's transmission facilities is the result of an interplay between an above-cost price for the utility's transmission service and a lower price for the bypass service. However, it is not just any above-cost price that causes opportunistic bypass. This price has to be greater than the highest above-cost price that barely deters market entry by an alternate transmission company. Essentially then, opportunistic bypass can be prevented by bringing the above-cost price for transmission service down to a level that is just below the price of the bypass service and above the compensatory price for the transmission service. The next three sections look at factors that cause opportunistic bypass. The fourth section shows that an almost efficient component price for transmission service *Z* minimizes opportunistic bypass by rural cooperatives and municipally-owned utilities.

PRODUCTION TECHNOLOGY AND OPPORTUNISTIC BYPASS

Production technologies and input prices determine the costs of the utility-owned and alternate transmission companies. These companies can choose either high- or low-cost technologies. Furthermore, they can set either high or low prices for their services. In our story, the utility sets a high price for its transmission service. It does so to finance its assistance programs. However, we argued that the ceiling for the above-cost pricing of the utility's transmission service could not be broken without creating market-entry opportunities for alternate transmission companies. Finally, we argued that the utility would not break this ceiling voluntarily.

Although the utility does not want to set an above-cost price that breaks the price ceiling for its transmission service, regulatory authorities could force it to do so. Perhaps, such a price is required to support the assistance programs that the regulators have decided are essential to the well-being of society. In this case, inefficient alternate transmission companies could enter the market profitably. They are inefficient because their production technologies do not permit them to compete with the utility-owned transmission company if the utility set an almost efficient component price for its transmission service. Consequently, the alternate transmission company uses a higher-cost production technology as compared to the utility-owned transmission company.

Our dynamic for opportunistic bypass requires that the utility's support of assistance programs creates a pseudo-production cost for the utility-owned transmission company that exceeds the production cost of the alternate transmission company. It is the difference between these production costs that opens the door to opportunistic bypass. Therefore, it does not matter that much whether the utility's transmission company uses a high- or low-cost production technology. What really matters with respect to opportunistic bypass is the markup that is required over the almost efficient component price of the utility's transmission service to support the utility's assistance programs and the difference between the utility's pseudo-production cost and the actual production cost of the alternate transmission company. Given this description of opportunistic bypass, it is clear that the regulatory authorities and the utility can conceive of the best of all possible worlds. They want to see a low-cost production technology for the utility-owned transmission company and a high-cost production technology for the alternate transmission company without any significant differences in the qualities of the competing transmission services. This distribution of production technologies provides a lot of room for the utility's support of assistance programs without incurring the risk of the opportunistic bypass of the utility's transmission service.

We have just suggested that the utility would prefer to use a low-cost technology to produce its transmission service. Although this preference indeed may be the one that the utility holds, this company is pressured into using a low-cost production technology only when the bypass providers are using low-cost production technologies and the qualities of the competing services are about the same. Consequently, the utility might choose for some reason to use a high-cost production technology when the bypass companies have chosen to use high-cost technologies. The most obvious reason is that the higher cost technologies produce higher quality transmission services as compared to the services that are produced by the lower cost technologies. These observations indicate that the likelihood of opportunistic bypass is a function of the technology decisions that are made by the bypass providers.

PRICES OF BYPASS OPTIONS AND OPPORTUNISTIC BYPASS

A utility that faces bypass threats is expected to adjust its transmission price to maintain a competitive posture with respect to its customers' bypass options. Perhaps, a particular transmission company might respond by setting a price that is within the low end of the range of prices for bypass options. Or perhaps, another transmission company might choose to place its transmission price at the high end of the range of prices for bypass options. These two possibilities suggest that the utility's specific pricing strategy to avoid opportunistic bypass may be dependent on more than the bypass provider’s pricing and technology choices.

With this thought in mind, opportunistic bypass occurs in two ways. First, the regulatory authorities force the utility to set a price for its transmission service that induces market entry by alternate transmission companies. Second, the utility simply guesses incorrectly about the prices that are set by the bypass companies. Figure 6-1 summarizes a situation where no one guesses incorrectly about prices. The downward-sloping line, DD_Z, is the market demand schedule for the utility. The U-shaped curve, AC_{tsp}, is the utility's average cost schedule, and the U-shaped curve, MC_{tsp}, is its marginal cost schedule. The downward-sloping line, DD_B, is the market demand schedule for the bypass company. DD_B is that portion of DD_Z that the bypass company can serve. The smaller U-shaped curve, AC_{bp}, is its average cost schedule, and the other smaller U-shaped curve, MC_{bp}, is its marginal cost schedule. As shown in the figure, the bypass company is not in the position to drive the utility from the transmission market, even though its minimum average cost is lower than the utility's minimum average cost. However, the bypass company is in the position to set a lower price as compared to the minimum price that can be set by the utility. Consequently, the utility and the bypass company potentially can share the transmission market.

Figure 6-1 shows that the utility can be profitable at a price that is equal to or greater than p_{tsp} when it produces the quantity q_{tsp}, while the bypass company can be profitable at a price that is equal to or greater than p_{bp} when it produces the quantity q_{bp}. Per the construction of the figure, q_{tsp} represents the production level that is associated with the utility's minimum nonpredatory price. Similarly, q_{bp} is associated with the bypass company's minimum nonpredatory price. The minimum nonpredatory prices for these two companies are the unique prices such that these companies can just sustain their financial integrity, given their production technologies.

Let's suppose for simplicity that the market demand schedule, DD_Z, intersects the utility's average cost schedule at the quantity q. Let q be equal to the sum: $q = q_{tsp} + q_{bp}$. From the figure, it is apparent that p is the price that equals the utility's average cost when it produces q units of transmission service. Because p is greater than p_{tsp},

FIGURE 6-1. *NONCONFRONTATIONAL MARKET SHARING.*

and p_{tsp} is greater than p_{bp}, the utility and the bypass company can share the transmission market profitably when $q = q_{tsp} + q_{bp}$. The utility produces the quantity q_{tsp} and charges the price p, while the bypass company produces the quantity q_{bp} and charges a price that is slightly less than p and greater than p_{bp}.

Figure 6-1 demonstrates that the utility and the bypass company are profitable simultaneously despite the fact that the bypass company introduces a comparable bypass service at a lower price. However, two conditions must be met before the profitable sharing of the transmission market actually can occur in this manner. First, the market must be large enough. In particular, q has to be greater than or equal to $q_{tsp} + q_{bp}$. Second, the utility's and the bypass company's minimum average costs have to be lower than the utility's average cost when it produces q units of transmission service. In other words, it is not efficient to have the utility serve the entire market for transmission service. Figure 6-1 also indicates that the utility and the bypass company are able to earn supernormal profits. The utility charges a price p that is slightly above p_{tsp}, and the bypass company sets its price above p_{bp}. Finally, Figure 6-1 can be used to show a pricing mistake by the utility that would cause opportunistic bypass. In fact, it always is a mistake of this kind that causes this form of bypass. Let the utility set a price for its transmission service that exceeds p. Then the bypass company can increase its production from q_{bp} to some level that is greater than q_{bp} and less than q. This additional production represents the opportunistic bypass of the utility's transmission service.

DECLINING COSTS AND OPPORTUNISTIC BYPASS

Presumptively, the utility is acting according to its legitimate self-interest when it lowers the price of its transmission service in an effort to retain the majority of its customers. This strategy is used most often when its average cost is declining, and it faces credible bypass threats. We use Figure 6-2 to show how this strategy might

FIGURE 6-2. *FORECLOSED MARKET ENTRY*.

play out. We continue to assume that the utility faces a downward-sloping market demand schedule that summarizes the prices that the utility can charge for different amounts of its transmission service. As is the case with all companies facing a downward-sloping market demand schedule, the utility has to contend with a downward-sloping marginal revenue schedule, MR_Z. This schedule summarizes the additional revenue that the utility receives from the sale of an additional unit of its transmission service. Its average cost schedule is denoted by AC_{tsp}, and its marginal cost schedule is denoted by MC_{tsp}. We assume that the bypass company also faces a downward-sloping market demand schedule, DD_B, and a downward-sloping marginal revenue schedule, MR_B. As before, DD_B is that portion of the utility's demand schedule that can be served by the bypass company. The bypass company's average cost and marginal cost schedules are represented by the smaller U-shaped curves.

Per Figure 6-2, a *monopolistic* utility prefers to produce in the declining region of its average cost schedule. If it is allowed to do so and the bypass company does not exist, then it would earn the maximum monopoly rent as it sold q^* units of transmission service at the price p^*. However, this outcome is inefficient from society's perspective for two reasons. First, the utility's production level is lower than the cost-minimizing production level that is achieved at q_{tsp}. Second, the price, p^*, is greater than the marginal cost of producing the last unit of the q^* units of transmission service.[1] Meanwhile, per this figure, a *monopolistic* bypass company prefers to produce in the increasing-cost region of its production technology because this is where it achieves its maximum monopoly rent. However, neither company can realize its maximum monopoly rent because neither company can drive the other from the transmission market.

The bypass company achieves its minimum average cost when it produces q_{bp}

[1] A monopolistic utility's profit-maximizing behavior still would be inefficient from society's perspective even if its marginal revenue schedule intersected its marginal cost schedule at q_{tsp}. Although the utility would produce the cost-minimizing amount of its transmission service, it still would charge a price that is greater than the marginal cost of producing the last unit of the q_{tsp} units of transmission service.

units of its service, and the utility attains its minimum average cost when it produces q_{tsp} units of its service. Clearly from the figure's construction, the bypass company's minimum average cost is higher than the utility's minimum average cost. Also from the construction of Figure 6-2, $q_{bp} = q_{tsp} - q^*$, where q^* represents the profit-maximizing output for a *deregulated monopolistic* utility with these cost schedules. This particular construction ensures that the bypass company's minimum average cost is realized at the production level that is exactly equal to the maximum increase in production that would be considered by a rational utility. Finally, the market demand schedule, DD_Z, is drawn such that it intersects the utility's average cost schedule at q_{tsp}. This construction ensures that the utility has the option of minimizing its costs.

In the context of Figure 6-2, the utility effectively challenges any attempt at market entry. The bypass company can do no better than to enter at a price that is equal to p_{bp} and at a production level that is equal to q_{bp}. The utility can respond by setting its price at p_{tsp} and producing q_{tsp} units of its service. Per the construction of the figure, this competitive response forecloses entry by the bypass company because it loses money even if it minimizes its costs by producing q_{bp} units of its service. Therefore, the utility's price-reduction strategy has prevented uneconomic market entry and opportunistic bypass.

If the bypass company could produce q_{bp} units of service profitably at a price p_{bp} that is less than p_{tsp}, then the utility legitimately cannot prevent the bypass company from entering the market. Figure 6-3 describes a particular situation where the utility loses market share to the bypass company. Deviating from the assumptions underlying Figure 6-2, we assume that the bypass company's cost-minimizing production level of q_{bp} is less than the maximum production increase from the rational profit-maximizing, unregulated, monopolistic utility. Under this assumption, q_{bp} is less than the difference $q_{tsp} - q^*$ and the difference $q_{tsp} - q^* - d$. When fulfilled, these two conditions guarantee that the bypass company can sell q_{bp} units of its service because p_{bp} is less than the

FIGURE 6-3. *LOSS OF MARKET SHARE.*

utility's minimum average cost of production. We also assume that the bypass company's average cost of production at q_{bp} + d units of its service is equal to the minimum average cost that the utility reaches at q_{tsp} units of its service. This assumption implies that the bypass company has an opportunity to sell an additional d units of service to wholesale customers. We assume that the bypass company actually sells these d additional units of its service. What then is the position of the utility?

Figure 6-3 indicates that the utility should not sell more than q_{tsp} units of its service because DD_Z intersects its average cost schedule at that quantity. But in fact, it cannot sell even q_{tsp} units of its service because the bypass company already has sold q_{bp} + d units of bypass service. Therefore, the utility has an opportunity to sell no more than $q_{tsp} - q_{bp} - d$ units of its service. Fortunately for the utility, Figure 6-3 has been constructed such that its average cost of producing $q_{tsp} - q_{bp} - d$ units of its service is less than the average cost that the bypass company would realize if it produced an additional $q_{tsp} - q_{bp} - d$ units of its service. Consequently, the utility sells $q_{tsp} - q_{bp} - d$ units of its service at a price that is equal to p.

Two lessons are learned from Figure 6-3. First, there are times when wholesale customers are able to get a better deal from a bypass company, despite the best legitimate efforts of the utility. Second, sometimes simply lowering price is not enough to prevent bypass. We now need to consider what happens to the utility when the bypass company profitably can produce q units of bypass service at a price that is equal to p such that $p_q > p > p_{bp} > p_{tsp}$, where p_q equals the utility's average cost at q_{tsp} + q units of its service. We use Figure 6-4 for this purpose.

Per this figure, the utility achieves its minimum average cost of production when it produces q_{tsp} units of its service. The bypass company realizes its minimum average cost of production when it produces q_{bp} units of its service. As is seen, the utility's minimum average cost is less than the bypass company's minimum average cost. However, the utility's market demand schedule, DD_Z, intersects its average cost

FIGURE 6-4. *APPARENTLY INEFFICIENT BYPASS PROVIDER.*

schedule at a cost that is greater than its minimum average cost of production. This fact implies that the utility profitably can produce within the increasing-cost range of its production function. In fact, it covers its total cost of production when it sells q_{tsp} + q units of its service at a price that is equal to p_q. But we know that there is a bypass company in the picture that wants to sell q_{bp} units of its service at a price that is equal to p_{bp}. Can the bypass company sell that much service?

Figure 6-4 indicates that the bypass company can sell q units of its service at a price p that is equal to the utility's average cost of production when it produces q units of its service. The figure also indicates that the wholesale customers are willing to purchase q_{tsp} + q units of the utility's service at a price that is equal to p_q. Clearly, the utility cannot sell q_{tsp} + q units of its service at a price that is equal to p_q. If it attempted to do this, the bypass company could undercut this price and sell in excess of q units of its service. Therefore, the utility and the bypass company will share the transmission market. How exactly will the sharing occur?

The utility can sell q_{tsp} units of its service without fear of an effective response from the bypass company. The utility is able to act in this manner because its minimum average cost of production, which occurs at q_{tsp} units of its service, is less than the bypass company's minimum average cost of production. Furthermore, the utility can increase its production up to the point where its new average cost of production is equal to the bypass company's minimum average cost of production. A visual inspection of Figure 6-4 shows that the utility is able to maintain this level of output. Let the additional production by the utility be equal to $q - q_{bp}$ units of its service. Then the utility sells $q_{tsp} + q - q_{bp}$ units of its service at a price that is equal to p_{bp}. Meanwhile, the bypass company sells q_{bp} units of its service at the same price. This outcome can be maintained for the following two reasons. First, the wholesale customers are willing to pay a price that is equal to p_q for $q_{tsp} + q = q_{bp} + q_{tsp} + q - q_{bp}$ units of transmission and bypass services. Second, p_q is greater than p_{bp}. In fact, the wholesale customers actually want to buy more than q_{tsp} + q units of transmission and bypass services when the price is equal to p_{bp}, and they can.

Figure 6-4 indicates that each additional unit of transmission or bypass service that is produced above q_{tsp} + q units of production drives up the average costs of the utility or bypass company. Higher costs usually mean higher prices. Therefore, we assume that both companies set their prices equal to the new and higher average costs whenever they increase their production levels. The wholesale customers respond to these higher prices by pulling the quantity demanded of transmission and bypass services back toward q_{tsp} + q units of production. This process of price increases and reductions in quantities demanded reaches its equilibrium at some price that is greater than p_{bp} and less than p. Consequently, the wholesale customers purchase a quantity of transmission and bypass services that is greater than q_{tsp} + q units and less than $q_{tsp} + 2q - q_{bp}$ units. Per the figure, it is clear that the bypass company's average cost is rising faster than the utility's average cost. Consequently, the utility captures more of the additional quantity demanded of transmission and bypass services than does the bypass company.

The next issue for us to consider is how the transmission market reacts when the bypass company has a lower minimum average cost than the utility. We use Figure 6-5 to discuss this phenomenon. Per the figure, it is clear that the bypass company can sell q_{bp} units of its service without fearing an effective response from the utility. It also is obvious that the bypass company can increase its production to the point where its average cost of production equals the utility's minimum average cost of production. Per the figure, this production level is greater than q_{bp} and less than q_a. Meanwhile, the utility can sell q_{tsp} units of its service at a price that is equal to p_{tsp}. Thus far, slightly less than $q_{tsp} + q_a$ units of transmission and bypass services have been purchased by the wholesale customers. But it is clear from the figure that these wholesale customers want to purchase more than $q_{tsp} + q_a$ units of transmission and bypass services when the price is equal to p_{tsp}.

FIGURE 6-5. *EFFICIENT TRANSMISSION SERVICE PROVIDER.*

Once again, we are in the position where the utility and the bypass company have to increase their prices to accommodate any production in excess of $q_{tsp} + q_a$ units of transmission and bypass services. Figure 6-5 indicates that the bypass provider can deliver q_a units of its service at a price that is equal to the price that the utility would charge for the production of q_a units of its service. However, the figure also indicates that the utility cannot produce an additional q_a units of its service and still remain competitive with the bypass company. But it does remain competitive when it produces an additional $q - q_a$ units of its service. These are the starting points for a feasible equilibrium for the circumstances reflected in Figure 6-5.

The utility sells $q_{tsp} + q - q_a$ units of its service at a price that is equal to p_2. The bypass company sells q_a units of its service at a price that is equal to p_1. Therefore, $q_{tsp} + q - q_a + q_a = q_{tsp} + q$ units of transmission and bypass services are sold at these prices. However, the wholesale customers want to purchase more than $q_{tsp} + q$ units of transmission and bypass services at these prices. Therefore, the equilibrium for this example occurs at some price greater than p_1 and p_2 and less than p_q, while the wholesale customers buy some quantity of transmission and bypass services that is greater than $q_{tsp} + q$ units of service.

EFFICIENT COMPONENT PRICE FOR TRANSMISSION SERVICE *Z* AND OPPORTUNISTIC BYPASS

When thinking about the pricing behavior of a single-service utility-owned transmission company that competes in a perfectly contestable market, the first thing that comes to mind is that the price of transmission service *Z* has to be equal to its marginal cost. Any other price courts economic disaster. Either there is successful market entry by bypass companies, or the utility's profits are insufficient to maintain the confidence of its investors. This common knowledge rests on two assumptions that concern the parameters of the transmission company's production technology and the amount of transmission service *Z* that it produces. First, it uses an increasing-cost production technology. Second, it produces in the nondecreasing-cost range of its technology. These assumptions ensure that the marginal cost of transmission service *Z* equals or exceeds its average cost. Consequently, the utility covers its total cost of production when it sets its price at marginal cost.

The existence of a perfectly contestable market for a single transmission service also ensures that marginal cost pricing is efficient pricing. First of all, the utility-owned transmission company only earns a competitive rate of return on its investments. Therefore, for any given level of production, the price of transmission service *Z* cannot exceed this service's average cost at the given level of production. Consequently, this price must be the one where average cost equals marginal cost. In addition, the perfectly contestable market forces the utility-owned transmission company to minimize its other costs of production. Therefore, a marginal cost price for transmission service *Z* is a first-best price.

It should be clear why a marginal cost price for transmission service *Z* may or may not be first best when the transmission market is not perfectly contestable. The absence of the threat of costless entry and exit by competitors frees the utility-owned transmission company from the necessity of minimizing its production costs and earning no more than the competitive rate of return on its investments. Therefore, it can inflate its total cost of production, which, in turn, would inflate marginal cost at every production level. Furthermore, it can produce transmission service *Z* at a level where marginal cost exceeds average cost, which implies that it is earning monopoly profits. Therefore, a marginal cost price may not be first best when a utility-owned transmission company competes in a single-service transmission market that is not perfectly contestable.

We expect that the utility-owned transmission company will not compete in a perfectly contestable market. As a result, we are on the lookout for inefficient pricing. We also expect that this company will produce its service in the declining-cost region of its production technology. Therefore, if this company is to remain economically viable, we know that it has to set a price for transmission service *Z* that exceeds its marginal cost at the existing level of production. However, we also know that such a price does not result necessarily in monopoly profits for the utility-owned transmission company.

A price is second best when it (1) is greater than marginal cost, (2) does not imply monopoly profits, and (3) is set by a cost-minimizing company. Such a price can be realized in a single-service transmission market that is not perfectly contestable. The trick is to know the competitive rate of return for the utility-owned transmission company and its efficient cost at every level of production. If these things are known, then the transmission company's schedule of average costs is efficient. Therefore, the second-best price for transmission service *Z* is achieved simply by setting price equal to the utility-owned transmission company's average cost at the quantity of the service where quantity demanded is equal to quantity supplied. This procedure minimizes the decline in economic welfare that is caused by a forced deviation from first-best prices.

However, the regulatory authorities probably will not know the competitive rate of return for the utility-owned transmission company that competes in a market that is not perfectly contestable. In addition, they probably will not know that company's efficient average cost of production for its existing level of production. Therefore, a second-best price appears to be beyond their reach. So, how do they find some sort of price for transmission service *Z* that prevents opportunistic bypass? Perhaps, they can find a price that promotes competition in the transmission market to the maximum extent practical by preventing the entry of an inefficient bypass company.

What is an inefficient bypass company? One way to think about such a firm is to imagine that everywhere its average costs are higher than the average costs of the utility-owned transmission company. It also is useful to imagine that the quality of the bypass service is less than or equal to the quality of transmission service *Z*. Then, it is seen immediately that the bypass company simply produces a comparable service at a higher cost. Therefore, the bypass company is everywhere inefficient.

The preceding description of an inefficient bypass company suggests that an antibypass price for transmission service *Z* has to prevent a higher cost bypass company from displacing the lower cost utility-owned transmission company. However, the preceding discussion of the utility-owned transmission company's production parameters indicates that its price for transmission service *Z* has to be greater than marginal cost. Recall that this transmission company is producing in the declining-cost region of its production technology. Therefore, the regulatory authorities are looking for an antibypass price that is related to the utility-owned transmission company's efficient average cost of production for any given quantity of transmission service *Z*. However, we already have concluded that they never will know these costs. Consequently, they are looking for an antibypass price that approximates the transmission company's efficient average costs.

The regulatory authorities know the utility-owned transmission company can eliminate the threat of opportunistic bypass if it pays competitive prices for production inputs and chooses the efficient production technology. If the single-service transmission company does not decided to do these things for some reason, then the regulatory authorities know that they can minimize the threat of opportunistic bypass by setting a price for transmission service *Z* that recovers only the actual per-unit stand-alone cost of producing any given level of this service. They also know in this instance that the actual per-unit stand-alone cost is equal to the sum of the actual fixed and variable costs that the company incurs to produce the given quantity of transmission service *Z* divided by that given quantity of the service. Finally, they know that this cost calculation also yields the actual average incremental cost of transmission service *Z*.

We know that the average incremental cost of transmission service *Z* is the efficient component price for transmission service *Z* when the transmission market is perfectly contestable. However, we also know that the transmission market is not perfectly contestable. Therefore, we suspect that the utility-owned transmission company is incurring costs inefficiently and may be earning more or less than the competitive rate of return on its investments. As a result, we know that it is most accurate to describe the utility-owned transmission company's actual average cost at any given level of production as approaching the efficient component price for transmission service *Z*, that is, an almost efficient component price for transmission service *Z*. Consequently, we view a price that is equal to the average incremental cost of transmission service *Z* as approximating the second-best price for this service.

A price that approximates a second-best price cannot eliminate opportunistic bypass. The best that such a price can do is to reduce opportunistic bypass. Therefore, it would appear that a price for transmission service *Z* that is set equal to its actual average incremental cost for any given production level will trade some opportunistic bypass for more redundancy in the production process through inefficient costs or more profits to stockholders through inefficient pricing.

Now, we need to extend this discussion to the utility-owned transmission company when it produces more than one transmission service. We assume that production occurs within the declining-cost range of this company's production technology. Therefore, it faces a revenue insufficiency problem when it sets prices equal to its marginal costs. Furthermore, we assume that the market demand schedules for these transmission services are independent of each other and inelastic. These two assumptions allow us to solve the revenue insufficiency problem by applying the inverse-elasticity rule.[2]

However, the application of the inverse-elasticity rule can have a disturbing aspect in terms of market entry. This rule does not limit the price increases that may be assigned to the transmission services with the most inelastic demands because the only objective to be achieved is to find the set of price increases that solves the revenue insufficiency problem and minimizes the reduction in the total production of transmission services. Consequently, it is possible that the blind application of the

[2] This rule has two articles. The first is that it is appropriate economically to raise the prices of the transmission services with the most inelastic market demand schedules. The second is that it is never appropriate to raise the price for any transmission service with an elastic market demand schedule. See William J. Baumol and David F. Bradford, "Optimal Departures from Marginal Cost Pricing," *American Economic Review* 60 (1970): 265.

inverse-elasticity rule will result in prices for some transmission services that are higher or lower than their respective average incremental costs. A price set with this characteristic may allow the entry of an inefficient bypass company or discourage the entry of an efficient bypass company.[3]

Reacting to the possible distortion to market entry that can be caused by the application of the inverse-elasticity rule, Baumol and Sidak propose that the price increases needed to solve the revenue insufficiency problem should not violate the parameters of efficient component pricing and Faulhaber's cross-subsidization tests. Therefore, because the market demand schedules are inelastic, the prices for these transmission services should not be less than the average incremental costs of these services and should not be more than their stand-alone costs.[4] It is not impossible to find such prices, as we demonstrated in Chapter 3.

CONCLUDING REMARKS

We started the analysis of the opportunistic bypass of transmission service *Z* with the supposition that efficient component pricing can prevent it. The support for this supposition, which is provided in Chapter 3, is that an efficient component price for this transmission service is subsidy free and compensatory. We believe that we validated this supposition analytically in this chapter. In particular, we described how an efficient component price eliminates the opportunistic bypass of transmission service *Z*. We also described how efficient component pricing prevents the opportunistic bypass of multiple transmission services when the utility-owned transmission service provider produces services with independent and inelastic market demands.

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[3] The entry of an inefficient bypass company is encouraged when the prices above their respective average incremental costs pertain to transmission services that can be produced by the potential entrants. The entry of an efficient bypass company is discouraged when the prices below their respective average incremental costs relate to the transmission services that can be produced by the potential entrants.

[4] Baumol and Sidak, *Local Telephony,* 101-107.

To make our theoretical points about the elimination of opportunistic bypass, we proceeded on the basis that the average and marginal cost schedules for the utility-owned transmission service provider and the bypass provider were not distorted in any fashion. That is, these cost schedules did not include any costs that would not be incurred by a cost-minimizing company that can earn at best the competitive rate of return on its investments. However, we know that an actual utility-owned transmission company is not the idealized transmission company. Most probably the regulatory authorities are dealing with a transmission company that does not incur the efficient level of production costs and hopes to earn more than the competitive rate of return on its investments. Furthermore, the probabilities are in favor of the regulators having to deal with a utility-owned transmission company that has been asked to provide financial support for low-income, demand-side management, and renewable resource assistance programs. This support would not be forthcoming from a self-interested utility-owned transmission company that focuses on the minimization of its private costs. Consequently, there is a positive probability that the opportunistic bypass of the utility's transmission services will occur.

Would a utility ever voluntarily increase the risk of the opportunistic bypass of its transmission services? Perhaps, a utility might do this if it believes that monopoly profits are a short-term source for the cross-subsidization of its generation companies. Accordingly, the opportunistic bypass of transmission facilities is something for everyone to worry about when the utility-owned transmission company uses a low-cost production technology to produce its transmission services.

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CHAPTER 7

SUMMARY OF CONCLUSIONS

Separated and unregulated generation companies represent the utility's competitive opportunities in the market for wholesale power. These companies compete directly with nonutility generators for the right to supply rural cooperatives, municipally-owned utilities, and utility-owned distribution companies with power at wholesale prices. But to be profitable, they must be able to sell their power at prices that are lower than or equal to the prices that are charged by nonutility generators. Therefore, we concluded that the utility has an incentive to drive the costs of its generation companies to levels that are as low as possible.

To analyze this conclusion further, we built a model for the price regulation of utility-supplied transmission services. We started with the premise that price regulation of the utility-owned transmission company should provide an environment that (1) promotes the efficient pricing of transmission services, (2) supports the rapid introduction of new transmission services, and (3) induces lower transmission costs. We proposed that two forms of price-cap regulation are candidates to achieve these objectives. The first is price-cap regulation with profit monitoring. The second is price-cap regulation with profit sharing. We found that profit monitoring causes a risk-averse transmission company to vacillate with respect to the reduction of its costs. We also found that profit monitoring involves more political risk for the regulatory authorities than profit sharing. Therefore, we concluded that most regulators would choose price-cap regulation with profit sharing over profit monitoring. Profit sharing has more potential to reduce the political costs that are associated with the regulation of prices rather than profits.

However, price-cap regulation with profit sharing is a feasible alternative only if regulatory authorities commit (1) to allowing the utility-owned transmission company to keep more profits as it earns more profits, (2) to not reintroducing rate-of-return regulation as the company's profits rise, and (3) to not drastically reducing over time the maximal rate of return that has been approved for the utility-owned transmission company. Unfortunately, we believe that there are valid reasons why the regulatory authorities cannot make these commitments. Therefore, we looked at price-cap regulation with profit sharing and without commitments. This form of regulation came up short because the utility-owned transmission company would vacillate in its cost reduction efforts.

Because we could not eliminate any semblance of a regulatory commitment from our analysis, we searched for substitutes with some but not all of the characteristics of a commitment. In this regard, we looked at credibility. We proposed that the criterion of credibility obligates the regulatory authorities to select a form of price-cap regulation with a high probability of being around for a while. We found that this criterion could serve as the basis for the price-cap regulation of the transmission market. However, the obvious slack in the credibility criterion, as proposed, introduced some problems that had to be dealt with. The first step taken to shore up our concept of credibility was to require the annual recalculation of the utility-owned transmission company's maximal rate of return for the year in question. Unfortunately, we found that the annual recalculation of the maximal allowed rate of return causes a risk-averse transmission company to be at least hesitant about rapid cost cutting. Consequently, we had to find a way to encourage such a company to cut its costs. This led to a flexible date for the review of the effectiveness of price-cap regulation as the second step taken to shore up our concept of credibility. A flexible review date avoids administrative costs when price-cap regulation is perceived by the public as working satisfactorily.

But every change has a cost. We found that the threat of regulatory review causes the utility-owned transmission company to hold onto two efficiency-reducing beliefs. First, in an effort to soften the review of its pricing initiatives, it may place equity considerations above efficiency considerations. Second, it may hesitate to cut the costs of producing its transmission service because it fears a return to rate-of-return regulation. Therefore, we introduced the criterion of payoff dominance into the selection process. This criterion causes the regulatory authorities to select the form of price-cap regulation that maximizes the expected price reductions in transmission services. We believe that this criterion will subdue some of the disruptive political forces that influence the marketplace for transmission services.

In the end, we proposed a three-component form for the price-cap regulation of the utility-owned transmission company. First, it shares its profits. Second, a maximal allowed rate of return "caps" its profits on an annual basis. Third, a program of flexible review prevents the transmission company and the regulatory authorities from incurring unnecessary economic costs. We recognize that this form of price-cap regulation provides the utility-owned transmission company with a significant amount of pricing flexibility. We realize that this transmission company cannot be allowed to use this pricing flexibility haphazardly or anticompetitively. We know that information asymmetries prevent the regulatory authorities from stopping anticompetitive behavior based on the utility's pricing flexibility. Therefore, we concluded that regulatory authorities have to hold back on the implementation of price-cap regulation for the utility-owned transmission company until they are convinced that this company has the incentive to set efficient prices for its services. We concluded that this incentive is most likely to exist after the utility's generation companies have cut their costs aggressively in an effort to become competitive in the wholesale power market.

To give the utility additional incentives to cut its generation costs, we used the standards of comparability and open access to model the nonprice regulation of the utility-owned transmission company. Under the comparability standard, a wholesale customer transports power to its distribution gateway on essentially the same basis as any other wholesale customer. If for some reason the transmission services cannot be identical for every wholesale customer, then this standard ensures that a competitive advantage does not accrue to the utility-owned distribution companies. The open-access standard ensures that new types of wholesale customers and nonutility generators, as well as existing types, can gain admittance to the utility's transmission network. We concluded that more nonutility generators and new types of wholesale customers represent a strong inducement for the utility to reduce its generation costs.

To strengthen the standards of service comparability and open access, we modeled the utility-owned transmission company as a fully separate subsidiary of a utility that also owns generation and distribution companies. We insisted that this company should have no interests in the sale of power to wholesale or retail customers, thereby restricting it to the supply of transmission-access services to all types of generation companies and transmission services to rural cooperatives, municipally-owned utilities, and utility-owned distribution companies. Essentially, this modeling decision implies that the conclusion that the additional private cost of a fully separate subsidiary, as compared to using nonstructural means to separate regulated and unregulated costs, is worth incurring to provide the maximum assurance that the wholesale power market is competitive.

The modeling decision to have the utility create a fully separate subsidiary for its transmission services means that transmission services are components of a larger system that begins with the transport of power from the generation site and ends with its use by retail customers. The larger system consists of generation service, transmission-access service, transmission service, distribution-access service, distribution service, and appliance-access service. Transmission service begins with the interface that separates the transmission-access service from the transmission service, and it ends with the interface that separates the transmission service from the distribution-access service. In between, there are high-voltage lines. Therefore, we concluded that efficient component pricing could be useful with respect to the pricing of transmission services.

Efficient component pricing is used most productively when the firm under consideration is a monopolist. Therefore, we modeled the utility-owned transmission company as an *administrative monopolist* that produces in the declining-cost region of its production technology. This model implies that the utility is not necessarily the most efficient producer of all combinations of transmission and transmission-access services. In addition, it implies that the transmission company would not be economically viable if it set its prices equal to the marginal costs of its services. Because transmission prices equal to the marginal costs of transmission services represent first-best prices when the transmission market is perfectly contestable, we concluded that second-best prices are the most economically efficient prices that the utility-owned transmission company can achieve in a perfectly contestable transmission market.

In this report, we examined two analytical methods that ensure the achievement of second-best prices for a perfectly contestable transmission market with inelastic market demand schedules. The first method is the inverse-elasticity rule. This rule is used when the market demand schedules are independent of each other. The second method is a full Ramsey analysis. Its rules are used when transmission services are substitutes and complements for each other. We found the inverse-elasticity rule to be inappropriate because the transmission company will produce transmission services that are substitutes for or complements to other transmission services. It is well-known that a full Ramsey analysis is not feasible because of data limitations. Therefore, even if the utility-owned transmission company and its regulators knew production costs with absolute certainty and these production costs were efficient, we concluded that second-best prices for transmission services are beyond the grasp of the utility-owned transmission company and its regulators because they cannot use either of these methods effectively.

We need to worry about anticompetitive transmission-service prices because second-best prices for these services are beyond anyone’s grasp for a variety of reasons. To focus our attention in this area, we concentrated on examining how the utility might use noncompensatory prices for its transmission services as the source for the cross-subsidization of its generation companies. Cross-subsidization occurs when the utility-owned transmission company sets above-cost prices for one or more of its transmission services and recovers more than its total cost of production. A particular transmission service is the source of a cross-subsidy when this price recovers more than the stand-alone cost of this service. However, the company's total cost of production and the service's stand-alone cost must be measured in terms of the competitive rate of return for transmission investments and efficiently-incurred production costs. Assuming that the appropriate stand-alone and total costs could be determined by the interested parties, we looked at three possibilities to examine the potential for the utility-owned transmission company to be the source of a cross-subsidy for the utility's generation companies. First, we considered a transmission company that does not incur any common costs to produce multiple transmission services. Second, we considered a company that incurs common costs to produce transmission services with market demand schedules that are independent of each other. Third, we considered a company that incurs common costs to produce transmission services that are substitutes for or complements to each other. We found that each type of transmission company could be the source of a cross-subsidy for the utility's generation companies. However, we also found that a set of prices that do not cross-subsidize the utility's generation companies is available to a transmission company and its regulators. Therefore, based on an assumption of perfect contestability, we concluded (as do many others) that regulatory authorities can prevent the cross-subsidization of the utility's generation companies by a utility-owned transmission company.

We found that it is not difficult for the regulatory authorities to take the initial step toward preventing noncompensatory pricing by the utility-owned transmission company when the market demand schedules for its services are inelastic. They simply have to ensure that the prices for these services are above their pertinent average incremental costs and below their pertinent stand-alone costs. We found that it is more difficult for the regulatory authorities to take the final preventive step. In particular, they have to ensure that the prices for the individual transmission services pass Faulhaber's cross-subsidization tests. To demonstrate how these two tasks are completed, we examined a set of transmission services with the characteristic that the common costs that the utility-owned transmission company incurs to produce various combinations of these services do not overlap. Relying heavily on the nonoverlap and inelasticity restrictions, we found that compensatory prices for this unique set of transmission services always are greater than or equal to the subsidy-free prices for these services. Therefore, we concluded that compensatory prices for this particular set of transmission services have "nice" characteristics.

We found it more difficult to find compensatory prices for a similar set of transmission services with elastic market demand schedules. It was necessary to know the rates of change with respect to revenue and cost that are induced by changes in the prices of the company's transmission services. We showed that these rates of change determine whether the utility-owned transmission company raises or lowers its prices to solve its problem of insufficient revenue. Price increases result in compensatory prices when revenue falls slower than cost. Conversely, price decreases secure compensatory prices when revenue rises faster than cost. These findings enabled us to reach the following conclusions. The compensatory price for a transmission service exceeds its average incremental cost when price increases are required to solve the insufficient revenue problem. The compensatory price lies below its average incremental cost when price decreases solve the revenue problem.

Next, we examined efficient component pricing with an eye toward fixing its position in a hierarchy of pricing approaches that also includes subsidy-free and compensatory pricing. We did not consider marginal cost and Ramsey pricing because we found them to be infeasible. First, we explored the relationship between efficient component pricing and average incremental costing for services with inelastic market demand schedules. We found that the definition of an efficient component price ensured that it could never be less than the pertinent average incremental cost. Therefore, we concluded that the efficient component pricing of transmission services will not be burdened with allegations that these prices are below-cost. Second, we looked at the relationship between efficient component pricing and subsidy-free pricing for transmission services with elastic market demand schedules. Once again, we concluded that efficient component pricing would not involve allegations of below-cost pricing.

We investigated the relationship between efficient component pricing and compensatory pricing. Not surprisingly and consistent with our previous results, we found that the range of compensatory prices for a transmission service is larger than the range of efficient component prices for the same service. However, this result depends critically on the validity of our argument that explains why the utility's overall profitability is not affected adversely by the sale of transmission services to rural cooperatives and municipally-owned utilities. Therefore, we concluded that compensatory pricing provides the regulatory authorities and the utility with more pricing flexibility than does efficient component pricing.

We finished the analysis by listing the conditions that are necessary to ensure that efficient component pricing is indeed efficient. The first condition is that the utility-owned transmission company earns the normal (competitive) rate of return on its investment and no more. The second condition is that it minimizes its variable service-specific fixed and common costs of production. These two conditions ensure that the transmission company earns only the minimum amount of revenue that is necessary to supply transmission services to wholesale customers. These conditions are met when a bypass company does not face any barriers to market entry or exit. But we found that there is a sunk cost exit barrier. For example, the carrying charges on borrowed funds do not disappear fully in the short term after the bypass company pulls the plug that connects its facilities to its customers. Therefore, we found that the utility-owned transmission company is not required by market forces to minimize its production costs and earn a competitive rate of return on its investments. Consequently, we concluded that efficient component pricing cannot occur in the pure sense of the concept.

With these thoughts in mind, we demonstrated that a blind reliance on the transmission company's actual costs and the rules of efficient component pricing runs the risk of inefficiently high prices for transmission services. During this demonstration, we explained why the transmission company's actual total cost of production is likely to be higher than its minimum total cost of production. We cited the cardinal rule of efficient component pricing, which is that the resulting set of prices should not recover more than the minimum total cost required to produce the given levels of transmission services. Therefore, we concluded that the best we could expect from the use of the rules of efficient component pricing and actual production costs is almost efficient component prices.

We believe that a price that approximates the efficient component price is a useful ratemaking tool. Using a method that does not include any lost profits from the sale of transmission services and premiums over reasonable profits and production costs to support assistance programs, we found that the resulting approximations of efficient component prices minimize the decline in the sum of producer and consumer surplus. Furthermore, we found that these prices cause the low-cost producers of transmission or bypass services to be the winners in the transmission market. We also found that retail price differences are created by the wholesalers' skill with respect to the purchase of power in the competitive market and their efficiency when it comes to distributing this power. Therefore, we concluded that our approximations of efficient component prices for transmission services have desirable qualities in terms of economic efficiency.

It is important that approximations of efficient component prices have "nice" qualities with respect to economic efficiency because wholesale customers have few to no options when it comes to the purchase of unbundled transmission services. With no place to go, they have to worry about lost sales in their retail markets because the prices for unbundled transmission services are too high. Furthermore, they have to worry about the willingness of the utility-owned transmission company to invest adequately in transmission facilities when the prices for its transmission services are too low. Therefore, we concluded that reasonable approximations of efficient component prices for transmission services are desired by the wholesale customers.

With a method in hand for obtaining reasonable approximations of efficient component prices, we looked at the behavior of these prices over time. We argued that they will rise over time because of the regulatory dynamics of the generation and retail electricity markets. Consequently, we examined what rising and above-cost transmission prices mean to the wholesale customers. We found that rural cooperatives and municipally-owned utilities are likely to be courted by bypass companies. We also found that the resulting credible threats of bypass cause the utility-owned transmission company to become more cost conscious. Finally, we found that the transmission company is likely to push its transmission service prices back down after it lowers its costs in response to rising competitive pressures. Therefore, we concluded that a round of rising and above-cost transmission service prices is a precursor to falling costs for the utility-owned transmission company.

We determined that the opportunistic bypass of the utility's transmission services is not a trivial matter. It causes some transmission assets to lie idle at a time when they should be producing revenue for the utility. Although the utility's transmission company avoids variable costs when its assets are not being used, it will be forced to defer the recovery of some of its fixed costs. If the deferral period is sufficiently lengthy, then this company may endure a noticeable revenue loss that adversely affects its profitability. Therefore, we examined ways to reduce the opportunistic bypass of the utility's transmission services. We concluded that opportunistic bypass can be minimized by using a combination of reasonable approximations of the efficient component prices of transmission services and keeping generation costs in the generation market.

The threat of bypass is not the only reason why it would be a mistake for regulatory authorities to be sanguine about rising and above-cost prices for transmission services. The utility has access to a mechanism that it can use to cross-subsidize its generation companies. Its transmission company simply has to set the prices for transmission services at levels that imply monopoly profits. This mechanism is feasible because the transmission company has market power that it can use against its wholesale customers. We found that the utility has the incentive to order its transmission company to use this market power when the utility knows that its generation companies are capable of reducing their costs to competitive levels. We also found that our method for reasonably approximating the efficient component prices of transmission services does not prevent the transmission company from earning monopoly profits. Therefore, we concluded that the regulatory authorities have to worry that rising and above-cost approximations of the efficient component prices for transmission services may represent the cross-subsidization of utility-owned generation companies.

After finding that the practical pricing of utility-supplied transmission services cannot eliminate the threat of cross-subsidization when the utility-owned generation companies are in financial trouble, we noted that regulatory authorities need to find ways to prevent the utility from acting out this anticompetitive behavior. We argued that rate-of-return regulation is the best tool for this purpose whenever it is obvious that the utility's generation companies have not yet exercised the variety of ways they possess to cut their costs in an effort to become competitive with nonutility generators. After generation costs have been cut aggressively, we concluded that rate-of-return regulation can give way to our proposal for the price-cap regulation of transmission services.