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OPTIONAL CALLING PLANS AND BYPASS EFFICIENCY

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1. Introduction

In the brave new world of telecommunications regulation, endusers have enjoyed increasing freedom to install and utilize bypass technologies that circumvent regulated utility facilities, such as central office switches. If utility prices were above marginal cost, such bypass could be economically inefficient. This issue emerged full force in the mid-1980s, when local companies contended that contemporaneous procedures for recovering nontraffic sensitive costs led to inefficiently high usage charges that posed the danger of uneconomic bypass. While the heat of the issue dissipated somewhat after the FCC increased the subscriber line charge, the concern can reemerge in the future should bypass costs fall considerably.

For three reasons, traditional cost-based regulation may be a seriously flawed means of addressing the issue of uneconomic bypass; alternative suppliers are not legally required to report their costs to regulators, reported costs may be seriously distorted, and forecasting the future of emerging bypass technologies and their associated costs is difficult, if not impossible. We now shall consider a more realistic strategy that involves optional calling plans with an imposed fairness constraint. Under the suggested strategy, the utility and its regulators would agree upon a fair two-part calling plan that any customer may choose for any switched access line; this tariff must be adjusted over time for inflation and anticipated productivity growth. Once the utility offers this fair tariff, it may design as many alternative calling plans as it wishes; a customer may "mix and match" available calling plans across existing switched access lines.

As will be shown, several benefits result. First, regulators could design the prices of the fair tariff specifically with the interests of small captive customers in mind. Second, such a mechanism gives the utility the correct incentive to determine—as best it can—all potentially relevant costs; it can instantaneously modify their prices should these cost estimates change. Third, regulated utilities would

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have more of an incentive to reduce costs than under traditional regulation with regulatory lag. Fourth, bypass will result if and only if it is economically efficient.

The article is organized as follows. Section 2 overviews the legal and technical aspects of the price cap and bypass issue. Section 3 introduces a nonuniform price schedule with a regulator-imposed constraint on one tariff. Section 4 complicates the schedule by introducing bypass technologies. Section 5 considers implementation, possible complications, and objections to the approach. Section 6 concludes the article.

2. Legal and Institutional Issues

The FCC has slated July 1, 1990, as the starting date for price-cap regulation of interstate local carrier prices. At that time, the commission must make some decision regarding its future method of switched access cost recovery; it is not clear whether these prices would be appropriately rolled into a composite basket. Indeed, many long-distance carriers, consumer groups, and large users recommended to the FCC that long-distance usage charges be separately capped and adjusted; the motivation is clear—long-distance users could face substantial rate shock if access charges were permitted to increase significantly. Although the commission has not done so yet, there is no reason why direct end-user billing cannot be implemented in the future; indeed, the FCC approved of the idea in principle in 1986 (*Petitions for Waiver of Various Sections of Part 69 of the Commission's Rules*, FCC 86-145, April 28, 1986).

Local companies have frequently claimed that uneconomic bypass of switched access facilities could result under fully distributed cost recovery methods that would allocate interstate revenue requirements without regard to marginal cost; these claims surfaced in the mid-1980's when the FCC attempted to increase its subscriber line charge to $6 per access line. A General Accounting Office study (1986) estimated that 16 to 29% of large volume telephone customers bypassed their local exchange and that 19 to 53% more were considering additional bypass activity; a loss of 1% of these customers could produce a 14 to 48% decline in long-distance revenues. Studies by Bell Communications Research (1984) and Jackson and Rohlfs (1985) concurred that uneconomic bypass constituted a present danger to local company revenues. However, not all commenters agreed; state commissions have varied widely in their response (Cross, 1986). In order to determine who is right, we would need to estimate the cost of all relevant technologies, an exercise that is next to impossible. Additionally, these relative costs can change over time; what is true regarding bypass costs at present may be irrelevant in five years.

Any solution to the NTS cost recovery problem cannot ignore the concerns of small users who are captive to the local exchange. Reps. Dingell and Markey issued a joint statement in May, 1988:

"We continue to be concerned that ordinary telephone customers will be worse off under this [price-cap] plan than they would be under an intelligent administration of the current system. Indeed, some studies show prices would be higher now had a price-cap regime been in place over the past eleven years." (*New York Times*, May 13, 1988, D-2)

Several state commissions and consumer groups have voiced similar concerns that emphasized the benefits of traditional regulation. This consumerist pressure induced the FCC to revise its earlier suggested price-cap procedure of 1987 from a single-index approach modeled after Great Britain to a multi-index approach that separately capped residential prices.

3. A Mathematical Model

In the following sections, we shall allow a regulated monopoly to design a menu of optional calling plans subject to the constraint that one tariff is regulator-approved. Let A_o and P_o represent the respective fixed and usage charges for this calling plan.

Faulhaber and Panzar (1977) establish—for deterministic demand—that a decreasing n-block nonuniform price schedule can be reexpressed as a menu of alternative two-part tariffs with connection and usage charges that are inversely related to one another. (For stochastic demand, these two are similar but not quite identical; under a nonuniform price schedule, the customer would have the additional benefit of being shifted to his best two-part tariff if his actual and expected demands were to differ from one another.) Therefore, designing a constrained menu is nearly equivalent to designing a nonuniform price schedule subject to the constraint that no user is worse off than it would be under A_o, P_o. Accordingly, we shall develop in this section a constrained nonuniform price schedule for a profit-maximizing monopoly with captive *single-line* customers; in later sections, we consider multiline customers and customer bypass.

3.1 Notation and Assumptions

Following previous authors, we shall assume that single-line customers vary in their usage intensities and that customer demand curves do not cross one another (Faulhaber and Panzar, 1977; Spence, 1977; Mirman and Sibley, 1980; and Goldman, Leland, and Sibley, 1984). Consequently, we may index each customer with an ordinal parameter $i \in [0, 1]$; i is continuously distributed with density $f(i)$ and distribution $F(i)$. Let a (e) designate the infimum (supremum) of intensities i of customers who select utility service; in this section, we shall assume that both a and e are fixed at 0 and 1.

Let A represent the connection charge for a utility customer; $R(q)$ represents the necessary revenue payment for a usage level q. At any usage level q, net welfare $W_i(q)$ of consumer i is the difference between his willingness-to-pay $U(i, q)$ and revenue payments $A + R(q)$; i.e.,

$$W_i(q) = U(i, q) - R(q) - A. \tag{3.1a}$$

Under a binding fair tariff A_o, P_o, net consumer welfare is subscripted with an

o:

$$W_{io}(q) = U(i, q) - A_o - P_o \,. \tag{3.1b}$$

Under the assumed fair tariff constraint, no customer can be made worse off under $R(q)$ than he would be under A_o, P_o; i.e., $W_i(q_i) \geq W_{io}(q_{io})$. If equality holds, we shall term the customer *fairness-indifferent*. (If customer demand curves are independent of one another, imposing this constraint is equivalent to imposing the requirement that the utility's schedule A, $R(q)$ weakly Pareto-dominates the tariff A_o, P_o; see Willig, 1978.)

Einhorn (1987) demonstrates that if users a and e are utility customers and demand curves do not cross, a profit- or constrained welfare-maximizing utility would attract all customers between. We let Z and c represent the respective marginal hookup cost and the running cost of usage. For each customer i, utility profits are the difference between revenues and costs; i.e., $A + R(q_i) - Z - cq_i$. Total customer demand cannot exceed in-place capacity Q, which has a per unit cost of k. Total company profits are then:

$$\pi = \int_a^e [A + R(q_i) - Z - cq_i] \, dF(i) - kQ \,. \tag{3.2}$$

We shall always assume that the resulting price schedule single-crosses (Goldman, Leland, and Sibley, 1984) each customer's demand curve from below at her optimal usage level q_i. As a result, second-order conditions for a maximum will always be met and customer usage q_i will monotonically increase with user intensity i.

3.2 First-Order Maximizing Conditions

The utility then constructs a revenue schedule $R(q)$ to maximize its profits (3.2) subject to two constraints. First, total customer demand cannot exceed capacity Q; i.e., $\int_a^e q_i \, dF(i) \leq Q$. Second, no customer is worse off than he would be under the tariff A_o, P_o; i.e., $W_i \geq W_{io}$. The utility's objective function can then be expressed as follows:

$$L = \int_a^e [A + R(q_i) - Z - cq_i] \, dF(i) - kQ$$

$$+ \, v \, [Q - \int_a^e q_i \, dF(i)] + \int_a^e h_i [W_i(q_i) - W_{io}(q_{io})] \, di \,. \tag{3.3}$$

An extension of two earlier derivations (Spence, 1978; Einhorn, 1987) shows:

$$P_i = P(q_i) = c + v + [1 - h_i] \, t(i) \left(\frac{\partial^2 U(i,q)}{\partial i \partial q} \right) \tag{3.4a}$$

where:

$$t(i) = \frac{F(e) - F(i)}{f(i)} \geq 0$$

$$W_i(q_i) \geq W_{io}(q_{io});\ h_i \geq 0;\ h_i[W_i(q_i) - W_{io}(q_{io})] = 0 \tag{3.4b}$$

$$v - k \leq 0\,;\ Q \geq 0\,;\ [v - k]Q = 0\,. \tag{3.4c}$$

From (3.4c), if $Q > 0$, $v = k$. Therefore, $c + v = c + k$; the latter is the long-run marginal cost, which we shall represent with a C. We rewrite (3.4a):

$$p_i = P(q_i) = C + [1 - h_i]\, t(i) \left[\frac{\partial^2 U(i,q)}{\partial i \partial q}\right] \tag{3.4a$'$}$$

L_1 in figure 1 illustrates the shape of an optimal nonuniform price schedule when the fairness-indifference constraint is not binding (i.e., $h_i = 0$ in (3.4a$'$). Because $\partial^2 U(i,q)/\partial i \partial q > 0$, the usage price P(q) must exceed or equal the short-run marginal cost C; since $t(e) = 0$, $P(q)$ must eventually fall to C. The schedule need not be monotonically decreasing but I shall assume that it is.

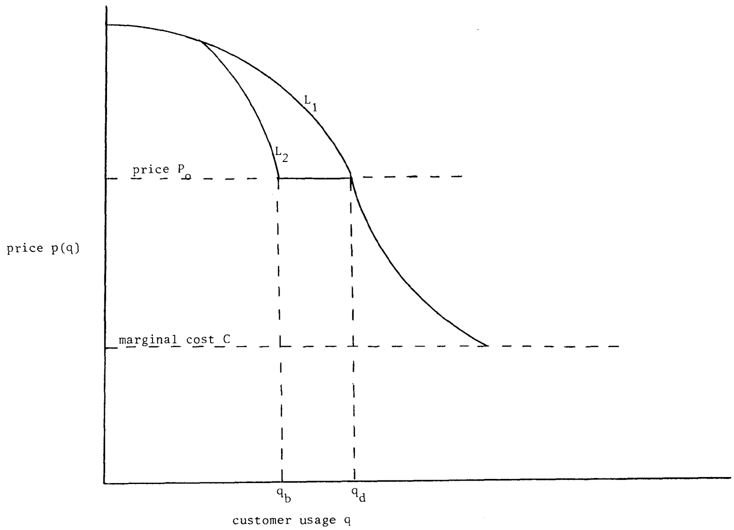

FIGURE 1 Profit-maximizing Price Schedule with and without Regulator Constraints: e=1

3.3 Fairness Indifference

We now consider the implications of adding the fair tariff constraint (3.4b) to an optimal nonuniform price schedule. Rather than formally deriving the results, we can compare our problem to an earlier paper (Einhorn, 1987) and intuitively justify our conclusions. The more technical reader is referred to the earlier study for proofs.

In Einhorn (1987), the regulated utility attempted to maximize profit-constrained welfare. The maximand was $[1-g]W+g\pi$, where π = utility profits and W = consumer surplus. If $g=1$, the maximand is simply π. Therefore, by setting $g=1$, the general optimizing conditions of Einhorn can be used, *mutatis mutandis*, for the present problem-at-hand.

Einhorn attempts to maximize $[1-g]W+g\pi$ subject to the constraint that no utility customer would be worse off than he would be with a bypass system with respective access and usage prices of Z^* and C^*. Under these circumstances, the resulting price schedule $P(q)$ reaches a plateau along which the usage price $P(q)=C^*$; once it reaches the plateau, the price-schedule can never rise above the plateau price for higher levels of customer usage. But for differences in the levels of A_o and Z^* or P_o and C^*, there is evidently a basic similarity between designing a price schedule under bypass and the fairness constraint.

Based on a similar derivation in Einhorn (1987, 556-7), L_2 in figure 1 illustrates the effects of adding the fairness constraint at A_o, P_o. Unlike the unconstrained price schedule L_1, the constrained schedule L_2 reaches a plateau $(q_b, q_d]$ along which $P(q)=P_o$. Einhorn shows that inframarginal charges prior to point q_b under the utility schedule must be identical to those under the fair tariff; i.e., $A+R(q_b)=A_o+P_oq_b$. All users along the plateau are indifferent between $A, R(q)$ and A_o, P_o; all users before and after the plateau strongly prefer $A, R(q)$ to A_o, P_o.

3.4 A Second Fair Tariff

By adding a second fair tariff, we set the stage for the analysis of Section 4 that will introduce customer bypass.

If regulators were to impose a second fairness constraint, no customer could be worse off than he would be under either of the two schedules. We represent these two tariffs by A_o, P_o and A^o, P^o; assume that $A_o<A^o$ and $P_o>P^o$. Because consumer demand curves do not cross one another, only one customer could be indifferent between A_o, P_o and A^o, P^o. Therefore, *at most* one customer can be simultaneously indifferent between the two fair tariffs and the regulated utility's price schedule $P(q)$. Let $[q_b, q_d]$ ($[q_b', q_d']$) represent the segment over which customers $[b, d]$ ($[b', d']$) would be indifferent between the tariff A_o, P_o (A^o, P^o) and the utility's nonuniform price schedule $A, P(q)$; since at most one customer can be indifferent between A_o, P_o and A^o, P^o, $d \le b'$ is necessary.

A double-constrained price schedule $P(q)$ therefore would have two plateaus; usage price $P(q)$ would be constant over each. figures 2a and 2b illustrate two possibilities for $P^o>C$. If $b'>d$ (as in figure 2a), an interval of unconstrained customers (d, b') would lie between the two plateaus. If $d=b'$ (Figure 2b), the schedule would jump immediately from one plateau to the second by moving down the demand curve of customer $d=b'$.

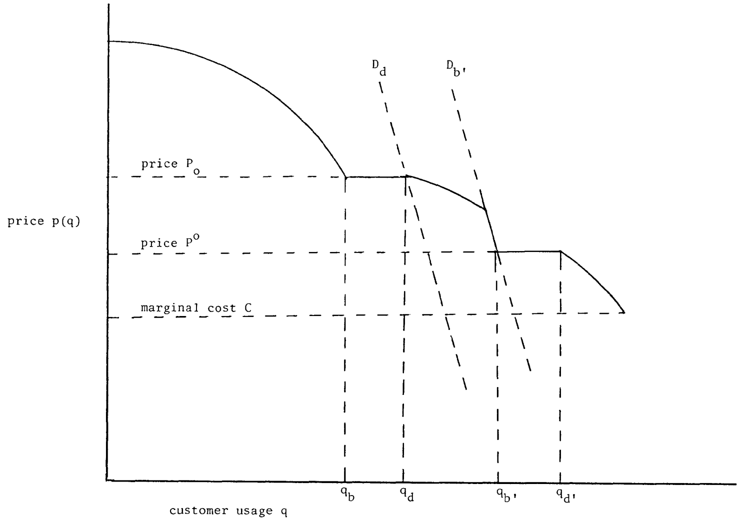

FIGURE 2a Profit-maximizing Schedule with Two Regulator Constraints: Case 1

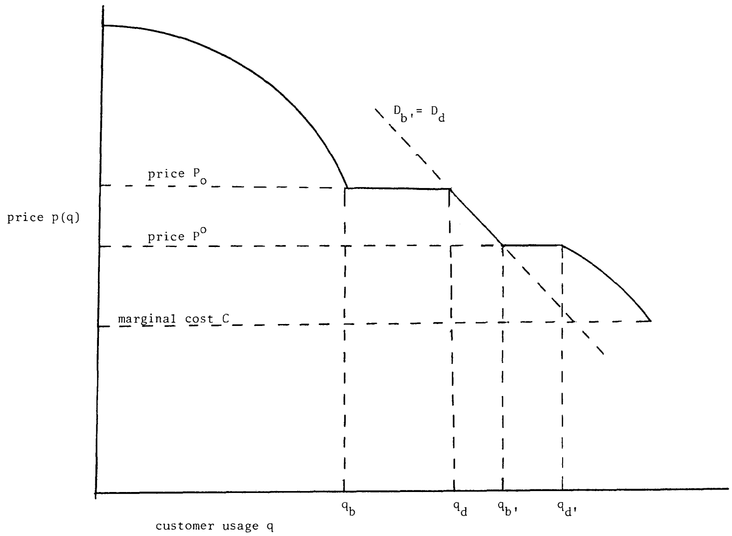

FIGURE 2b Profit-maximizing Schedule with Two Regulator Constraints: Case 2

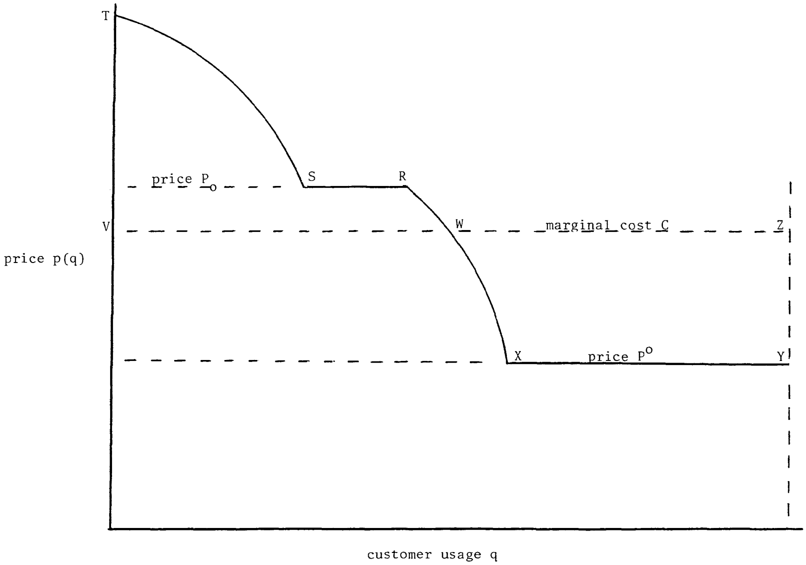

FIGURE 3 Profit-maximizing Price Schedule with Regulator Constraint:

As long as A^o is high enough, there is no reason why $P^o > C$ must hold. Figure 3 is analogous with $P^o < C < P_o$. Under these circumstances, usage by the largest customers $i > b'$ would be subsidized; i.e., usage would be priced below marginal cost C.

4. Fair Tariffs and Bypass

We now shall modify the model of Section 3 to allow for a variable endpoint; i.e., the maximum endpoint e may vary due to large customer bypass. Bypassers pay an up-front connection fee and a per unit usage price. Assuming that bypass vendors constitute a competitive market, their connection and usage prices will be driven to associated costs, represented by Z^* and C^*.

Assuming that the fair tariff is designed to protect smaller users, $P_o > C^*$ and $A_o < Z^*$ is probable; i.e., small users will pay higher usage charges but lower connection charges compared to bypassers. We therefore may conceive of the bypass alternative as being a second fairness-indifference constraint with $A^o = Z^*, P^o = C^*$. Accordingly, figures 2a and 2b represent cases where $C^* > C$; figure 3 represents the case where $C^* < C$.

4.1 High Endpoint e

We turn to the choice of the high endpoint e. We differentiate (3.3) with respect to e.

$$A + R(q_e) - Z - Cq_e \geq 0\,;\; e \leq 1;\; [e-1]\,[A + R(q_e) - Z - Cq_e] = 0\,. \quad (4.1)$$

If $C^* > C$, figures 2a and 2b would be relevant. Evidently from both figures, usage price $P(q)$ weakly exceeds marginal cost C for each unit of usage; therefore, each utility customer would generate positive profits for the company. As Einhorn (1987, 556-7) shows, each customer before $q_b{'}$ and after $q_d{'}$ strongly prefers utility service to bypass; each customer $i \in [b', d']$ is indifferent between utility and bypass service. In (4.1), $e = 1$; since $P(q) > C, A + R(q_e) > Z + Cq_e$.

If $C^* < C$, figure 3 would be relevant. Since $C^* < C$, the utility evidently would subsidize some usage by the largest customers beyond point W; however, each such customer would generate a cushion of profits RSTVW from its early usage before this point. In selecting its preferred maximum intensity e, a profit-maximizing utility would want to keep customers until the point where the entire profit cushion RSTVW is paid back; i.e., RSTVW = WXYZ. At this point, customer revenues and costs would be equal.

Einhorn shows that all customers along XY are indifferent between utility service and bypass; in order to retain a customer $i > e$, $P(q) = C^* < C$ would be necessary. Because customer revenues and costs are equal to one another at point e, all customers $i > e$ would be nonprofitable and would not be retained. Consequently, a profit-maximizing utility may select an interior endpoint $e < 1$ where (see (4.1)) $A + R(q_e) = Z + Cq_e$.

Because $P(q) < C^*$, all customers $i < e$ are evidently profitable and are retained. Therefore,

$$\text{For } i < (=, >)\; e,\; A + R(q_i) > (=, <)\; Z + Cq_i\,. \quad (4.2)$$

Customer e, who is the transition customer between the two technologies, must be indifferent between utility service and bypass if intensity i is continously distributed; therefore, $U(q_e) - A - R(q_e) = U(q_e) - Z^* - C^*q_e$ must hold. Using (4.2),

$$U(q_e) - Z - Cq_e = U(q_e) - Z^* - C^*q_e\,. \quad (4.3a)$$

The LHS and RHS expressions respectively represent the net social gains from utility and bypass usage by customer e. From an efficiency perspective, it is then a matter of economic indifference whether user e joins the regulated utility or the bypass technology. Since $P(q) = C^*$, $Z + C_q = Z^* + C^*q_e$. Because $C^* < C$, $Z + Cq_e > Z^* + C^*q_e$ for all $i > e$. For users $i < e$ who join the regulated utility, $U(q_i) - A - R(q_i) > U(q_{i*}) - Z^* - C^*q_{i*}$; using (4.2),

$$\text{For } i < e,\; U(q_i) - Z - Cq_i > U(q_{i*}) - Z^* - C^*q_{i*}\,. \quad (4.3b)$$

Evidently, each customer makes a socially efficient choice regarding his service selection.

5. Implementation and Practical Considerations

We now further consider various aspects of the problem and some advantages of optional calling plans.

5.1 Multiline Customers

To this moment, we have assumed that the customer makes one decision regarding utility service—whether or not to bypass the regulated utility. However, in telecommunications, large users install several access circuits, which may be a mixture of bypass and switched access.

The above results can be extended to a multiline model provided the per unit price on each switched access line is a declining function of line usage (Einhorn, 1987). This constraint ensures that each caller would attempt to concentrate phone calls over as few lines as possible and to route calls over available lines with a nonvarying order of preference. Therefore, intensity of line usage is now unambiguously ranked as had been intensity of customer demand before. The parameter i in Sections 3 and 4 now represents the intensity of line-usage instead of customer demand; previous theoretical results would hold *mutatis mutandis* if a revenue schedule $R(q)$ were designed for usage on each access line.

5.2 The Tariff Menu

There is a practical manner in which regulated utilities may implement this price schedule. As noted, a nonuniform price schedule and a menu of optional calling plans are the same when demand is deterministic and nearly the same when demand is stochastic. Therefore, we might implement the incentive mechanism as follows. Regulators may prescribe access and usage prices A_o, P_o for one two-part tariff that the utility must offer; the utility may then design a menu of alternative two-part tariffs that any subscriber may select for any line.

Regulators must determine starting prices for A_o, P_o; such starting prices would involve establishing some notions of fairness, an area of theoretical economic research (Kolm, 1973; Varian, 1976; Pazner and Schmeidler, 1978) now lacking application to public utility regulation. Schmeidler (1969), Loehman and Whinston (1971), and Billera and Heath (1982), among many, have suggested an axiomatic cost-allocation procedure that produces prices conforming to a set of properties that are purportedly fair; however, economic efficiency is not a consideration in axiomatic cost allocation. Baumol (1986) advocated a fairness constraint that no utility service be permitted to recover more revenue than its associated stand-alone cost or less than its incremental cost; the FCC disqualified this as the basis for fair prices, arguing that rates based on stand-alone cost could be excessively high and would necessarily involve detailed "paper engineering" of hypothetical utility systems. In the face of theoretical and practical difficulties that have clouded the fair pricing issue, the FCC adopted present fully distributed cost procedures as its fair ratemaking strategy, arguing that such procedures have presumably been designed with the intent of being fair.

To this juncture, we have assumed that regulators specify a fair calling plan individually for each service that the regulated utility offers. Alternatively, regulators may stipulate that a price index of designated core services not exceed a predetermined index limit, to be adjusted over time for general inflation and expected technical change. For each offered utility service, one tariff must be incorporated in the aggregate price index.

Two problems may result. First, as the case of Britain's short-haul rates illustrates (see introduction), certain prices may climb considerably with an index ceiling; this outcome may be politically difficult. Second, indexing invites room for strategizing when demand is changing (see Brennan's chapter in this book). Since long-distance access represents a politically important component of telecommunications service, a single ceiling approach may then be preferable.

5.3 Cost Efficiency

To circumvent the inefficient pass-through of the utility's actual costs, Littlechild (1983) and Egan and Taylor (1987) suggest that a general inflation index (such as the consumer price index or the GNP deflator) be used to adjust the price ceiling; this ensures that real prices to consumers do not increase. However, general price indexes might not accurately track company costs reasonably; since 1935, the consumer price index has risen eightfold while its telecommunications component has risen twofold (Lande and Wynns, 1987). For this reason, the National Telecommunications Information Administration (1987) advocates the use of a telephone input price index, which presumably mimics the effect of a competitive market and can more accurately represent a reasonable rate of cost inflation. However, constructing a specific cost inflation index may involve considerably more data-gathering by utilities and oversight by regulators; the FCC used a GNP deflator in its 1989 price-cap decision.

The utility cannot then expect to pass along to its ratepayers its actual cost increases; it therefore has an incentive to reduce its costs at every moment. Furthermore, if it is able to improve productivity beyond expectations, it can keep the resulting profits. This contrasts with traditional cost-based regulation, where prices that are based upon actual cost afford no incentive (but for regulatory lag) for utilities to minimize costs.

5.4 The Resale Problem

A reseller of telecommunications services might take advantage of the utility's menu of optional calling plans by installing a group of switched access lines and charging arbitrage prices to attract small usage customers. By providing this opportunity for arbitrage, the local company could lose its own customers (White, 1982). Assuming that resale is legal, why would a local company choose to implement a declining block schedule?

In response, note that resellers always have the option of concentrating subscriber calls over bypass circuits instead. If the local company does not implement an optional calling plan menu, resale could result nonetheless over bypass circuits.

By designing the menu, the local company would capture all of the reseller's outgoing circuits that it efficiently could. The main issue is not whether optional calling plan menus lose customers to resellers; rather, the issue is whether the resellers will use bypass or local company switched access circuits to route customer calls.

5.5 Predation

Since some usage prices may be below marginal cost, some may consider this predatory. Indeed, many commentators to the FCC suggested that the commission establish price floors and/or minimum duration requirements in order to reduce the danger of predatory pricing. Regarding this problem, Section 4 demonstrated that $A + R(q_i) > Z + Cq_i$ for $i < e$; a profit-maximizing utility therefore enjoys a positive net contribution from each customer. Therefore, each customer passes the net revenue test and no cross-subsidization occurs (see Sibley, Heyman, and Taylor's chapter in this book). Consequently, if the profit-maximizing utility prices $P(q)$ and selects endpoint e as we have assumed, predation is not a well-founded charge.

However, a strategizing utility could attempt nonetheless to retain some customers i above its profit-maximizing value of e as part of a short-run predatory strategy; as shown in Section 4, $A + R(q_i) < Z + Cq_i$ must hold for these intensities i. Although predatory pricing cannot be profitable if employed indefinitely, a short-run application might destroy competition and make way for a long-run monopoly.

However, if predatory pricing is a danger, it is, realistically speaking, just as profound a danger under any market—regulated or not—with marginal costs that are difficult to measure. The danger of predation emerges in unregulated markets where large competitors with difficult-to-measure costs can temporarily "take a hit" to eliminate unwanted competitors. Under the traditional regulation schemes that price caps would replace, companies must report to regulators their marginal costs, which can be distorted in order to lower usage prices and stifle competition; whether regulators can confirm that these reports are fallacious is arguable. In a different context, Noll and Owen (1987) write:

> The FCC could not determine AT&T's costs, nor could it settle on a sensible cost-based method for pricing. One set of AT&T prices, the Telpak tariff, went through nearly two decades of hearings without a final determination of its lawfulness. It was apparent that even with a fully informed regulatory policy and the best will possible, the FCC could not cope successfully within available administrative procedures with AT&T's control of the information necessary to regulate prices effectively.

Finally, the issue may be more appropriately settled in antitrust litigation than in regulatory hearings.

The problem of predatory pricing does not then hinge upon whether optional calling plans are implemented or not. The danger evidently arises whenever any firm, regulated or not, has marginal costs that are exceptionally difficult to determine.

6. Conclusion

We can conclude the article by summarizing the benefits of optional calling plans. But for the fact that regulators design one calling plan for each utility service, utilities may price freely in order to maximize profits. Unless it engages in predatory pricing, the utility will profitably attract only those large customers whom it can efficiently serve; the rest will bypass. Furthermore, it has incentives to reduce costs and to estimate demand and cost parameters as accurately as possible. Finally, regulators benefit from the reduced work load.

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