Extended Area Service:
A Cost-Benefit Approach with Illustrations

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March 17, 1983

Preliminary Version
to solicit comments

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Abstract

1. Costs and benefits need to be examined. Policy makers cannot make decisions based solely upon costs. Benefits to society from EAS policy implementation diminish the closer toll prices are to their marginal cost and the larger the difference between the fixed costs of toll equipment and local EAS equipment.

2. Distribution of benefits from EAS implementation is skewed towards those in relatively rural areas while the costs are placed upon both urban and rural dwellers. In addition, business users tend to have a larger calling area than residential telephone users and would thus benefit more from EAS than residential customers.

3. Communities of interest definitions are nebulous at best, but according to the data, communities of interest if defined solely on how the relative percentage of calls by mileage band may not be very large at all. For example, for the five study exchanges residential customers placed between 61 and 85 percent of their calls within 5 miles while business customers placed 43-80 percent of their calls within 5 miles.

4. Alternatives to EAS such as local measured service are more desirable based upon notions of efficiency. Those that use a particular service are thus required to pay for it.

Introduction

The implementation of Extended Area Service (EAS) on a county-wide basis in the State of Florida as a result of the investigation by the Public Service Commission in Docket 810415-TP may result in an unneeded and perhaps undesirable reallocation of plant and resources. EAS, the expansion of the customer's "free" calling, involves the removal of relatively inexpensive toll equipment to be replaced with more expensive local plant. This change may or may not be in the best interest of the consumer, but there are proponents pressing for EAS implementation based on the grounds that everyone should have toll free access to their county government. Others complain that they cannot call their children's school or their friend living 15 miles away without incurring a toll charge.

EAS, it is said, should be extended to cover all the relevant "communities of interest" throughout the state. The commission in Docket 810415-TP is asking for a cost study for EAS implementation on a county-wide basis, presuming that some sort of community of interest exists. EAS was initially instituted during the 1950's and early 1960's when the first of the new electronic switching systems were installed; many areas received EAS because it became more expensive to offer toll service which had to have operator assistance for that area. Now, with direct distance dialing (DDD), some of these early cost advantages and economies of scale are no longer present for EAS.

In some cases EAS may be warrented, but the cost investigation of Docket 810415-TP is soley a measurement of costs. When the final study is completed, how will the results be evaluated? Will the commission decide the cost to be high, low, or about right? What criteria will the commission use to evaluate the study? Clearly, benefits to individuals, firms, and society must be weighed against costs in making the decision. The purpose of this working paper is to provide some basic economic perspectives on the issues involved in EAS implementation, to stress the need for an analysis of both costs <u>and</u> benefits, and to discuss an alternative pricing mechanism that has desirable efficiency consequences.

Introduction to Consumer Surplus

When economists talk of benefits, they are generally referring to benefits accruing to individuals.[1/] One way of approximating these benefits is to sum up each individual's utility or satisfaction. Since utility is a difficult notion to measure, a proxy is used to examine the underlying changes of utility due to a change in prices. This concept, consumer surplus, is defined to be the amount the consumer values of the the product above the price paid for a particular quantity of the product.

Figure 1 shows that at an initial price of \$3 (P_1), the quantity demanded is 2 (q_1), which yields a particular level of consumer surplus. At

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1/ If the consumer of a good is the only one affected by the product's consumption, we can equate private benefits with social benefits. If gains (or losses) are imposed on others (as when my flower garden is enjoyed by a neighbor or my barbeque smoke ruins a neighbor's laundry), then such impacts also need to be taken into account from the standpoint of full economic efficiency.

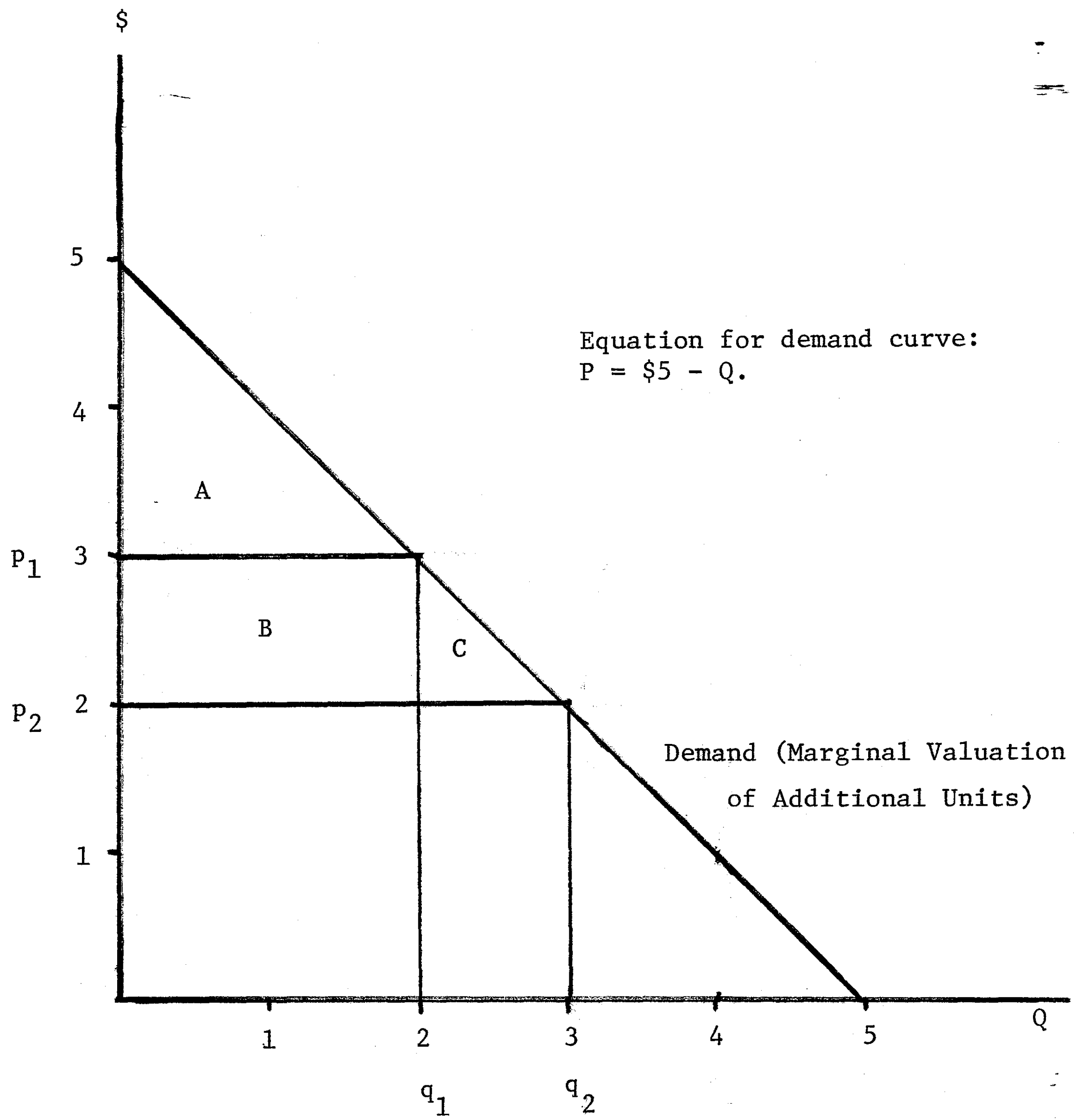

Figure 1
Demand and Consumer Surplus

the price of P_1, the consumer pays a total of \$6 for 2 units, but he values the consumption by more than his expenditures: that is, by the area A (\$2 = ½ • base • height). In addition to \$6, the consumer would be willing to pay A to consume the amount q_1. Now, if the price of this good falls to P_2, the quantity demanded increases to q_2. The question here is: What happens to the benefits to the consumer, or how does consumer surplus change? As the price falls the consumer surplus increases by area B (reduction in outlays for units the customer continues to consume) and area C (valuation of the additional consumption which is greater than the price paid for the third unit). To find a total change in benefits to society, all that would be needed would be a sum of the changes for consumer surpluses for all individuals (Willig, 1976). In our simple example, the new consumer surplus is A + B + C (or \$4.50).

Economists generally deal with a market demand curve and not an individual's demand curve. By definition, this market curve is the horizontal summation of individual demands. This summation in turn gives the consumer (or societal) surplus for this market at a given price. For example, assume two individuals exist who demand a particular item. Each places different valuations on particular consumption levels, so they have different demand curves. By summing horizontally the two individuals' demand curves, the resulting market demand is obtained, as shown in Figure 2.

At any price the market demand curve shows the sum of the individuals' quantities demanded at that price. When the price is \$4, person A consumes 1 unit while person B consumes 2 units which gives a market demand of 3 units when price is \$4. Similarly, the market quantity demanded is 7 when price is \$2. What is the gain from a price reduction from \$4 to \$2? Under a reasonable set of assumptions, the shaded areas (changes in consumer surplus) for consumers A (X + Y = $3) and B (R + S = $7) are equivalent to the shaded area under the market demand curve (change in society's surplus, $10). Thus, the consumer benefit from a price reduction would be calculated as $11.

This estimate of the impact of a price change is quite different from the change in customer expenditures. At a price of $4, A and B spent $4 and $8, respectively, on the good, while at a price of $2, expenditures were $4 and $10, respectively. Total expenditures increased by $2 (from $12 to $14), yet the perceived benefit increased by $10. The economists' measure of changes in benefits induced by price changes is conceptually clear, yet many engineering studies focus on changes in costs rather than taking changes in benefits into account.

Note that if the production cost were actually $2 per unit, the price reduction would increase customer's satisfaction by $10, while reducing producer profits by $6 (X + R). The net social gain from the price reduction would be $4 (Y + S in Figure 2). The higher price of $4 had resulted in underproduction of the product from the standpoint of economic efficiency. Since only three units were produced, output that would have been valued at greater than the opportunity cost of production was not available. Thus, customers gained more than producers lost when output increased to 7 and price dropped to $2. In addition, total cost of production rose from $6 to $14 as market output expanded from 3 to 7.

If regulators and utility managers used traditional measures to evaluate the price reduction, they might argue that since costs have gone up $8 (while revenues only increased by $2), the price reduction is unjustified. Yet the firm could still obtain those profits of $6 (X + R) from

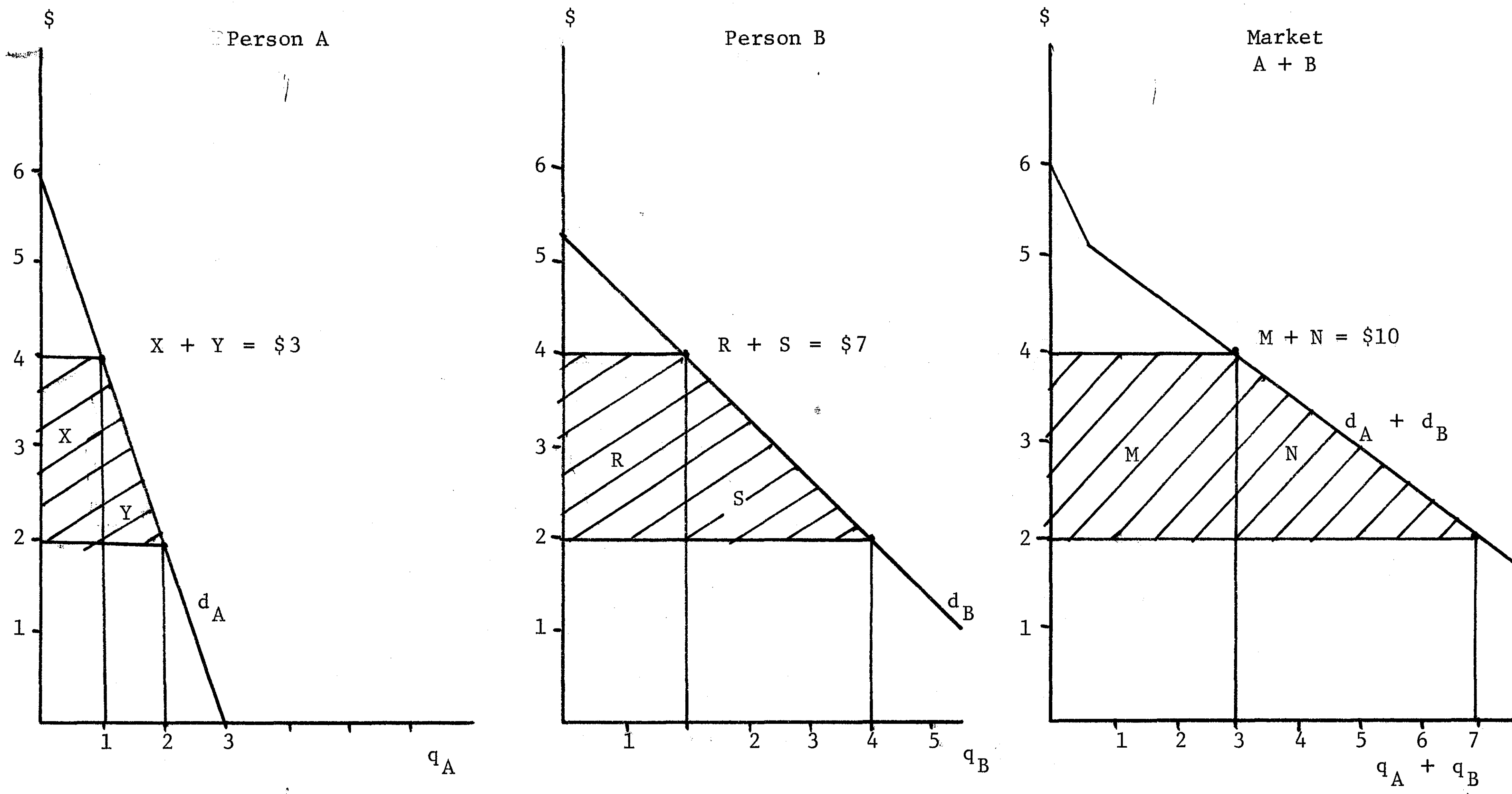

Figure 2
Market Demand and Consumer Surplus

customers A and B through monthly fees, while lowering the per unit price to \$2. The two customers would, on net, be better off by \$5 (\$11 in surplus gain due to the price reduction, less \$6 from the increase in fees) and the producer no worse off than before.

Thus, in addition to consumer surpluses, there exists a corresponding concept for producers. Producers may receive revenue above the minimum amount they are willing to accept for goods (or services) supplied. This notion is represented in Figure 3, where opportunity costs are assumed to rise with increased output.

Starting at P_1, producer surplus is area A, the amount being paid for that product above the minimal amount the firm is willing to accept for the product. If the price goes to P_2, producer's surplus increases by the area B. In the earlier example (Figure 2), producer surplus would have risen from zero to R + X when price increased from \$2 to \$4. The corresponding consumer net gain to a price increase in Figure 3 would be area B. To see this, note that price was P_1 and output was q_1, total revenue was P_1q_1, or areas A + E. If an increase in demand results in price increasing to P_2 and output expansion to q_2, total revenue rises to P_2q_2, while costs increase by F. The net gain to the producer is B.[2/]

This discussion of economic concepts serves as the basis for evaluating regulatory pricing decisions, since decision-makers are presumably trying to maximize the social benefits associated with utility investments. Thus, regulation can simulate a competitive outcome, where the

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2/ Algebraically, the gain could be expressed as $(P_2 - P_1)q_1 + \frac{1}{2}(q_2 - q_1) \cdot (P_2 - P_1)$, where the first term refers to the additional revenues received for the first q_1 units sold, and the second term corresponds to the revenues (above the opportunity costs) for the additional units produced if price increases.

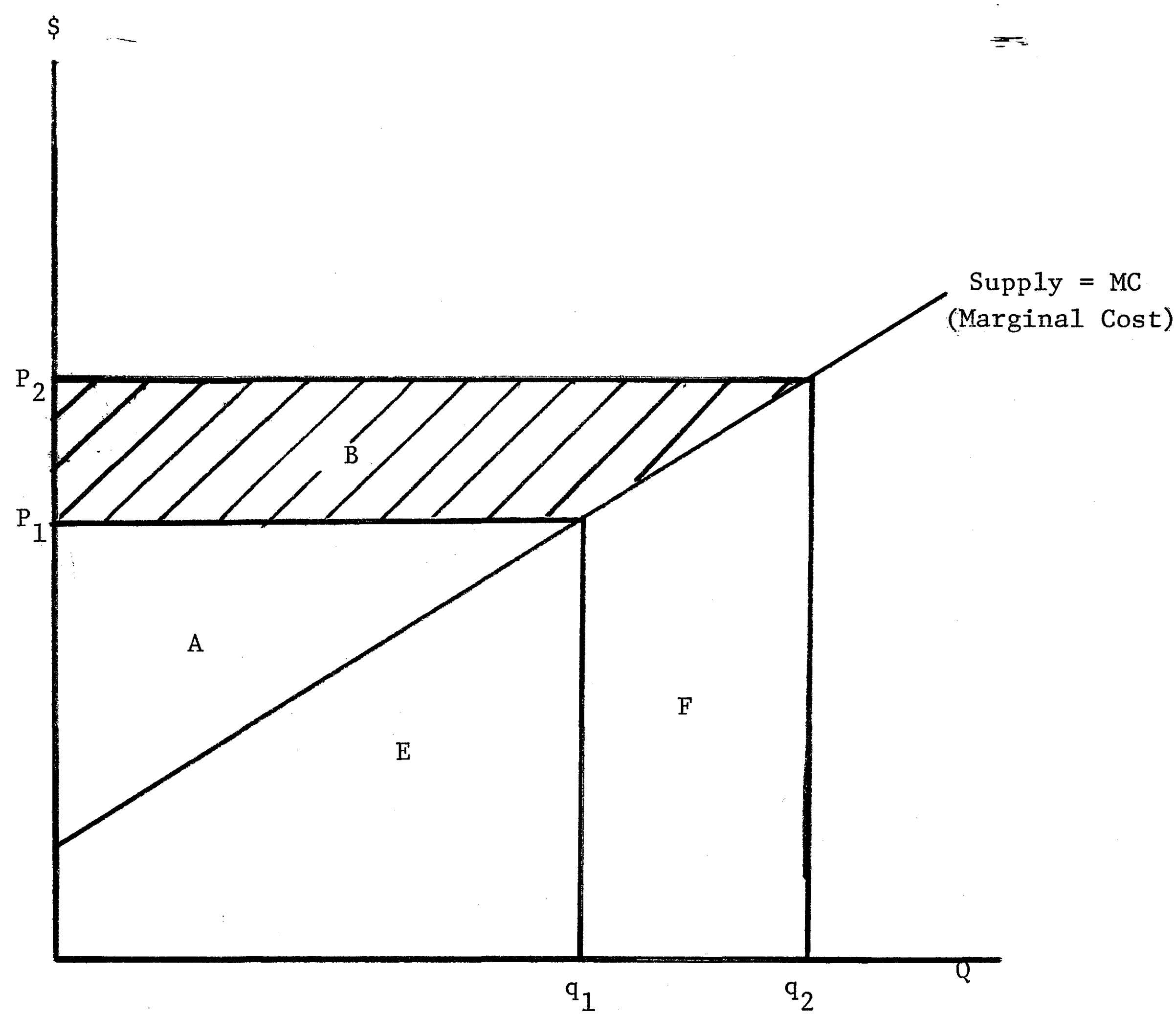

Figure 3
Opportunity Cost and Producer's Surplus

latter is viewed as promoting an efficient allocation of resources. Under competition, the sum of producer plus consumer surplus is maximized, indicating that we are getting optimal levels of output--neither too much nor too little of a good or service. The question that arises under potential EAS offerings is whether the level of benefits from change outweigh the costs of implementing EAS.

An Application to Directory Assistance

The framework presented in the previous section can be used to analyze pricing policies, such as EAS. First we present an application to Directory Assistance (DA) pricing to illustrate how the concepts of efficiency and equity can be applied to a telecommunications issue. Past studies indicate that 20% of the calling population make about 80% of the directory assistance calls. Most people make use of the service less than twice per month. Since DA had become a relatively expensive service due to its labor intensity, the telephone companies became alarmed by costs stemming from increased usage. When DA was free, companies had to allocate the costs to all customers via higher monthly rates. A high proportion of the cost, therefore, was borne by those who did not utilize the service and who subsidized those who overused DA. Higher monthly basic exchange rates resulted from the overproduction of DA. Many states (including Florida) adopted a system whereby after a certain number of DA calls were placed, the user is charged for additional service. Those that use DA heavily pay for their use, which in turn helps to keep basic exhcange rates lower than would otherwise be the case.

Ironically, consumer advocates were slow to join the movement to place costs upon those customers responsible for incurring them. They viewed the telephone company as able to afford special services for customers, as they gave little thought to who actually had to bear the costs of providing those services. The concept of having price track costs is widely accepted in competitive markets, but under administratively-determined prices, special interest groups (such as high DA users and those who view any price change as unfair) can keep outmoded policies in effect long after they should have been modified.

Figure 4 contains a relatively simple graph illustrating the DA situation. Let the D_1 demand curve represent the demand for DA for 40 customers who are normal users of the service and D_2 represent the demand curve for DA for the 20% of the population who are heavy users. Now we see who benefits from a zero price. The 40 people who make up D_1 gain some benefits from the zero price. They make 200 "free" DA calls per month (5 per customer). The 10 people who comprise D_2 are making 800 DA calls per month (or 80 per customer). If the actual cost incurred by the company is $0.25 per call, people are getting a price signal that does not reflect costs. With a total of 1,000 DA calls made per month, the total cost would be $250. In this simple example, each of the 50 customers must pay an additional $5 per month (in the monthly basic charge) for the privilege of making "free" DA calls.

If <u>everyone</u> were charged $0.25 per DA call, total calls would be cut in half, from 1,000 to 500 per month. The 40 low-use customers would make 100 DA calls, while the 10 customers (comprising D_2) would make 500 DA calls. Calls that had an expected value of less than $0.25 would not be made, implying that people would begin to keep such information available or that they would take the time to "let their fingers do the walking." All the customers (together) would lose consumers surplus equal to $187.50 (area under the market demand--$D_1 + D_2$--from p = 0 to p = $0.25).

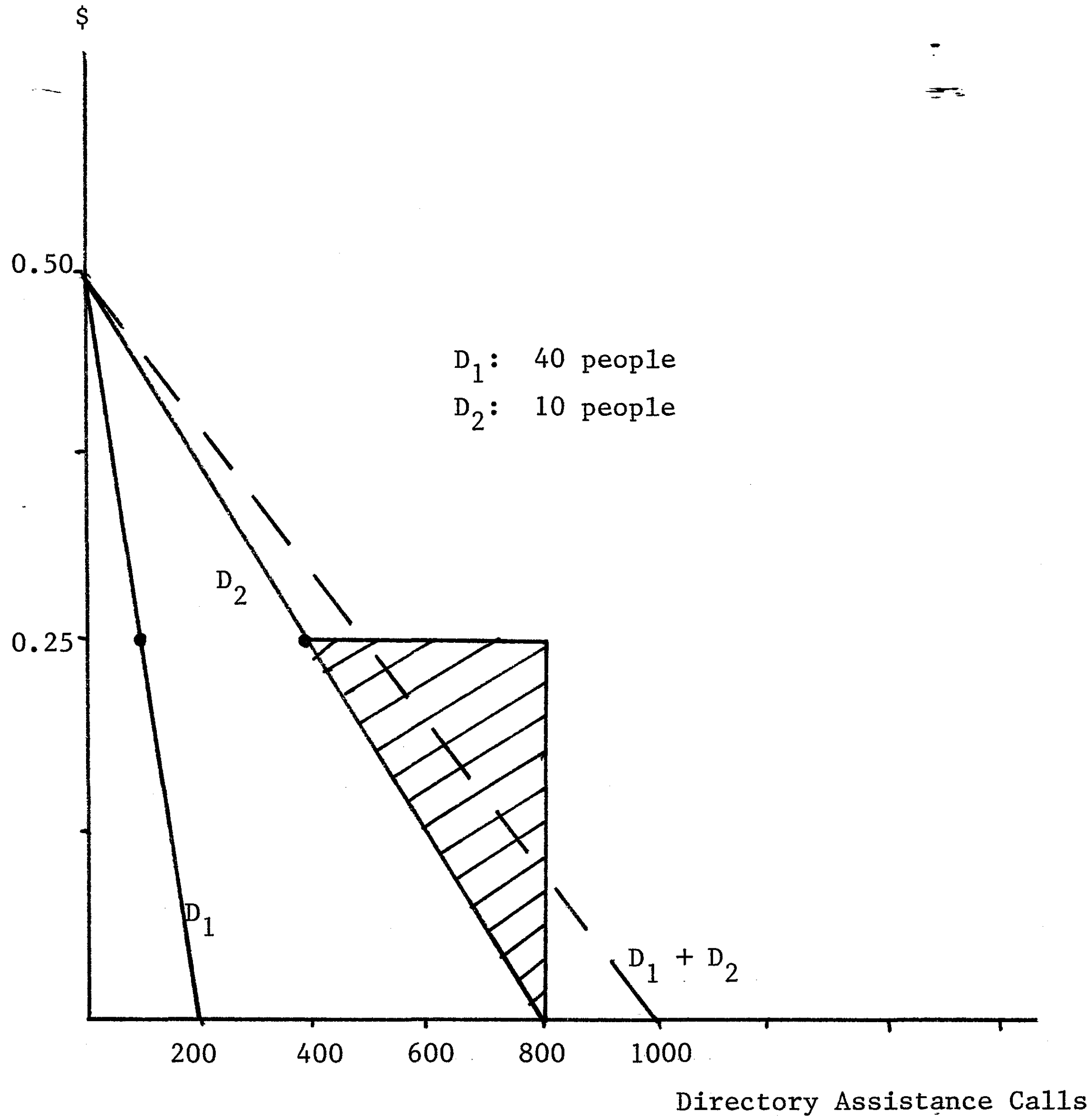

Figure 4
Directory Assistance for Two Groups of Customers

However, those 50 customers would have their monthly basic charges drop \$250 (as the DA subsidy was eliminated), for a net improvement of \$62.50. As a <u>group</u>, telephone customers are better off without this "free" service. Of course, the big gainers are the 40 low users, whose monthly basic bills drop \$5.00 and who each spend an average of \$0.62 for 2½ DA calls per month (40 customers make 100 calls).[3/]

The distribution of benefits is concentrated with the 40 D_1 demanders. The losers are the 10 customers comprising D_2, who cut their DA calls from 800 to 400 with the price increase. Their basic bills drop \$5.00 per customer, but the bill for DA service is \$10 per customer (\$0.25 X 40). Furthermore, each loses an additional \$5.00 in consumer surplus that had been obtained from the 40 calls/customer that are no longer made. The equity of charging for DA assistance depends on whether regulators place more weight on the losses experienced by 10 customers or the gains experienced by 40. On net, customers are better off as efficient price signals are given.

Of course, there are many alternative price structures to the two cases considered here. Five "free" DA calls could be allowed, with additional calls costing \$0.25/call. Such a structure might be more politically acceptable since it has the superficial appearance of giving all customers some "free" DA calls for obtaining the phone numbers of new businesses and of people who have just moved into town. Also, people may not realize that they do not use the service very often, so they may object to paying for a service that used to be "free."

[3/] To be precise, each is better off by \$5, less \$0.62 for DA calls that used to be free, less \$0.31 for the valuation placed on DA calls no longer made. The <u>net</u> gain is \$4.07 per customer.

To diffuse such complaints, the structure may be adopted as a compromise.

This "five free calls" structure would not be completely efficient, since some calls valued at less than \$0.25 would be made by the 40 low use customers. Nevertheless, most of the economic-efficiency gains would be obtained as the 10 heavy users cut back their use of DA. The net economic efficiency gain is shown as the shaded area in Figure 4. It represents the avoided costs that are greater than the lost benefits to the D_2 customers.

EAS and Community of Interest

Now that the economic approach to price signals, costs, and benefits has been described and applied to one telephone example, we turn to a current policy issue, EAS. The first conceptual point that needs to be addressed is whether a community of interest can be identified.

At present no substantive definition of the term community exists. A community can range in meaning to include a neighborhood, or a town, or a religious group, or a group of users of a particular service. Before analyzing the merits of EAS, a definition of community and its resulting interests or economic, cultural, and sociological ties must be established.

We begin with a typology of communal units showing the classifications (Table 1). Although Table 1 is a subjective breakdown of relative relationships, a knowledge of "communal unit" differences is important. EAS has the potential of crossing all types of communal boundaries, with the link between a communal unit and its outlying regions the point of focus here.

Outlying regions can be described through particular variables and relationships. The demography and ecology of the hinterlands are best understood by examining the size and shape of the area. The hinterlands have relationships with the corresponding community through the exchange of goods and services and from population movements into the community from the hinterlands for shopping, visiting, and utilization of community facilities. Economic and cultural ties must be present for community and community of interest to be viable constructs. In addition, the hinterland can be described in terms of influence to TV and newspapers and "commonality" in terms of values, opinions, attitudes, and knowledge (Poplin, 1980: 32).

Given this description of community, almost any relationship involving commerce or family ties could be termed a community of interest. The resulting conclusion then is that the whole state is a community of interest in a sense. More likely, the state has several regional communities of interest (i.e., East coast, West coast, North Central), with subcommunities of interest in each of these regions (i.e., Tampa-St. Pete, Dade County-Palm Beach County).

One of the "consumer" reasons given for implementing EAS is that a call to one's government is presently a toll call. By expanding the exchange to the limits of the county it would be possible to reach the county government toll free. Following the same reasoning, however, a similar argument can be formulated for statewide EAS so that citizens of the state of Florida can have toll-free access to their state government. The hypothesis would be hard to test, but it is possible that people within counties have a higher need for contact with those in state government than with county government.

Table I

Communal Units

	Small town	City	Metro area
Demographic characteristics			
Population Size	small (under 10,000?)	intermediate (10-50,000?)	large (50,000 + ?)
Population Density	low	intermediate	high
Community-Outlying Region Relations			
Outlying region population	small	variable	large
Community's influence on outlying region	limited	variable	extensive
Number of community-outlying region ties	few	variable	many
Sociocultural Characteristics			
Population Heterogeneity	low	intermediate	high
Availability of organizations and services	limited	intermediate	extensive
Division of labor	low	variable	high

Source: Adapted from Edgar W. Butler, Urban Sociology: A Systematic Approach, (New York: Harper and Row, 1976) p. 266 cited in Dennis E. Poplin, Communities, (New York: 1980, p. 30).

One might ask why, in the interest of economic, social, and distributional efficiency, everyone should be required to pay for having the cost of particular groups for interacting with a "community of interest." Some businesses or consumers could tend to have a large calling area while some others (probably a majority) do not. Those people desiring to call beyond the present limits of the exchange are presumably charged a higher price because the demand for such service does not justify the use of additional EAS equipment. The benefits to the individual firm and consumer from extended exchange boundaries may not be great enough to conclude that EAS is justified in most cases. (See the Appendix for a more elaborate analytical framework.)

The telephone company, when deciding on whether to institute EAS, searches for a "community of interest." This is done by finding a given level of toll calling along a particular route, conducting a route study, and applying a stimulation factor to incorporate the effects of a lower call price on demand for calls over that particular route.[4/] Unfortunately, that methodology explicitly ignores transportation patterns, social patterns, school districts, county lines, as well as the distribution of benefits. The underlying community of interest is not really identified (any it may not even exist), but rather the stimulation factor is just assumed and applied. Even larger problems creep into the definition of what constitutes costs and their relative assignment to the firm and to society. The commission, through past policy, has

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[4/] The calculation of the appropriate stimulation factor (which can be likened to an elasticity) warrants more attention than has been given it to date.

implemented a fully distributed cost (FDC) pricing approach and in doing so opened itself to a host of costing problems.[5/]

Another Look at Community of Interest

An examination of calling patterns reveals that a sample of Southern Bell customers has a relatively small actual calling area, where a person actually places a call. This geographical range contrasts to the potential calling area which is defined to be the area the customer is allowed to call toll free. Table 2 shows 5 exchanges and the cumulative distribution of calls by mileage for residence and business customers. All exchanges have at least 70% of their calls within 10 miles, and two had at least 90% of the calls within 10 miles. For business customers the distribution was wider, but all had at least 62% of the local calls being within 10 miles and three offices had at least 80% of the calls within 10 miles. Thus, the vast majority of both business and residential messages are within 10 miles, pointing out the discrepancy between previous opinions concerning communities of interest and calling patterns. Another statistic, local minutes of use, LMU, follows local messages as a percentage of total messages very closely, also giving credence to the hypothesis of relatively small communities of interest.

5/ For example, FDC pricing bears no relationship to incremental or marginal costs usually since it is based upon some notion of revenue or output shares. When a cost methodology is used, joint costs are allocated in proportion to the other costs then can be directly attributed to the various services--again marginal costs are not used. Another problem with FDC is that it may be actually anti-competitive since the supplier of a service is prevented from offering that service at a lower tariff than the FDC price, even if the proposed tariff exceeds marginal costs. FDC, in fact, depends on the output mix and thus on a previous tariff structure: The costing problems are compounded due to circularity. (Braeutigam, 1980)

There is another way of examining the problem, but it is subject to the problem of exchange size. Exchanges are difficult to define since similar sized exchanges may not have the same equipment and may not have similar population characteristics. For the record, however, Table 3 shows the residence messages as a percentage of total local message to the same exchange, same central office, different central offices, and to EAS exchanges. In four out of the six offices, at least 72% of the calls were placed in the same exchange. The other two had approximately 42% of calls placed to an EAS exchange. The two offices, Jupiter and Orange Park, may have a "community of interest" with other areas since they both have relatively low residence and business cumulative frequencies in Table 3.

Figure 5 shows the average percentage distribution of calls for all five offices by distance, reaffirming the notion that communities of interest may not be as large as previously thought. From the figure, it can be seen that the business calling distribution is slightly flatter, which makes intuitive sense since commercial ties are more spread throughout the calling area, in contrast to personal ties which tend to be in neighborhoods.[6/]

One of the main reasons for the implementation of EAS is the contention by some telephone customers that a community of interest exists between their exchange and another. As mentioned in the main section of this paper, community of interest is extremely difficult to define. Perhaps, a critical number of calls could be used to determine whether

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6/ The "waves" between miles 4 and 13 tend to reflect geographical conditions of the study offices and would probably disappear with data from more exchanges.

Table 2

Office	Cumulative % of Residence Calls Within			Cumulative % of Business Calls Within		
	1	5	10 (miles)	1	5	10 (miles)
Pembroke Pines	38.3	66.1	90.0	18.4	54.3	80.7
Jupiter	63.66	63.66	70.93	53.51	53.51	62.26
Delray Main	72.6	85.2	95.1	61.9	79.8	94.4
Orange Park	61.6	61.6	82.1	43.5	43.5	67.4
Dade Metro	27.7	67.6	80.9	14.7	64.3	85.9

Table 3

Office	Residence messages as a % of total to			
	Same exchange	Same Co	Different Co	EAS Exchange
Pembroke Pines	72.90	36.70	36.20	27.10
Jupiter*	59.08	59.08	—	41.92
Delray Main	73.78	72.61	1.17	26.46
Orange Park	61.56	61.56	—	42.58
Dade Metro	95.32	27.67	67.64	4.68

*Local minutes of use as a % of total

Source: Data provided to Public Utility Research Center by Southern Bell. Study took place June - November 1977.

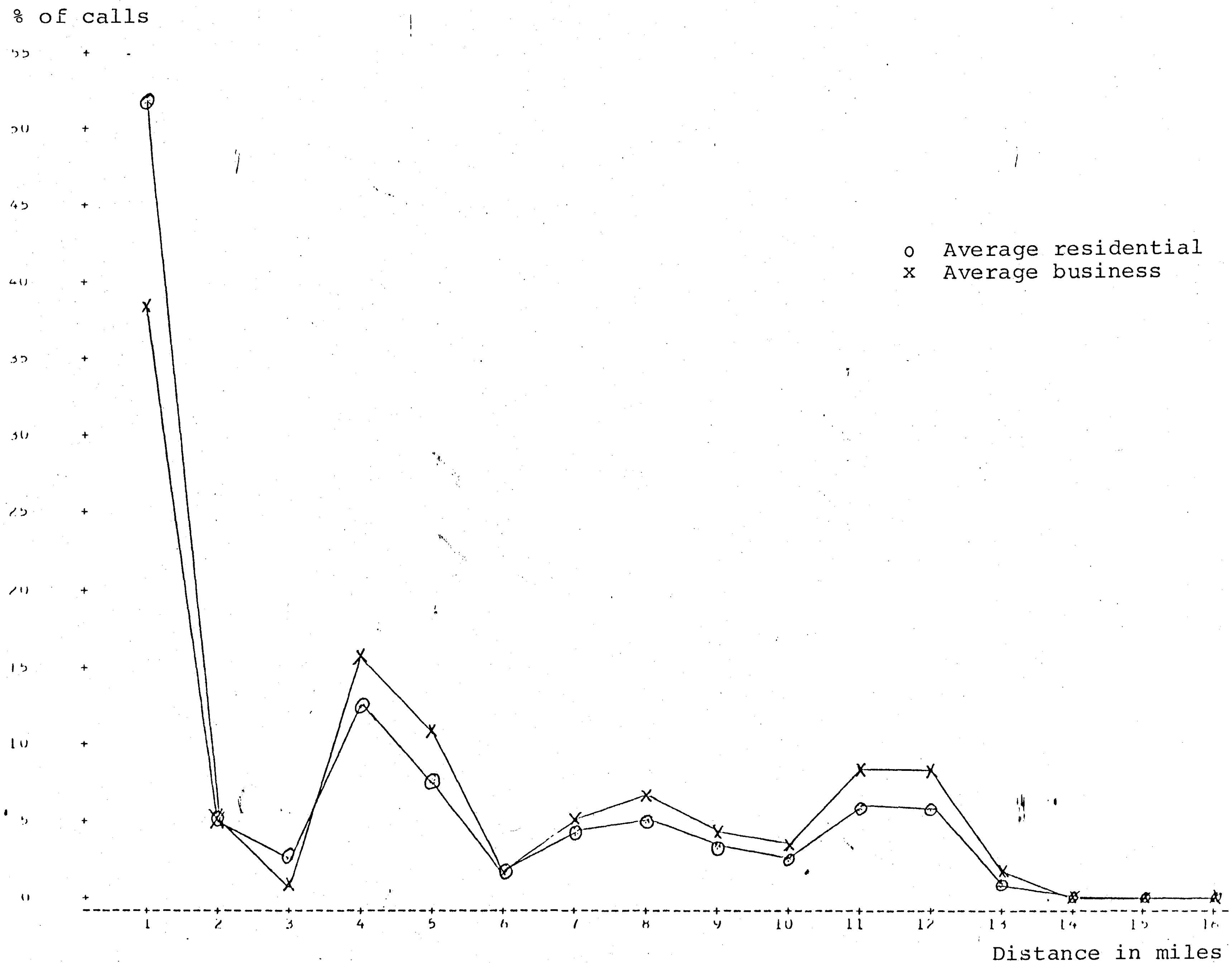

Figure 5
Distribution of Telephone Calls by Distance
(1977, Sample of Five Exchanges)

community of interest exists, but that is left to others to decide. Figure 5, the average percentage distribution of calls by mile, shows that a large percentage of calls occur over a short distance, indicating that the "critical" level of calling may be relatively small for county-wide EAS to be justified on the basis of this concept.

A simple regression analysis was employed to assess the strength of the community of interest argument. Four models, two for each class of service, were estimated in model 1, $\hat{R}$ is the estimated percentage of residential calls and D is the distance in miles. In the second model, B is the estimate of the percentage of business phone calls placed in each mileage band. For models 1 and 2, all four of the t statistics are high (indicating statistically significant values for coefficients). However, the explanatory power, as reflected in the R^2, is weak. Models 3 and 4 are an attempt to better describe the relationship between the percentage of calls and distance. Employing a double log model, the following form was used: $\%\ \text{calls} = D^{-\beta}$. As can be seen from Table 4, the t statistics are significant and the corrected R^2's are much higher.

Business customers have a lower intercept and a flatter slope due to their commercial nature and residential customers have a higher percentage of calls in the immediate vicinity due to the structure of residential needs, neighborhoods, and location of friends. What is surprising about these two simple models is the fact that they are only two variable models, but have relatively high explanatory power when geographical considerations or commuting patterns of the areas being studied are not included.

These models tend to support the idea that the community of interest argument may not be as strong as was previously thought based on the

Table 4

Estimates of Regression Coefficients for % of Calls by Distance

Model		R^2
1:	$\hat{R} = 21.37 - 1.67D$	.20
	t = (5.52) (-3.7)	
2:	$\hat{B} = 17.46 - 1.17D$	.14
	(5.11) (-2.9)	
3:	$\ln\hat{R} = 3.704 - 1.015 \ln D$	.60*
	(11.18) (-5.91)	
4:	$\ln\hat{B} = 3.34 - 0.71 \ln D$	.40*
	(9.8) (-4.0)	

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*R^2's are corrected so that they can be compared to non log models by the following formula.

$$R^2 = 1 - \frac{\Sigma e^2}{\Sigma y^2} = 1 - \frac{(\mathrm{Var}[\mathrm{Error}] + \overline{\mathrm{Error}}^2)}{\mathrm{Var}[\mathrm{Dependent\ Variable}]}$$

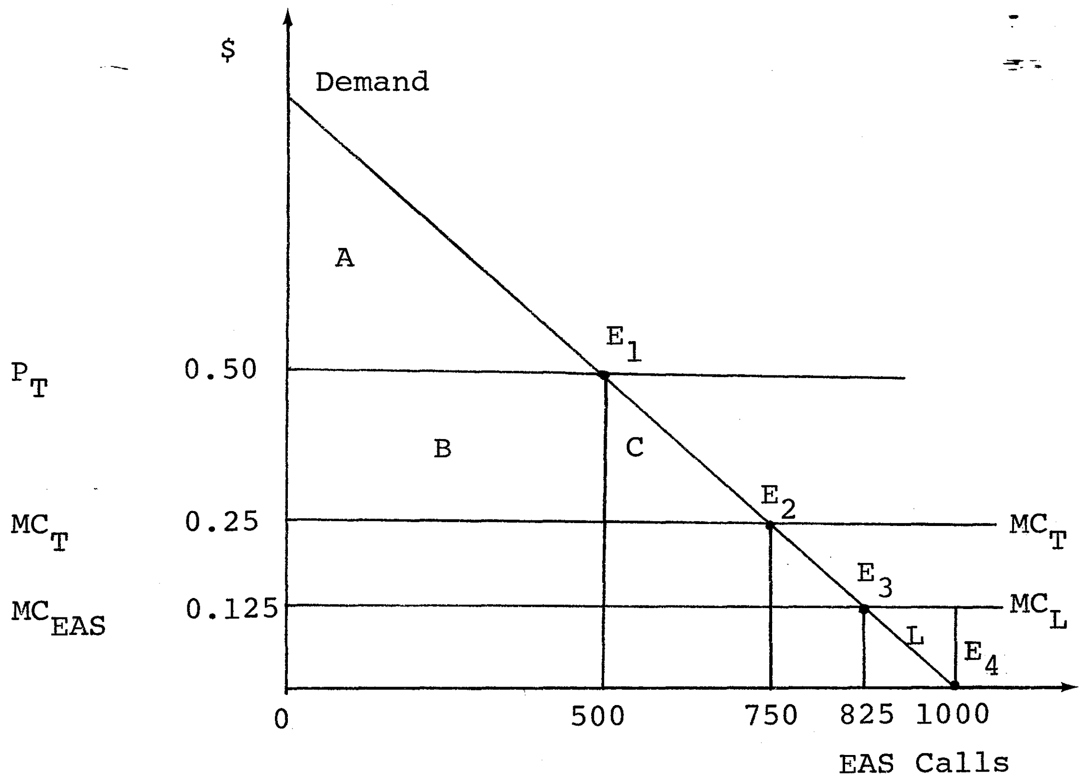
calling patterns of these five offices. These results should be tempered by the fact that the only calls measured were outgoing calls. For a true community of interest study one would have to have data on both incoming and outgoing calls. What these data show is that those living in relatively "urban" areas do not tend to call more than 5-10 miles. Businesses do have a more spread-out calling area and would benefit more than residential customers from EAS implementation.

Graphical Application of EAS Model

Following Dansby's (1980) approach, a graphical presentation of the cost-benefit framework is used to show when EAS should be implemented for a particular area. To use this analysis some basic assumptions are needed. First, assume there is a linear demand for calls in a particular area as shown in Figure 6. Also assume the price (P_T) for such calls within this area to be \$0.50. Finally, assume the marginal cost (MC_T) or the additional cost per each increment of phone calls to be \$0.25 which is less than the current price for the call within this area.

Given this situation where P_T is greater than MC_T a certain amount of welfare to society is foregone since the price is non-optimal. Society is faced with a deadweight loss in the form of underconsumption of the area C, in that a lower price of \$0.25 would hurt the firm by area B, but consumers would benefit by areas B + C (an increase in consumer surplus). Thus as P_T moves towards MC_T an economic gain of \$375 occurs (area C = ½ · base · height = \$375). Since measurement costs are already included in MC_T, this result would be welfare optimal.

Figure 6
EAS Demand and Costs



The phone company, however, is being asked to provide EAS for a particular area but charge a price of zero for each additional call. For the purposes of exposition some additional assumptions concerning the nature of costs are needed. First, the annualized revenue requirement for EAS equipment is greater than that of toll equipment. This implies that the EAS equipment's annualized costs cover economic depreciation, taxes, and a fair rate of return on investment. The marginal cost (opportunity cost) is approximated by the additional operating expenses for blocks of additional calls (MC_{EAS}); average cost would be higher, and include annualized equipment cost.

Before the introduction of EAS, the marginal cost of calling was \$0.25 (MC_T). With the introduction of EAS, the price of this call falls to zero, but the marginal cost is still positive. At P_T (with the corresponding MC_T) revenues to the firm were \$250 (i.e., \$0.50 X 500 calls) and after EAS implementation revenues from calls will be zero, but 1000 calls will be demanded. The problem here is to find the benefits and the costs and decide whether the adoption of EAS is in the best interest of society. A cost-benefit comparison must be made between equilibrium positions E_1 and E_4. E_2 and E_3, the equilibrium positions when price = MC_T and price = MC_L respectively, are not among the relevant policy alternatives being considered and will not be discussed below even though marginal cost pricing is economically efficient.

A problem exists, however, due to the fact that utility shareholders expect a return on their investment, and the assumption that the EAS equipment is more costly (higher annualized revenue requirement) than the toll equipment. This situation would force the firm to regain revenue by raising the fixed monthly flat fee to cover the increase in revenue requirements. Examining the welfare differential between E_1 and E_4 , benefits exist in the form of a change in consumer surplus of $375 per thousand calls and a savings to the firm in the form of lower marginal costs of $101.5 per thousand calls. Costs are incurred in the form of lost revenue of $250 and a deadweight loss (L) due to overconsumption of $10.96. Thus total benefits are $476.5 and total costs are $260.9.

Two problems exist, however, with this analysis. The first is that the additional annualized revenue requirement to cover the costs of EAS equipment are not included. For the sake of this illustration, if it is assumed that the difference between the EAS and toll annualized revenue is greater than $216 per 1000 calls (the difference between costs and benefits), total costs would be greater than total benefits. The result, a larger calling area due to EAS implementation, but a higher monthly charge (to cover the differences in annualized revenue requirements) which may not increase net consumer and producer benefits.

As a result two observations can be made. The first is that the closer the price of a toll call is to its corresponding marginal cost, the smaller will be the welfare gain from adopting EAS. The second is, the larger the difference between annualized revenue requirements for toll and EAS equipment, the smaller will be the welfare gain. Thus, the worst possible time to implement EAS would be when the price of a call is close to its marginal cost and the difference in revenue requirements is substantial enough to remove any positive change in consumer surplus.

The second problem with the above analysis is that <u>total</u> costs and <u>total</u> benefits are being compared. Dansby (1980) and Mitchell (1979) state that as rule of thumb, the benefits must outweigh the costs by a two-to-one ratio. The reasoning behind this rule concerns the important and necessary distinction between total costs and total benefits and marginal costs and marginal benefits. A firm, for example, does not maximize its profits by setting total revenue equal to total costs, but by equating costs and revenues on the margin. This gives the greatest profit since additional output would generate less revenue than the costs incurred. A similar relationship holds true in cost-benefit analysis. Society does not want total benefits driven to total costs, but to set marginal benefits equal to marginal costs.

Figure 7a shows total cost to be rising at a constant rate as output increases while total benefits increase at a decreasing rate and then decrease once satiation occurs. The reasoning behind the assumption concerning the benefit curve is that if a person is currently making ten toll calls per month, the gain to making 5 additional calls (the benefit) is less than the perceived benefit from the first 5 calls. Total cost of calls when toll equipment is in place is given by the line segment $\overline{F_T TC_T}$ and when local equipment for EAS is employed total cost is the line segment $\overline{F_L TC_L}$. Each has a different fixed cost ($F_L > F_T$), which again represents an annualized outlay to cover the revenue requirements associated with the equipment, and a different marginal cost ($MC_T > MC_L$) which is defined to be the slope of the respective line segment. With these assumptions in mind, it is possible to show that the net benefits (benefits - costs) are greatest when toll pricing is used, (i.e., $B_T - C_T > B_L - C_L$). At B_T, the slope of the total cost curve is equal to the slope of the total benefit curve and thus welfare is maximized. At B_L, the total benefit curve reaches a maximum and total cost is still increasing.

Figure 7a

Total Costs and Benefits

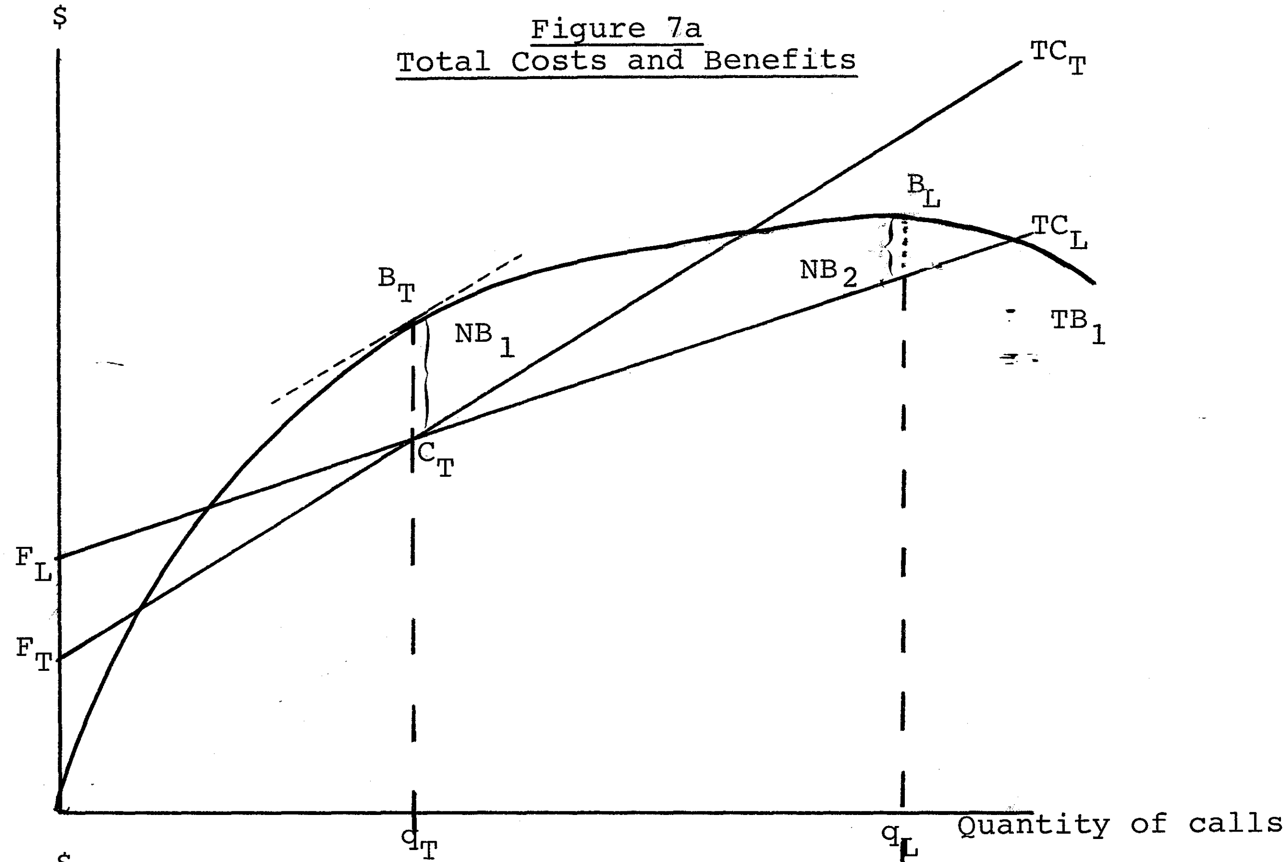


Figure 7b

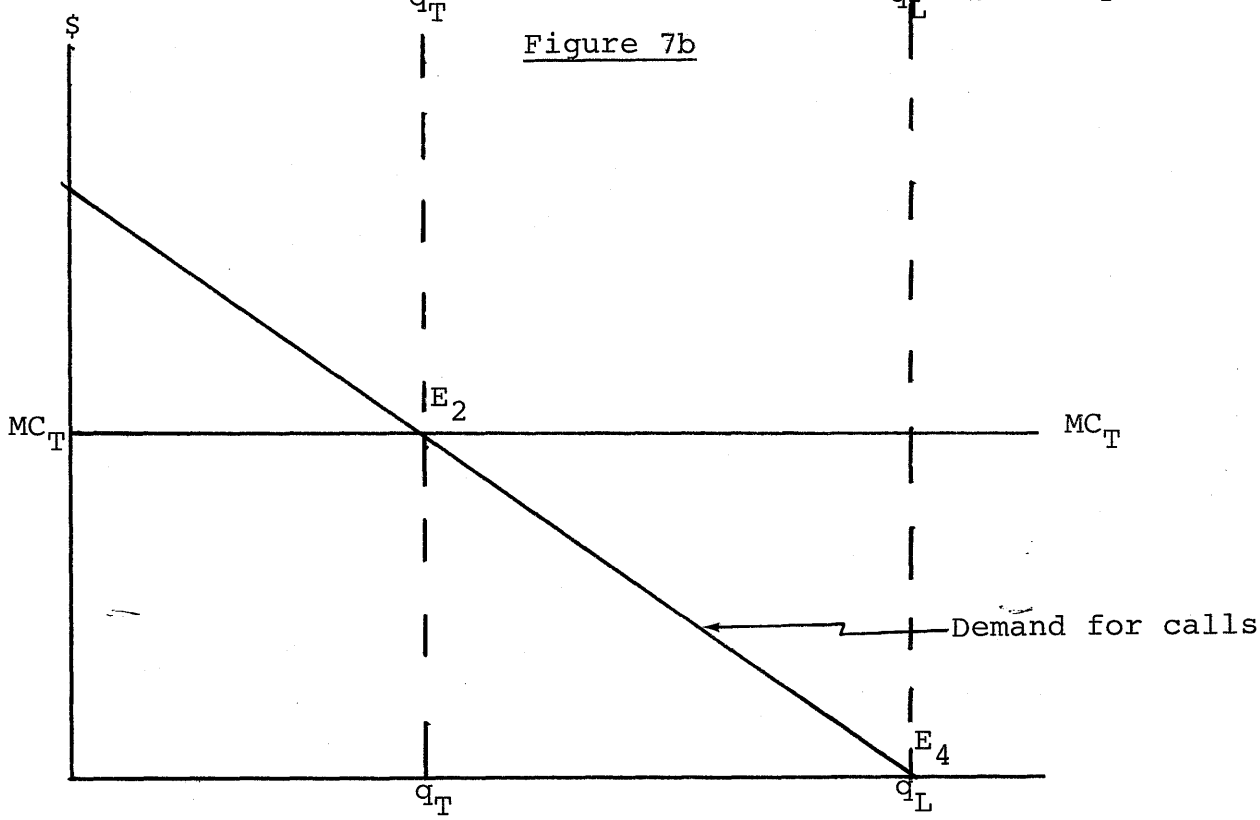


Figure 8
Effect of Alternate Valuation on Cost-Benefit Decision

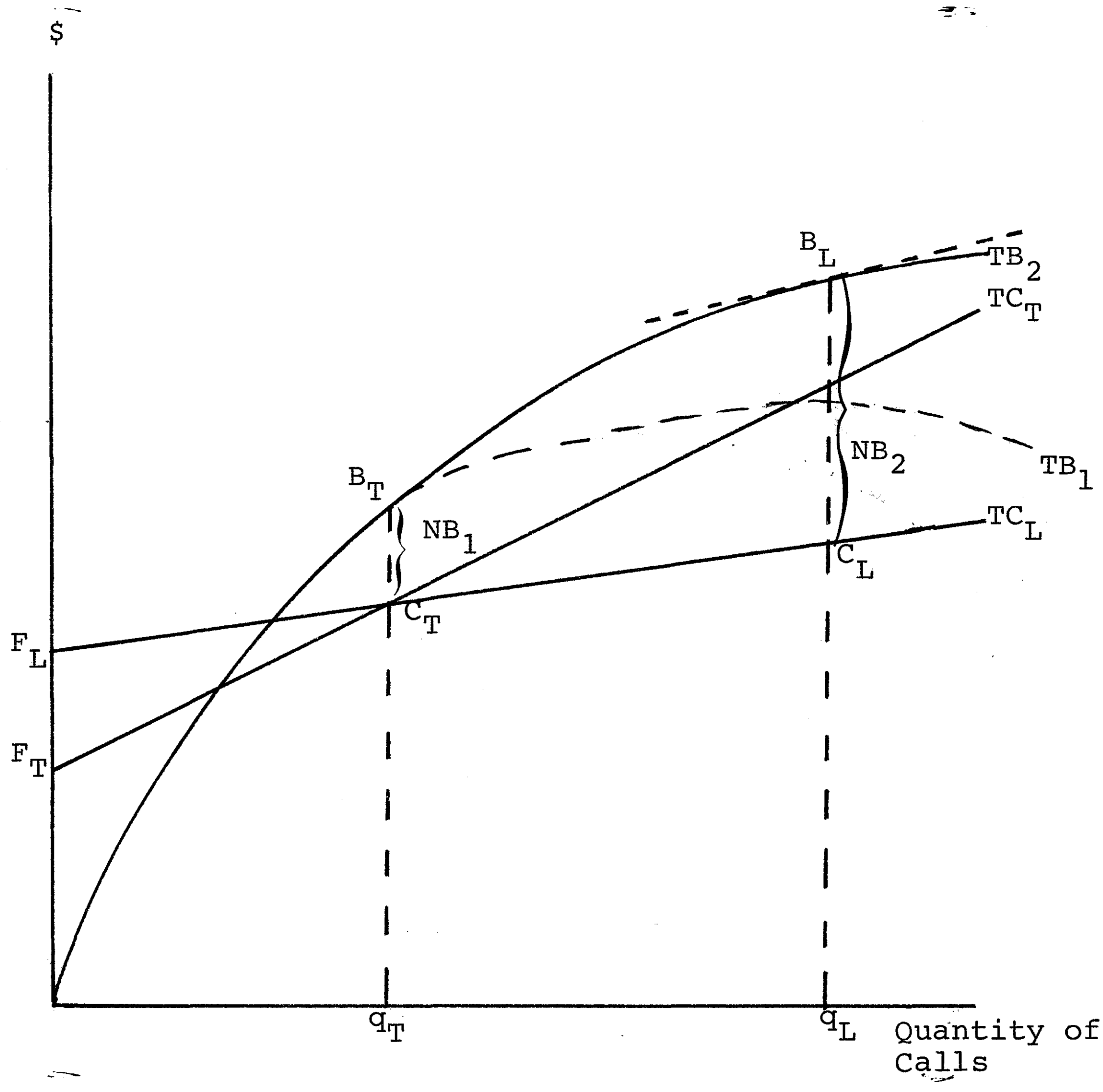
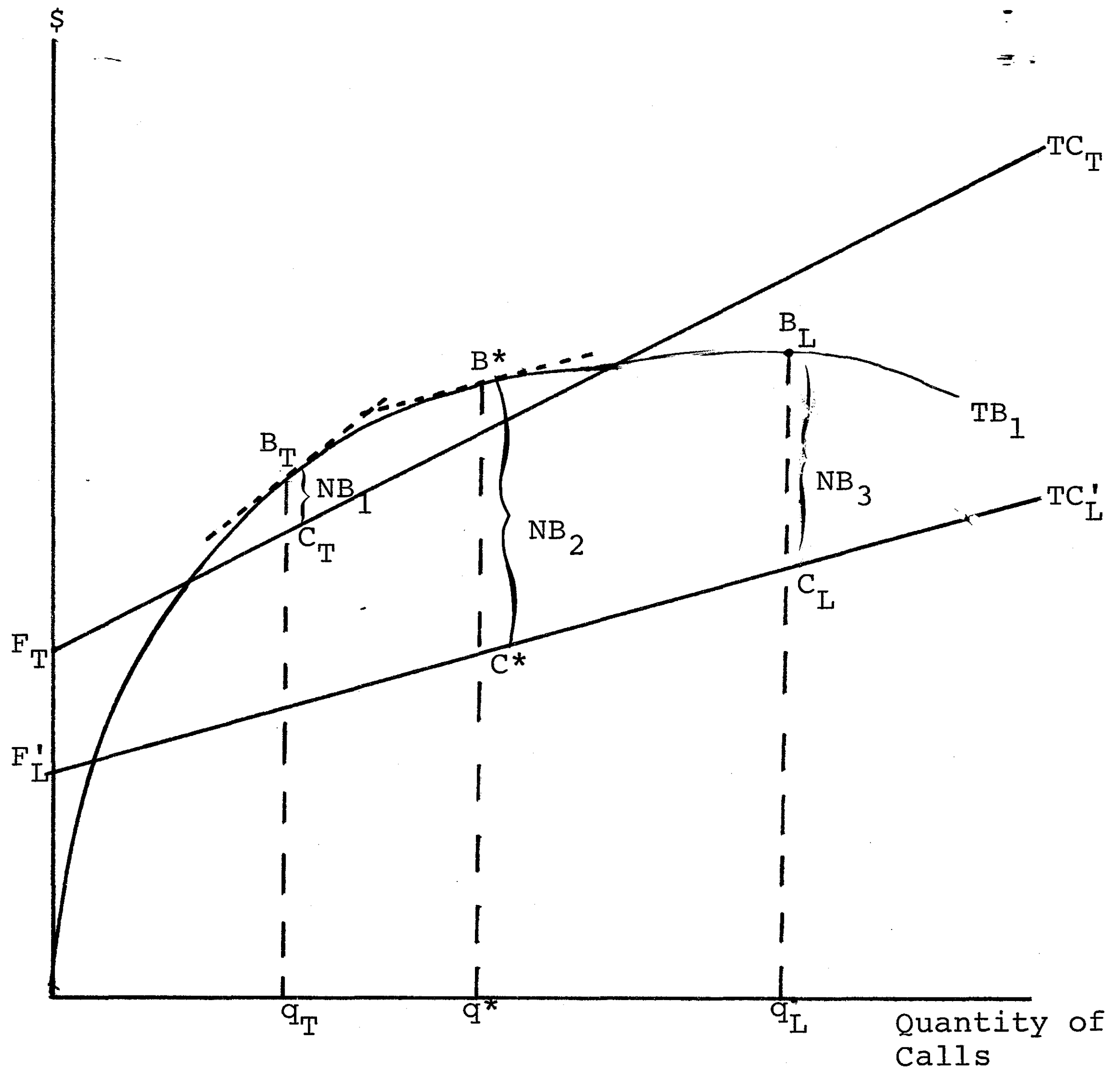


Figure 9
Effect of Alternate EAS Revenue Requirement on Cost-Benefit Decision



The marginal cost of an EAS call is greater than the marginal benefit. If, however, the consumers place a higher value on their calls than that shown in Figure 7a, a situation like that in Figure 8 can develop.

In Figure 8, the value consumers place on their calls is given by the total benefit curve (TB_2). This added benefit could be a result of an increase in demand.[7/] As can be seen, the difference between costs and benefits using EAS (NB_2) is greater than the net benefits derived from using toll.

In Figure 8, the valuation the consumers placed upon each call was changed to show the effects upon a cost benefit decision. In Figure 9 the annualized revenue requirement for EAS (F_L) is lowered to show how this effects the cost-benefit decision. At point q_T there is a net benefit of NB_1, while at q_L (which represents the quantity of calls demanded when price is zero) the net benefit NB_3 is greater than NB_1. At q*, the difference between costs and benefits is maximized and would be the most preferred state if it were available. However, this alternative implies pricing at marginal cost, but making such calls local would imply measurement and billing of EAS/local calls without charging for other local calls. It is unclear whether such a policy makes sense. Of course, measured service pricing to all local calls (covering an extended area) could be cost-effective.

7/ In addition to communities of interest, other factors such as population, income, and perhaps density of the population could change the valuation consumers place on their calls. The social valuation is captured in the demand for calls, unless externalities are present.

Summary and Conclusions

Regulators cannot be expected to undertake important decisions without basic information regarding both the benefits and the costs of alternative pricing policies. To implement county-wide EAS without an estimate of the benefits would go against sound planning and economic reasoning. The framework presented here captures the essential elements of analysis that must be quantified in any evaluation process.

From the point of view of efficiency, two rules were derived concerning the benefits and the costs resulting from EAS implementation. The first states that when toll prices are greater than marginal costs, benefits will increase the further the toll price is from its marginal cost. The second rule says that as the difference in annualized revenue requirements between toll equipment and EAS equipment gets larger, the lower will be the net benefits derived from EAS. The worst possible case would be where toll prices are close to their marginal costs and the revenue requirement for EAS plant is substantial. EAS plant, based on 1977 data is approximately 1.12 times more expensive per switching mechanism (CSS), (Spann, p. 64-68).

Distribution of benefits due to EAS implementation is not necessarily in the direction of greater equity. Those living in relatively rural areas reap more benefits than those living in more urban areas since the former have a higher demand for EAS calls than those in urban areas. Urban ratepayers, who do not have a strong demand for EAS calls due to the proximity of business, friends, and amenities, pay for a service they will not use, thus subsidizing those rural EAS customers. In addition, since business customers have a more spread out calling distribution compared to residential customers, businesses will benefit more than residential users. From the standpoint of economic efficiency, those who use the service should be required to pay for it.

The concept of community of interest was also examined and found to be a relatively nebulous concept; nevertheless, using actual calling patterns for five exchanges, a community of interest may not be as large as some think. The data show the relative percentage of calls is highly skewed towards the lower mileage bands with most calls being placed in the 0 to 5 mile range.

The above analysis points to the acceptance or rejection of EAS implementation on an exchange by exchange (or some other type of calling area) basis. In some areas EAS will be justified, while in other areas it will fall short of being economically feasible. Hopefully, the state-wide EAS cost study will provide disaggregated data for specific areas, so that the benefits, as well as the costs, can be identified.

If the situation is as outlined above, then the evaluation of the data generated by the EAS docket needs to be handled in a consistent manner. The public will benefit from competitive long distance rates. Granted, many of the possible EAS routes will not be viable markets in the near term, but in the long run there will be many firms supplying long distance services to most areas of the state. The EAS docket seems to reflect or derive to continue regulating rates when they could be deregulated and thus be open to competition. If the PSC mandates countywide EAS for all counties, it does so at the risk of implementing EAS when it is not cost effective. The state as a whole will pay higher rates to cover the additional annualized revenue requirement, but only a few will actually benefit.

Technical Appendix

Conceptual Framework

Dansby (1980) has provided a method of analyzing the change in consumer benefits on a more rigorous basis. The following approach is a simplified version of his methodology. The demand for calls to a location "x" located at any point r is denoted by q(P, r, x) where P is the unit price of calls. When the call is a local call (within exchange) the price is zero and is represented by P_L and when the call is interexchange, the price is P_T. If we let "A" be the set of households located in exchange 1 and "B" the set of households located in exchange 2, the total demand for intraexchange calls $q_A(P_L)$ and interexchange calls $Q_A(P_T)$ by subscribers in exchange 1 is thus

$$q_A(P_L) = \int_A \int_A q(P, r, x)drdx$$

and

$$Q_A(P_T) = \int_B \int_A q(P, r, x)drdx$$

The demand for similar services to those residing in exchange 2 are of similar form

$$q_B(P_L) = \int_B \int_B q(P, r, x)drdx$$

and

$$Q_B(P_T) = \int_A \int_B q(P, r, x)drdx$$

The issue facing the regulatory body (and the firm) is whether an enlargement of local exchanges is justified on the basis of benefit-cost criteria. Two alternative states exist--one with EAS and one without EAS. It is possible, given some assumptions, to compare the welfare these alternative states generate to society. For the case of no EAS where there is an exchange of a given size and a toll charge for calls outside the exchange the following equation represents society's welfare.

$$w^1 = \int_0^\infty [q_A(s) + q_B(s)]ds + \int_{P_1}^\infty [Q_A(s) + Q_B(s)]ds$$

$$-\rho_A N_A - \rho_B N_B + P_1[Q_A(P_1) + Q_B(P_1)] + \rho_A N_A + \rho_A N_A$$

$$-C_1[q_A(0) + q_B(0)] - C_2[Q_A(P_1) + Q_B(P_1) - F_1]$$

Where the first two terms represent measures of consumer surplus, ρ_i is the access cost for subscribers in exchange i, N_i is the number of telephone customers living in exchange i, P_1 is the price of toll calls, $Q_i(P_1)$ is the demand function given prices P_1, $C_j[\cdot]$ is the total cost of providing service j, and F_1 is the level of fixed costs.

Simplifying we have:

$W^1 = CS_{LOCAL} + CS_{TOLL}$ - access costs for A + access costs for B + toll total revenue - total variable costs - total fixed costs.

Given this formulation, the corresponding marginal costs are C_1 for local service and C_2 for toll and exhibits constant returns to scale in both markets.

Dansby points to some simplifying assumptions which make his model more tractable. First, the number of subscribers is fixed and is independent of price. Secondly, the expected benefit from having a large network is assumed to be small relative to the consumer surplus effect due when P_T goes to zero with EAS pricing. Finally, the practice of basing toll price on distance and duration is not explicitly taken into account.

Introduction of two way EAS changes the relative social welfare measurement such that

$$W^2 = \int_0^\infty [q_A(s) + q_B(s) + Q_A(s) + Q_B(s)]ds - \rho_A N_A - \rho_B N_B$$

$$+ \rho_A N_A + \rho_B N_B - C_1[q_A(0) + q_B(0) + Q_A(0) + Q_B(0)] - F_2$$

or

$W^2 = CS_{EAS}$ - total variable cost - total fixed cost - access costs for A + access costs for B.1/

1/ In both W^1 and W^2 from our assumptions, the access costs to and from the two exchanges net out due to similarity of costs, but in reality due to different plant and equipment costs, this may not be true.

W^2 represents the reclassification of interexchange calls from toll to local. Now examining the change from one welfare state to another

$$W^2 - W^1 = \int_0^{P_1} [Q_A(s) + Q_B(s)]ds - P_1[Q_A(P_1) + Q_B(P_1)]$$
$$+ C_2[Q_A(P_1) + Q_B(P_1)] - C_1[Q_A(0) + Q_B(0)] - (F_2 - F_1)\underline{2/}$$

which in simpler notation is

$\Delta W = CS_{TOLL}$ - total variable cost of toll + total cost savings of toll - total cost of serving local area that was previously toll - total fixed costs.

As prices of toll calls go to zero, consumer surplus increases; in addition, there is an increase in welfare due to savings in measurement and traffic costs, but there are costs to society in the form of lost toll revenue and changes in fixed costs.

Since ΔW is the net change in welfare if current toll pricing is not economically efficient (i.e., $P \neq MC$), the ΔW may be seen as a measure of the combined effects of adjustment of current toll price towards the optimal price and the transition from optimal toll prices to two way EAS.

This shows that if the toll price is above marginal cost then the first adjustment will increase welfare. The ΔW will in fact be smallest when the toll price is welfare optimal. It is possible, however, that the transition from toll prices to two way EAS can increase or decrease social welfare. These results can be seen in the following graphs.

The net benefit to EAS also increases as the ability to measure gets better and cost of measurement decreases. As ΔW decreases as the gap between the MC of toll and the MC of local decreases, then the differences between C_1 and C_2 are equal to the marginal cost of measurement. In addition, if EAS implementation substantially increases fixed costs, the net welfare decreases.

2/ F_i = depreciated amount of sunk capital costs, F = (Total Cost of plant)e^{-rt}.

Application of the Framework

If it is assumed that the demand curve for calls is linear [3/] then

$$\int_0^{P_1} Q(s)ds = P_1Q(P_1) + P_1/2[Q(0) - Q(P_0)]$$

and

$$Q(P_1) = Q_A(P_1) + Q_B(P_1)$$
$$Q(0) = Q(P_1)[1 - E(P_1)].$$

where $E(P_1) = [P_1/Q(P_1)][\partial Q(P_1)/\partial P_1]$. This in turn gives the welfare difference equation as:

$$W^2 - W^1 = Q(P_1)[C_2 - C_1 + (C_1 - P_q/2)E(P_1)] - (F_2 - F_0).$$

Dansby shows that the above formula shows that the transition from welfare optimal pricing ($P_1 = C_2$) to EAS decreases welfare depending on the relative magnitudes of C_1, C_2 and the elasticity of toll demand $E(P_1)$. Implementation of EAS in the absence of measurement costs will decrease welfare and if toll prices were welfare optimal a move to EAS would also decrease welfare.

With the linear model above, toll pricing would be preferable to EAS if

$$(C_1 - C_2) + (C_1 - P_1/2)E(P_1) < (F_2 - F_1)/Q(P_1).$$

If the savings due to minimal measurement costs plus the net change in usage costs is less than the average fixed costs, then toll pricing should be used. If fixed costs do not change ($F_2 - F_1 = 0$), then toll pricing should be used if savings in usage costs is at least twice the costs of measurement of

$$(C_1 - P_1/2)E(P_1) \geq 2(C_2 - C_1).$$

Bridger Mitchell (1979, 53) points out that this rule is different from a simple comparison of costs and benefits. Telephone company managers,

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3/ A host of problems is hidden with this assumption, but if the PSC is only searching for an order of magnitude for its cost study, the same can be true for the analysis. The numbers generated as a result reflect a magnitude and not an exact amount.

paraphrasing Mitchell, may favor a policy change if there are cost reductions sufficient to offset measurement costs, but regulators should apply a stricter test to offset the value of the lost toll revenues. Thus, toll pricing would be preferable if the savings in usage costs would be at least twice the cost of measurement due to the nature of marginal benefits and costs, demonstrated in the main portion of this paper.

This cost benefit decision rule is sensitive to the marginal cost differences. Table 1A shows the decision rule applied to various prices of three-minute phone calls in the 20-30 mile range throughout the country. These figures are used to represent the approximate marginal cost conditions. The elasticities used, 0.1 and .05 are cited in Taylor (1980, 137) and are used as upper and lower bounds. Since MC for a local call is hard to define, those of different cities with different regulatory conditions are used to show their effect on the decision rule when applied to Florida. The marginal cost of a 20 mile, 3-minute toll call (C_2) is assumed to be, for lack of a real estimate, 15 percent less than the corresponding price of \$0.59. This discount is used to take the separations process into account and results in a toll MC of approximately \$0.50.

As can be seen by Table 1A, only in the case of New York does the decision rule point to the adoption of EAS on the basis of welfare changes. It is also important to note that the cities listed are among the largest in the United States and thus would have the opportunity to enjoy economies of scale (if any) available in the provision of local service. Most counties in Florida would not be able to take advantage of these economies. Table A-1supports Dansby's contention that EAS implementation decreases welfare if measurement costs are small and if toll prices are "near" the welfare optimum.

Table A-1

City	MC* of local call in 20-30 miles for 3 minutes	Welfare Decision Rule if $F_1 = F_2$ and $C_2 = \$0.50$	Accept or Reject $E(P)i = .05$	Accept or Reject $E(P)i = .10$
St. Louis	.09	$(.09 - .59/2)E(P)_i \overset{?}{\geq} 2(.50 - .09)$	r	r
Washington, DC	.18	$(.18 - .59/2)E(P)_i \overset{?}{\geq} 2(.50 - .18)$	r	r
Boston	.28	$(.28 - .59/2)E(P)_i \overset{?}{\geq} 2(.50 - .28)$	r	r
Pittsburg	.30	$(.31 - .59/2)E(P)_i \overset{?}{\geq} 2(.50 - .31)$	r	r
San Franscisco	.46	$(.46 - .59/2)E(P)_i \overset{?}{\geq} 2(.50 - .46)$	r	r
New York	.51	$(.51 - .59/2)E(P)_i \overset{?}{\geq} 2(.50 - .51)$	a	a

*Amount is taken from latest available phone book serving region. Price is actual cost of call or cost in terms of additional message units (beyond those given "free" each month with basic service).

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