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A STUDY OF TELEPHONE ACCESS CHARGES: AN EMPIRICAL ANALYSIS OF BELL COMPANIES IN FIVE REGIONS

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EXECUTIVE SUMMARY

On February 28, 1983 the Federal Communications Commission (FCC) issued its Third Report and Order in FCC CC Docket No. 78-72, Phase I, "In the Matter of MTS and WATS Market Structure." In this order, the FCC adopted a system of access charges that would allow telephone companies to recover their costs for the local distribution of interstate calls. The initial inquiry of this docket was prompted by the development of competition in the interstate market for message toll service (MTS). With the divestiture of the American Telephone and Telegraph Company (AT&T), the resolution of this docket became crucial to a viable, competitive market for interstate services. The system of access charges adopted by the FCC consists of an end-user access charge, a carrier common line charge, and several categories of traffic sensitive (TS) charges. Of these charges, the end-user access charge has elicited the most controversy. After a seven-year phase-in period, the end-user charge will recover the cost of the loop allocated to the interstate jurisdiction through a monthly flat charge for each subscriber line. The primary concern surrounding this access charge is the effects it might have on rates for local exchange service and the goal of universal service as mandated in the Communications Act of 1934. The purpose of this study is to examine the impacts of access charges on the rate-paying public and to discuss the policy implications of these impacts for state commissions.

This study produced results that bear directly on four major policy areas:

1. Changes in the rates for intrastate MTS.

2. Implementation of a national access charge policy.

3. Anomalies in the allocation of traffic sensitive costs for toll service.

4. The design of the end-user access charge.

Of these four, the results bearing on the price changes of intrastate MTS are of immediate concern to state commissions. Our results suggest to us that by matching the price decrease currently proposed for interstate MTS, state commissions could substantially exacerbate the impact of access charges on rates for local exchange service. Instead, commissions need to investigate either increasing the price for intrastate MTS or adopting a policy of no price change. With either approach, state commissions could mitigate the impact of access charges on local exchange rates.

The second major policy area concerns the FCC approach to implementing a system of access charges. Our study results disclose that state-by-state differences in the costs of service and usage characteristics account for two-thirds of the total variation in the impact on local revenue requirements brought about by access charges and the several other variables delineated below. This suggests that a state-by-state approach to setting access charges might better further the goal of universal service, while allowing a competitive market for interstate services to develop. However, this approach would require a shift toward the states of certain federal cost responsibilities.

The third major policy area on which our study results bear has to do with the efficacy of the separations of traffic sensitive costs. Our study disclosed that increases in traffic sensitive toll costs increased local exchange revenue requirements. Careful examination of this result led us to hypothesize that the allocation of these costs in the separations procedure does not attribute these costs to the cost-causative service. This implies that there may exist a subsidy flowing from local exchange service to toll services.

The results bearing on the fourth major policy area of the form of the end-user access charge are based on the application of economic and game theory to the pricing of the telephone network. One focus of this analysis questions a conceptual foundation of the separations procedures that designates the loop and other costs as non-traffic sensitive. These costs are sensitive to coincident demands, and both outgoing and incoming calls impose congestion costs on a subscriber's loop. The theory of peak-load pricing indicates that these congestion costs should be recovered through a usage charge during peak periods. Hence, some portion of the loop cost properly may be recovered by means of a usage charge to interstate toll carriers. Application of the theory of cooperative games to that portion of loop cost not properly recovered through usage charges allows us to conclude that some of the loop costs might be allocated to the interstate carrier as a lump sum access charge. The interstate carrier needs the subscriber loop to complete calls it transmits. Without access to the subscriber loop, the carrier would have to bear the cost of completing the call. This fact implies that the carrier may be willing to bear part of the existing subscriber loop rather than enter *de novo*. Thus, conditions are ripe for negotiation with a public interest standard as the guiding criterion.

The history of FCC CC Docket No. 78-72 is long and varied. A central issue in its deliberation was the means by which telephone companies would be allowed to recover the interstate portion of the cost of the lines that connect subscribers to a central office. Four proposals for access charges were set out under the short titles of Pure 1, Pure 2, Mixed 1, and Mixed 2. Their purpose was to replace the division of revenues and settlements process which has been the traditional means for telephone companies to recover their interstate costs.

In adopting a modified Pure 2 approach to access charges, the FCC's rationale was to base access charges on costs to promote economic efficiency and to prevent uneconomic bypass of the existing telephone network. The costs of access are to be determined through revisions to the separations process. The FCC established a separate docket, FCC CC Docket No. 80-286, in which a Joint Board was established to recommend revisions to the current Separations Manual.

Up to the present time, the Joint Board's recommendations have included a non-traffic sensitive (NTS) cost allocation factor of .25 to replace the currently used subscriber plant factor (SPF) and a formula for distributing funds from a Universal Service Fund to companies whose loop costs are at least 115% of the national average.

In addition to access charges and changes to the Separations Manual, divestiture of AT&T, CPE deregulation, and changes in the accounting for inside wiring are occurring simultaneously. All of these changes in the regulation of telephone companies will interact with one another and create a situation so complex as to hamper comprehensive analysis. This study is mainly an attempt to make some sense out of the access charge portion of this complexity.

An experimental approach using a simulation model that incorporates institutional, financial, and economic factors was chosen by the NRRI research team. A computer simulation model, called a Simulation Model for Access Charges (SMAC), was developed within the framework of a general cost allocation program, Interactive Cost Allocation System (ICAS), developed at the NRRI. SMAC was implemented using a data set of accounting and usage information for Bell Operating Companies (BOCs) in Colorado, Michigan, Missouri, South Carolina, and Vermont. SMAC computes, among other things, the percentage change in average local revenue requirements per line for businesses and residences, and the percentage change in lines in service attributable to changes in local exchange rates. An experimental design known as a fractional factorial design was used to perform our simulation experiments. This design allows one to systematically vary the economic and other factors to determine their influence on the dependent variables of average exchange revenues per line and drop-off.

SMAC contains four major modules. They are:

1. A submodel that simulates the separations procedures and computes an intrastate jurisdictional revenue requirement.

2. A submodel that simulates consumer reaction to changes in the average price on interstate toll service and computes the consequent change in interstate toll usage.

3. A submodel that simulates consumer reaction to changes in the average price of state toll service and computes the consequent change in both state toll usage and toll revenues.

4. A submodel that computes an average exchange revenue requirement per business and residential line and simulates consumer reaction to the changes in the form of adding or dropping lines in service.

These four submodels are interconnected with feedback and feedforward loops to form the complete SMAC model. A solution to the model for a given set of parameters is an equilibrium solution in which the inputs to and outputs from each submodel are mutually consistent.

SMAC incorporates the following parameters:

1. State - this actually refers to hundreds of parameters that represent the accounting, separations, usage, and other data that are specific to the operations of a given company in a given state. These data are needed for the simulation of separations and the computation of a revenue requirement for the state jurisdiction.

2. The NTS allocation factor.

3. FCC end-user access fees.

4. The percentage change in interstate MTS rates.

5. The own-price elasticity of demand for interstate MTS.

6. The percentage change in state MTS rates.

7. The own-price elasticity of demand for interstate MTS.

8. The own-price elasticity of demand for residential connection to the local network.

9. The own-price elasticity of demand for business connection to the local network.

10. Relative interstate toll minutes of use (MOU) per average line that is dropped. (Relative to the average of all lines.)

11. Relative state toll MOU per average line that is dropped.

12. Relative exchange MOU per average line that is dropped.

13. The growth of traffic sensitive cost - this refers to several parameters used to expand TS toll plant and related expenses according to increases in toll traffic.

In the experiments with SMAC, the five different sets of values corresponding to the five study states, together with the combinations of two values for each of the other parameters, made up over 120 simulation runs. The experiments were designed to discover the best and worst combination of parameters for each state, where best is defined as the lowest increase in local revenue requirements and a minimum amount of drop-off. The worst is defined in opposite terms. The analysis of these experiments sought to determine the contribution of certain combinations of factors to the difference between the best and worst outcomes in the first year of access charges. They also sought to determine the likely effects on local revenue requirements of future changes in access charges and the newly proposed NTS allocator. Additional experiments were conducted after a slight modification of SMAC to get an indication of the potential for mandatory local measured service as a means of preserving universal service.

For the first year of access charges, the range of SMAC results as compared with just the single direct effect of the FCC's $2 and $6 end-user access charges is given in table ES-1.

The values of the parameters that produced the best and worst cases were the same for all states and are given in table ES-2.

One of the most important variables contributing to the range of outcome between the best case and worst case is the percentage price change for state MTS. Not surprisingly, the own-price elasticity was also important, and the interaction of it with the price change was another one of the most important effects in four of the five states.

TABLE ES-1

DIRECT EFFECT AND RANGE OF DIRECT AND INDIRECT EFFECTS ON LOCAL REVENUE REQUIREMENTS AND DROP-OFF DUE TO ACCESS CHARGES (IN PERCENT)

	Effects on Local Revenue Requirements						Effects on Number of Lines Dropped from Service	
	Direct Effect		Direct and Indirect Effects					
			Business		Residence			
State	Bus.	Res.	Best	Worst	Best	Worst	Best	Worst
Colorado	19	20	16	41	17	43	0.4	4.8
Michigan	23	15	19	31	11	24	0.4	3.2
Missouri	13	16	11	28	14	13	0.3	3.5
S. Carolina	12	13	5	15	6	15	0.2	2.5
Vermont	21	19	0	26	−1	25	0.0	2.9

Source: Tables 4-2 through 4-7

TABLE ES-2

PARAMETER VALUES THAT GAVE BEST CASE AND WORST CASE RESULTS

Parameter	Value for Best	Value for Worst
NTS Allocation Factor	SPF	SPF
End-User Access Fee	\$2, \$6	\$2, \$6
Percentage Change in Interstate MTS Price	−.20	−.10
Own-Price Elasticity for Interstate MTS	1.10	.50
Percentage Change in State MTS Price	.05	−.15
Own-Price Elasticity for State MTS	.50	.50
Residential Own-Price Elasticity for Connection	.025	.125
Business Own-Price Elasticity for Connection	.040	.175
Relative Interstate Toll MOU Profile for Dropped Lines[1]	0	.75
Relative State Toll MOU Profile for Dropped Lines[1]	0	.75
Relative Exchange MOU Profile for Dropped Lines[1]	1	.50
TS Cost Growth Related to Traffic Growth	No	Yes

[1]Relative to the average of all lines.

Source: Tables 3-3 and 4-23

An analysis and extension of these results showed that a 5 percent increase in the price of state MTS was beneficial in holding down local revenue requirements even when the own-price elasticity of demand was elastic, i.e., greater than 1. Specifically, this is the case as long as the own-price elasticity of demand is less than 2.0 in Colorado, 1.14 in Michigan, 1.26 in Missouri, and 1.31 in Vermont.

Other analyses showed that the parameters controlling the growth in TS toll plant due to the growth of toll traffic were also among the most important parameters in four states in explaining local revenue requirement increases. This raises questions about the appropriateness of using costs determined by the separations process as a basis for access charges.

An analysis of the composite results from all five states showed that the impact of access charges was influenced considerably more by state-to-state differences than by all the other parameter differences that produced the best and worst case in each state. As mentioned, it may be that the public interest is served better by state-specific access charge policies rather than by a uniform national policy because of the great divergence across states of the impact of such a uniform policy. It was further found in an analysis of variance that the interaction of the state differences with the other parameters produced very little effect on local revenue requirements. This result suggests that the study conclusions are reasonably transferable to other states, divested BOCs, and (at least in a limited way) to independent telephone companies.

After the first year of access charges, and according to specific schedules, the NTS allocation factors are proposed to change from SPF to .25, and when combined with the effects of the Universal Fund payments, will result in an effective NTS allocation factor as shown in the table ES-3.

The effects of the new allocation factors on local revenue requirements and the $4 residential end-user charge were examined in three of the five states as if they had been adopted for the first year of access charges rather than according to the proposed schedule. The results are shown in table ES-4.

The $4 end-user access charge and new NTS allocation factor could cause a percentage drop in the number of lines ranging from 1 percent to 9 percent in Colorado, 0 percent to 3 percent in South Carolina, and 1 percent to 7 percent in Vermont.

TABLE ES-3

EFFECTIVE NTS ALLOCATION FACTOR BY STATE

State	Present SPF	New Effect Factor Under FCC CC Docket No. 80-286 Proposals
Colorado	.42978	.25
Michigan	.17248	.25
Missouri	.27093	.25
South Carolina	.22070	.3108
Vermont	.43080	.2752

Source: Table 4-22

TABLE ES-4

EFFECT ON LOCAL RESIDENTIAL REVENUE REQUIREMENTS OF THE NEW NTS ALLOCATION FACTOR AND A $4 END-USER CHARGE GIVEN AS PERCENT CHANGE

	Effect Attributable to		Range of Increases in Average Revenue Requirement per Line	
State	New Allocation	$4 Charge	Best	Worst
Colorado	30	30	64	98
South Carolina	-11	13	10	23
Vermont	26	18	39	72

Source: Tables 4-24 through 4-29

The examination of mandatory measured service postulated a flat $5 per month residential charge plus the $2 FCC end-user fee, and a flat $5 times the state's business premium charge for business lines plus the $6 FCC end-user access charge. Given these flat charges and a postulated decrease of 20 percent in exchange usage, SMAC solved for the average revenue requirement per subscriber line minute of use (MOU) that would make the company whole. While this approach can only represent a very rough approximation of actual public response to measured rates, results are at least indicative of what might be accomplished with local measured service. The range of results obtained for three states was .73 to .93 cents per MOU for Colorado, 1.12 to 1.14 cents per MOU for South Carolina, and .70 to .98 cents per MOU for Vermont.

While SMAC was useful in giving empirical results for the first year of access charges and indicating the relative magnitude and direction of effects two or three years hence, a theoretical analysis is more appropriate for examining the future after the transition period is completed. The theory of cooperative games was applied to the access charge problem to investigate the kinds of information necessary to achieve the FCC's goals of efficiency, universal service, and the prevention of uneconomic bypass.

This theory is based on a set of maximum prices for telephone services that would prevent bypass of and drop-off from the local network. These maximum prices are related to the costs that might be experienced by a potential entrant into the access services market. The set of all prices that simultaneously prevent bypass and drop-off is called a core. The core establishes the range of possible cost allocations that are consistent with the FCC's objectives of economic efficiency, prevention of bypass, and universal service.

The existence and size of core is crucial to the resolution of the access charge problem. To determine its existence and size, the cost structure for telephone services and the subscribers' willingness to pay must be known along with the costs to potential entrants.

Since both cost and demand structures depend on local or regional conditions, a uniform national design of access charges may not produce core prices in every locality. If so, state-by-state determination of the prices of access service would be required to achieve sustainable, economically efficient prices.

The empirical findings and theoretical analysis of this study raise several concerns about the FCC decision in FCC CC Docket No. 78-72. A major concern involves the retention of a uniform national pricing policy when its impacts are so diverse. Furthermore, the use of cost allocations determined by the separations procedures to formulate access charges may be inappropriate. Currently proposed revisions to separations procedure may not be sufficient to remedy the anomalies we observed and, in fact, may exacerbate them.

The source of much of these problems with separations and the access charge design is the conceptual classification of costs into traffic and non-traffic sensitive. The narrow focus of this classification scheme is the basis of the apparent conflict between efficient pricing and universal service. The theory of cooperative games suggests one could charge an interexchange carrier for the use of a local loop. The charge could appropriately be any price up to some portion of the cost to the interexchange carrier of making the final connection to a user without using the existing local loop. This cost is clearly not zero. This is why the interstate carrier might properly be assigned a lump sum charge for use of the loop.

Although the purpose of this study is to examine the impact of access charges, the data base obtained from the five states consisted of undivested BOCs that still owned their customer premises equipment (CPE). When access charges become effective, these companies will be divested and will essentially own no CPE. Also, independent companies will be affected by access charges, but were not directly studied. Based on our empirical analysis, we can conclude that the effects of divestiture on local rates will be for the most part additive to the effects we describe. If the amount added is positive, greater drop-off will occur than we report, but it will be due to causes other than access charges. Thus, the general results about the importance of various factors and their contribution to the range of effects, as well as our policy discussion drawn from these effects, are more generally applicable than merely to the undivested BOCs in five states.

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We also thank the several persons employed by the five Bell Operating Companies who were assigned the difficult task of responding to our data request. Their cooperation and efforts were appreciated. We should also mention Douglas Fox and Lisa Ralphe, two student assistants, who accomplished many of the mundane tasks no one else wanted to do.

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FOREWORD

This is a study of access charges (not of divestiture). It tries to shed light on the impact of a national access charge policy along with the design of end-user access charges. It also identifies anomalies in the allocation of traffic sensitive costs for toll service and treats the question of setting rates for intrastate message toll service in light of possible adverse impacts of end-user access charges on universal service.

The approach of the study is essentially a quantitative one and employs actual data from five BOCs in the five NARUC regions. The model, cost assignments, and computer manipulations will be of special interest to the technically prepared regulator; the implications and conclusions of the analyses should be of particular interest to those of policy bent.

We believe that some of what is reported here is a fresh addition to the current debate on telephone access charges and their likely effects on revenue requirements and drop-off. We believe that other findings reported here can serve as reconfirmation of propositions and conclusions already part of the debate. In all events much of the study design and model building contained in this report can be used by other researchers and practitioners to run their own analyses with their own assumptions and data sets.

Douglas N. Jones, Director
December 31, 1983

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CHAPTER 1

INTRODUCTION

The purpose of this study is to examine the impact of a system of access charges on local exchange rates and subscriber drop-off. The analysis makes use of a computer Simulation Model for Access Charges (SMAC) developed by the National Regulatory Research Institute (NRRI). A sample of five Bell Operating Companies (BOCs), each operating in a different NARUC region, provided a 1982 data base of financial and other statistical data on which the analysis is based. SMAC used this data base to simulate changes in the average exchange revenue per line for business and residential subscribers, as well as the consequential drop-off. The simulation results are obtained under a variety of conditions established by systematically varying economic and other variables. The results are analyzed to examine the effect of the variables on local rates and drop-off and to examine some policy options state commissions have for dealing with the complex problem of a rapidly changing telecommunications industry.

In addition to the empirical analysis, an examination is made of an economic theory that has emerged in the literature in recent years. This theory characterizes the nature of common costs and the prices of services needed to prevent uneconomic bypass of the local telephone network. Both the theoretical and empirical results are drawn upon in the policy discussion found in a later chapter.

On December 22, 1982, the FCC voted to approve, and subsequently issued on February 28, 1983, its Third Report and Order in CC Docket

78-72, Phase I, "In the Matter of MTS and WATS Market Structure."[1] In this order the FCC adopted a new system for charging for the interstate portion of a local exchange company's costs. The historical settlements/division of revenue procedures are to be replaced with a system of access charges composed of three types of charges. These are the end-user charges, the carrier common line charges, and several categories of traffic sensitive charges. The order requires ultimately charging the end user for all of the interstate share of the non-traffic sensitive subscriber loop costs.[2]

The move to an access charge arrangement was prompted primarily by two factors. One was the advent of competitive carriers in the market for interstate services. This intensified the need for cost-based pricing. Second, the AT&T divestiture agreement contained a series of requirements for equal access arrangements and the replacement of the division of revenue process with access charges. This implies a need for all carriers to go to a system of access charges.

The decision in the Third Report and Order has generated considerable controversy, particularly with respect to the methods for charging for the non-traffic sensitive (NTS) loop costs. One concern for many parties is that by levying the subscriber loop costs on the end users (whether or not they actually make interstate calls), the FCC may have endangered universal service. Other parties argue that such an arrangement is necessary in order to achieve the economically efficient pricing structures that are needed for the successful development of competition in the interstate markets.

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[1]FCC 82-579, released February 28, 1983. MTS is message toll service, and WATS is wide area telecommunications service.

[2]The subscriber loop is that portion of the network that connects the customer's premises to the nearest central office. It is considered to be non-traffic sensitive because its costs do not vary with the amount of traffic.

On August 22, 1983, the FCC, upon reconsideration of its earlier access charge order, issued a new order prescribing modifications to the user access fee.[3] It changed the first year access charges from $4 per residential line per month to a requirement that the charge be a flat $2 per residential line per month. Business line charges were to go from a minimum flat charge of $4 per month to $6 per month.

Originally set to take place on January 1, 1984, the first year implementation of the FCC access charges has been delayed until April 1, 1984.[4]

The problems state commissions face as a result of the FCC decision are many, varied, and complex. In particular, each state commission must decide for its own state the same issues that concerned the FCC when it made its access charge decision. Additionally, many state commissions will most likely have to contend with two systems for charging for long distance calls: (1) an access charge system for interLATA[5] calls where several companies may compete for traffic, and (2) the present MTS system for intraLATA calls where competition might be excluded. Also, with state commissions having jurisdiction over local service rates, there follows the concern about universal service. Clearly, the potential for achieving and maintaining universal service is reduced with any increase in the flat rate part of subscriber telephone bills. Many see the FCC's restructuring of the interstate toll

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[3]"Memorandum Opinion and Order," CC Docket 78-72, Phase I, FCC mimeo 83-356, August 22, 1983. Some other modifications were also made but the user access fee was the most important change for the purposes of this study.

[4]FCC Press Release, 83-470, October 19, 1983.

[5]LATA stands for local access transport area and is an area which represents redefined exchange areas created for purposes of the divestiture of the Bell Operating Companies.

markets and the concomitant changes that both it and divestiture will bring to the intrastate toll market as resulting in a substantial increase in the flat rate part of subscriber's telephone bills. Hence, access charges, as prescribed by the FCC, are viewed as a threat to universal service. Thus, it seems that economic efficiency and universal service, both legitimate regulatory goals, are conflicting goals. Although limited in their choices, each state commission will want to strike the best possible balance between these conflicting goals in its state. To strike that balance, the full impact on local rates of the FCCs access charge decision and the parameters that affect that impact must be determined.

The approach used to examine the impacts mentioned above is described in the next section. That is followed by commentary on the creation of a research steering committee for this study, and finally, a guide to the rest of the report.

Approach

The FCC access charge decision has both short-term and long-term implications. The long-term impact develops over the next eight to ten years as the full interstate cost of the local loop becomes a flat charge for all users, as capitalized inside wire and installation costs are written off, as customer premises equipment (CPE) is written off from the interstate jurisdiction, as interstate competitive markets mature, and as new communications technology is introduced. Over that time, many issues will have come and gone, rate cases will have been processed, regulatory policies reformulated and perhaps Congressional action on the matter of telecommunications will have been passed. While it would be useful to be able to forecast local rates, eight to ten years hence, there are too many interceding events to allow this to be done with acceptable accuracy. Therefore, we have chosen not to attempt an empirical analysis of the long-term impact of access charges.

Instead, we have undertaken a theoretical examination of the ultimate structure of the telecommunications services that will emerge after access charges are fully implemented. This long-term analysis uses a game-theoretic framework to examine how the characteristics of telephone networks bear on the potential of simultaneously achieving universal service, network efficiency, and prevention of uneconomic bypass.

The short-term impacts of access charges are those that will occur within the first year or two.[6] As a direct and immediate result of the FCC access charge, it is expected that interstate message toll rates will decrease, state commissions will make changes in intrastate message toll rates (and perhaps the market structure), and local rates will be affected. All of these actions (direct effects) will cause a change in traffic of the three services and interact with the jurisdictional separations process to cause indirect effects on local rates. If those rates increase, some subscribers will drop off the local network leaving a smaller customer base over which to spread the costs; an additional indirect effect on local rates will ensue.

To examine these short-term effects, we use an empirical approach. As a natural byproduct of this effort, a computer model is developed that can be used to estimate these direct and indirect effects on local rates and concomitantly on universal service. This is accomplished by estimating changes in average exchange revenue per line for business and residential customers and the percentage of drop-off.

The development of SMAC is an important secondary purpose of the project. It can be made available to state commissions for the purpose of examining and reexamining these effects throughout the three to seven

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[6]The period of three to seven years is a transitional period during which several changes in the regulation of telephony will be phased in simultaneously.

year transition to a full user access fee. An alternative purpose would be to examine new changes in access charges that might emerge in the courts, the Congress, or the FCC. Once developed, SMAC served as an experimental apparatus which was calibrated to the situation in five states and used to conduct designed experiments.

Each of these five study states was from one of the five Regional Regulatory Conferences affiliated with NARUC. All five regions were represented; the participating states were Colorado, Michigan, Missouri, South Carolina, and Vermont. The study focused on the state operations of the BOCs serving these five states. Although the companies being studied were BOCs about to be divested at the same time as the first implementation of access charges, we made no attempt to make empirical estimates of the additional effects divestiture might have on local rates. There were several reasons for this:

1. The purpose of the study was to examine access charges and not divestiture.

2. The type, quality, and detail of data we felt were needed for studying access charges were (at the time we were requesting data) unavailable for a divested BOC.

3. To have studied the combined effects of access charges and divestiture would have probably meant not knowing what caused them--access charges or divestiture.

4. Several others are already studying impacts unique to divestiture itself.[7]

We do not leave the subject of divestiture untouched, however. The results of the experiments with the empirical model do allow us to

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[7]To cite but two studies: an internal study at the FCC is currently examining the rate effects of direct divestiture costs such as network reconfiguration costs and equal access costs and in July 1983 the Ohio Bell Telephone Company (OBT) was able to provide the Public Utilities Commission of Ohio with a proforma set of books to reflect a divested OBT.

suggest how results from these other studies being done on divestiture can be used to obtain an estimate of the combined effects.

Research Steering Committee

To aid the research team in this project, a steering committee was formed. This committee consisted of four staff members of state commissions and one commissioner. There were also staff alternates for the commissioner and one of the other committee members. The purposes of this committee were

1. to follow the progress of the study by the research staff;
2. to act as a sounding board for research ideas;
3. to provide information, offer comments, and give general advice;
4. to help plan, coordinate, and facilitate the collection of data from the BOCs in their state.

The five committee members were from the five states selected for the empirical part of the study. A request for information from the BOCs in each of the five states was routed through the commission via the state's member on the research steering committee. This cooperative effort among the five BOCs, the five state commissions, and the research team, made possible the empirical work for this project.

Two meetings of the steering committee were held. One was shortly after the project began, in which the research approach was reviewed and discussed and the data requirements were examined and finalized. A significant result of that first meeting concerning data requirements was a realization that the resulting data request was too massive to use with independent telephone companies in the time frame of the study. It was thus decided to restrict the empirical analysis to BOCs and to use those results to infer as much as possible about the independent telephone companies.

The second steering committee meeting was held midway through the data collection effort. It involved a review of the computer model, a review of the progress of the data collection effort, and finding the solutions to data problems. The committee members were contacted individually several times during the study.[8]

A Guide to the Report

Not all readers will necessarily need to read every part of this report. Some chapters stand alone and contain information already known to some readers. Other chapters are technical in nature and use mathematical expressions extensively to describe results. Persons interested in applying their own validity tests to the results will be interested in the technical chapters. Those interested mostly in study results will find them expressed in two chapters: chapter 4 gives the numerical results and a technical analysis of them, and chapter 6 gives the possible policy implications of the numerical results.

Chapter 2 contains a review of the history of the access charge decision. In it is a brief discussion of the important provisions of the access charge order, divestiture, and recent Congressional initiatives to overturn parts of the order. Commissioners and commission staff members already familiar with these events may want to skip this chapter. However, those who must draft a commission order concerning access charges may want to draw from this chapter in preparing their own "background" section of the order.

Chapter 3 contains a description of SMAC and the experimental plan. Recall that SMAC is a computer simulation model that is driven in this study by state-specific BOC data. Experimentation with SMAC was done to obtain results needed for the empirical analysis of short-term effects. The chapter is technical in nature and should be read carefully by

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[8]Because of a need to extend the time alloted for data collection, the committee had only limited opportunities to review this report before its publication.

anyone wishing to evaluate or to interpret independently the numerical results given in chapter 4.

The results of the experiments with SMAC are reported in chapter 4, both in raw form and in compiled form. The main purpose of chapter 4 is to present the numerical conclusions. Also contained in chapter 4 is an examination of the impact on local rates of future changes in end-user access charges and in separations procedures. Also included are the experimental plan, certain alterations to SMAC, and the results. In the next to the last section of chapter 4, the impact of local measured rates on the average revenue per line for residential customers is examined. The information in this chapter should be of particular interest to the technical staff at commissions.

Chapter 5 contains the theoretical analysis of the long-term effects of the FCC access charge order on the ultimate pricing structure of telecommunication services. The analysis is based on a game-theoretic framework set out in appendix A of this report. While those with a technical background in economics may want to read the appendix carefully, the chapter can be read by all and should be of particular interest to policy makers.

Chapter 6 contains a policy discussion on access charge issues, rate design problems facing state commissions, and the transferability of the results in this study. The federal policy on access charges is examined in light of the results of this study. It is suggested that the access charge policy may not be in the public interest nor achieve economic efficiency. The classification of loop costs as non-traffic sensitive is scrutinized and viewed as a potential source of the inefficiency. The discussion of rate-making policy for state commissions examines issues of intrastate toll access charges, local measured rates, and lifeline rates. The transferability of the results of this study is discussed with respect to divestiture, CPE deregulation, and independent telephone companies.

The impact of access charges has been widely (and hotly) debated. However, it has been the subject of few comprehensive studies. One such study by Lawrence P. Cole and Edward C. Beauvais[9] of the General Telephone and Electronics Service Corporation (GTE), was reviewed at the outset of this study. A purpose of the review was to determine the usefulness of their study to this one. Furthermore, since the Cole-Beauvais study had made use of an AT&T-developed computer model, called TELPOL (Telecommunications Policy Model), we had interest initially in being able to adapt TELPOL to meet the needs of this study. Both the Cole-Beauvais study and the TELPOL model turned out not to be helpful in this study. Our review of the study and a brief discussion of the TELPOL model is found in appendix B. Those readers already familiar with the Cole-Beauvais study, which was presented at the 1982 NARUC Williamsburg, Virginia Conference, or with TELPOL, will be interested in reading appendix B.

Appendix C contains a brief general description of the Interactive Cost Allocation System (ICAS) used to implement the SMAC model. A computer printout from an ICAS baseline run of SMAC using BOC data for Missouri is also found in appendix C.

Appendices D and E collectively provide a guide to the literature on demand for and use of telephone networks. Appendix D is mostly concerned with available demand elasticity estimates while appendix E reviews usage studies.

Appendix F documents preliminary data analysis done on the five state BOC data set in order to estimate a reasonable upper limit on certain cost elasticities needed by SMAC.

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[9]L. Cole and E. Beauvais, "The Economic Impact of Access Charges," presented to the 14th Annual Conference of the MSU Institute of Public Utilities, Williamsburg, Virginia, 1982.

As will be seen in chapter 3, the experimental plan employed for the empirical work in this study does not allow certain main effects and interaction terms to be distinguished from one another. Appendix G contains a detailed listing of the sets of indistinguishable effects.

Finally, appendix H gives the detailed calculations that support some of the experimental results presented in chapter 4.

CHAPTER 2

A REVIEW OF THE ACCESS CHARGE PROCEEDINGS

This chapter contains a summary of the proceedings in the FCC CC Docket No. 78-72 In The Matter of MTS and WATS Market Structure and a discussion of some major issues in the determination of the interstate access charge. The focus of the chapter is on the Fourth Supplemental Notice[1] and the Third Report and Order.[2] It was the Fourth Supplemental Notice that refined the issues in the access charge controversy and in which were proposed four alternatives for the treatment of the non-traffic sensitive loop plant. The Third Report and Order contains the FCC decision on access charges.

The first section of this chapter contains a brief summary of the early history of the docket. The second section describes the FCC decision on market structure. The third section describes the proceedings with respect to compensation arrangements, including detailed explanations of the Second and Fourth Supplemental Notices. The Second Supplemental Notice[3] contained a tentative access charge proposal which drew considerable controversy for its treatment of subscriber loop costs. The Fourth Supplemental Notice contained the four proposals for allocating loop costs that led to the final decision.

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[1]FCC 82-147, released June 4, 1982.

[2]FCC 82-579, released February 28, 1983.

[3]FCC 80-198, released April 16, 1980.

The remaining sections of this chapter contain a discussion of the primary considerations underlying the Fourth Supplemental Notice, the responses of various parties to the four proposals, an explanation of the access charge decision (Third Report and Order), and a review of the Congressional response to the access charge decision.

The Early History of FCC CC Docket No. 78-72

FCC CC Docket No. 78-72 was opened February 1978, originally for the purpose of determining whether or not services such as MTS and WATS should be provided on a competitive basis or should continue to be monopoly-provided services. The docket also included an investigation into the ways in which such services should be charged for their use of local exchange plant.

The opening of this docket was prompted by the decision of a U.S. Court of Appeals in the "Execunet" case.[4] This case was brought by MCI in an effort to reverse an earlier FCC decision which ruled that MCI could not offer Execunet service, which is essentially an MTS service. The court ruled against the FCC on the grounds that the FCC had not established whether a continuation of the traditional monopoly provision of MTS-WATS was in the public interest.[5]

The initial Notice of Inquiry and Proposed Rulemaking[6] released February 23, 1978 discussed the origin of the docket and suggested

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[4]MCI Telecommunications Corporation vs. FCC, 561 F 2d 365 (D.C. Cir. 1977) Cert. den.--U.S.--(January 13, 1978).

[5]Earlier FCC decisions had ruled in favor of MCI entry into private line services as being in the public interest, but no definitive public interest determination had been made with respect to the MTS-WATS market.

[6]FCC 78-144, released March 3, 1978.

several issues to be examined in the course of making a decision regarding the MTS-WATS market structure. One of the topics of concern was the current practice of rate averaging and the consequent uniform nationwide rates. The FCC planned to examine both the public interest benefits of uniform rates and the possible deterrent effect of rate averaging on competitive entry. Also, the FCC would examine the appropriate level of compensation from interstate services to local exchange companies on a cost-causative basis and would also consider whether any additional compensation should be made to local exchange companies. Other topics for review and evaluation included the existing settlements/division of revenues process and the method of allocating interstate costs among the various interstate services. The Initial Notice reported that in the process of making a decision about the MTS-WATS market structure, the FCC would study all interstate services offered by all carriers. The issues in this docket can be decribed as relating either to questions of market structure or questions of compensation arrangements.

Market Structure

Comments on market structure and related issues were received in response to both the Initial Notice and a Supplemental Notice of Inquiry and Proposed Rulemaking,[7] released August 30, 1979. Following FCC study and investigation of the issues and comments, the question of an appropriate market structure was essentially resolved in the Report and Third Supplemental Notice of Inquiry and Proposed Rulemaking,[8] released August 25, 1980. In this report the FCC made the determination that competition in the markets for all interstate services, except in the state of Alaska, would be in the public interest.

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[7]FCC 79-515, released August 30, 1979.

[8]FCC 80-463, released August 25, 1980.

Primarily because of Alascom's contention that Alaska is a unique situation, the FCC concluded that further inquiry was needed before a decision was made regarding market structure for interstate services in that state. Consequently, Docket 78-72 was divided into two parts. Phase I would deal with the unresolved questions relating to compensation for the use of local exchange plant, i.e., the access charge issues, and Phase II would deal with the issue of open entry in the Alaskan interstate markets. The Alaskan entry question was resolved in a Second Report and Order,[9] released November 30, 1982, in which an open entry policy in Alaska was determined to be in the public interest.

Compensation Arrangements

Comments received in response to the Initial Notice and the Supplemental Notice helped delineate the issues involved in determining arrangements for compensating local exchange companies for the use of their plant to originate and terminate toll traffic. The issues were further highlighted in discussions leading to the signing of the ENFIA agreements[10] which occurred in the time period between these two notices. These agreements set forth the arrangements by which other common carriers (OCCs) such as MCI would compensate local exchange companies for the use of their facilities for the provision of services that are functionally equivalent to MTS-WATS, such as Execunet. These agreements were to be a temporary solution, pending further action by the FCC.

To more fully understand the various proposals for NTS plant allocations it is useful to understand the current method of allocation. Under the existing separations process, allocations of NTS plant to the

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[9]FCC 82-515, released November 30, 1982.

[10]ENFIA stands for exchange network facilities for interexchange access.

interstate jurisdiction are done on the basis of the subscriber plant factor (SPF). The SPF formula is designed to increase the allocation over and above that which would occur if the relative use measure, SLU (subscriber line use), were used.[11] The SPF formula is applied to total NTS costs, including the non-traffic sensitive share of central office equipment, CPE, inside wiring, and subscriber loop plant, to derive the interstate share of NTS costs for MTS-WATS services. Interstate private line NTS costs are directly allocated, as are the costs of the private line portion of foreign exchange and common control switching arrangements (FX-CCSA).[12] The NTS costs for OCC services that are functionally equivalent to MTS-WATS are calculated according to the terms of the ENFIA agreements.

Second Supplemental Notice

As the FCC investigation progressed, the compensation issues appeared to fall into two general categories, i.e., the division of costs between interstate and intrastate services and the allocation of the interstate costs among the interstate services. The Second Supplemental Notice of Inquiry and Proposed Rulemaking (released April 16, 1980) announced a forthcoming notice to revise the Separations Manual and to establish a separate docket for doing so.[13] Since the division of costs between the two jurisdictions would now be debated in a separate docket, the remaining major question to be resolved in Docket 78-72 was the allocation of interstate costs among the interstate services. Four categories of interstate services were defined. They

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[11]The SPF formula is: SPF = .85 SLU + 2 (SLU) (CSR) where CSR is the composite station ratio.

[12]FX/CCSA are specialized private line services. A more complete explanation is found on page 21.

[13]The order establishing CC Docket 80-286 was released November 15, 1982 and established a Joint Board for the purpose of revising the Separations Manual.

are: MTS-WATS, foreign exchange and common control switching arrangements (FX-CCSA), private line, and OCC/ENFIA. The OCC/ENFIA category would contain only OCC services which are functionally equivalent to MTS-WATS. Private line and FX services offered by OCCs would be charged the same access charge as the FX and private line services offered by telephone companies.

In this Second Supplemental Notice, a tentative access charge plan was presented. This plan detailed a method for calculating access charges for each category of service. The non-traffic sensitive plant, including customer premises equipment (CPE), subscriber loop, and NTS central office switching equipment would be allocated among the four categories of services on the basis of holding-time minutes of use. The traffic sensitive local dial switching equipment would be allocated to the three categories of message access service (MTS-WATS, FX-CCSA, OCC-ENFIA) on the basis of relative dial equipment minutes of use. Any of this equipment currently assigned to private line, would continue to be directly assigned to private line.

Outside trunk used jointly by interstate and intrastate services, would be assigned to the three categories of message access service on the basis of relative minutes of use. Interstate private line outside trunk plant would be directly assigned to the private line category.

All other direct investment would be allocated among the service categories on the same basis as used in the Separations Manual (Manual).[14] The indirect investment (such as land and buildings, furniture and office equipment, and vehicles and other work equipment)

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[14]National Association of Regulatory Utility Commissioners, Federal Communications Commission, Separations Manual (February 1971).

would be allocated among services using factors and methods used by AT&T in its 1978 Central Submission.[15]

This tentative plan also called for pooling of the interstate revenues with the access charge revenues separated from the interexchange portion. Unlike the current pooling arrangements, this pool would also include revenues derived from the private line minutes of use, revenues from ENFIA, and interstate revenues from Alaska and Hawaii. AT&T would implement the access charge and manage the pool. Nationwide average data and the AT&T interstate rate of return would be used in computing access charges for each service.

Fourth Supplemental Notice

Comments in response to the Second Supplemental Notice spoke to many issues, but the proposed allocation of non-traffic sensitive costs to private line service on the basis of minutes of use generated the most controversy. This led to the issuance of the Fourth Supplemental Notice of Inquiry and Proposed Rulemaking (released June 4, 1982) in which four alternatives for the allocation of non-traffic sensitive costs were presented. These alternatives were labeled Pure 1, Pure 2, Mixed 1, and Mixed 2.

Under the Pure 1 proposal, interexchange NTS costs would be allocated among the four categories of interstate services on the basis of minutes of use, as proposed in the Second Supplemental Notice. Under Pure 2, all NTS costs would be allocated to the end user in a flat rate charge, on the assumption that the end user is the "cost causer" with respect to subscriber loop costs.

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[15]The 1978 Central Submission was filed by AT&T in the FCC Docket 18128. It contains a cost study of interstate services based on the FCC fully-distributed cost method 7.

The Mixed 1 allocation would result in a combination of flat and usage charges. Those non-traffic sensitive costs allocated to the interstate jurisdiction by SPF would be partially recovered from the switched services through charges that would be sensitive to subscriber line minutes of use. The residual NTS costs, i.e., the total interstate allocation minus the usage sensitive revenues, would be allocated among private line and switched services on the basis of the proportionate number of equivalent lines. Other private line costs would continue to be directly allocated to private line services.

The Mixed 2 proposal is another allocation resulting in both flat and usage charges. Under Mixed 2, multiline users would pay a flat per line charge to recover NTS costs, regardless of whether the lines were used for private line service or switched services. Residential and single line business customers could choose to pay either the same flat rate or a rate based on usage.

The focus of the Fourth Supplemental Notice was on alternative methods for allocating interstate non-traffic sensitive plant costs. Other issues were also discussed and required resolution before an access charge decision could be completed. These included the extent to which access charges should be aggregated, the organizational structure for implementing and administering the access charge, and the treatment of differences in the quality of interconnection among interexchange carriers.

Primary Considerations in the Fourth Supplemental Notice

In devising the access charge options in the Fourth Supplemental Notice there were four factors that had significant influence. These were: the need for nondiscriminatory pricing among the interstate services, the retention of universal service, the avoidance of uneconomic bypass, and compatibility with the access charge requirements of the AT&T divestiture agreement.[16]

Price Discrimination Among Services

Under the existing separations process, the SPF factor is used to allocate NTS plant to the MTS-WATS services. Cost allocations to interstate private line services do not receive the SPF increment, and this has been a source of controversy. Some private lines are truly dedicated point to point communication paths (e.g., data lines) and do not enter the public switched network. The direct allocation of private line NTS without a SPF increment elicits little controversy in this instance. However, other private lines terminate in a PBX,[17] making it possible to enter the public switched network in such a way that the service resembles MTS-WATS service without incurring the cost of the SPF addition. This had led some parties to seek a new allocation of NTS costs, such as Pure 1, so there would be less incentive to move from MTS-WATS to private lines. Others argue that heavy use of a private line imposes no greater cost to the network than does light use and, therefore private line service should not be charged on the basis of usage.

A second pricing differential problem relates to the FX-CCSA services which are specialized private line services. Foreign exchange

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[16]The Third Report and Order, describing the access charge decision, contains a statement of four goals the FCC considered important in making its determination. These four goals were discussed in various earlier notices and include three considerations mentioned here: non-discriminatory pricing, universal service, and the avoidance of uneconomic bypass. The fourth goal is efficient use of the network and was first referenced in the First Supplemental Notice. In addition to these four goals the FCC reported that the requirements of the AT&T divestiture agreement and the competitive impacts of alternative access charges were also considered in reaching its decision.

[17]PBX stands for private branch exchange.

is a service whereby a customer has a private line connecting to the switching system of another exchange. This allows the customer to dial directly into the other exchange without making a toll call. The interstate foreign exchange services have the private line portion allocated to the interstate jurisdiction. The message portion is priced the same as local calls in the foreign jurisdiction, and the minutes of use are counted as intrastate rather than interstate minutes. This is considered inequitable by many parties since the call is, in fact, an interstate call. CCSA is a service similar to foreign exchange but includes some dedicated switching and allows for communication among several exchanges. CCSA is billed in a similar manner to FX and creates similar controversies.

Another alleged source of price discrimination are the ENFIA agreements. Under the ENFIA agreements, the OCCs are charged less for use of the NTS plant than are the switched voice services provided by the AT&T and independent telephone companies. This arrangement exists primarily to compensate for the fact that OCCs typically receive inferior interconnection. The OCCs receive line side connections at the central office, and line side connections are considered inferior to the trunk side connections received by the AT&T/independent long distance carriers. In addition, OCC customers must dial several more digits than do customers of the AT&T/independent services and must use push button rather than rotary dial telephones to access the OCC. However, the argument has been made that any necessary price differentials should not be applied to the subscriber loop plant, since all customers of interexchange switched services use this plant in the same way and, consequently, do not create cost differentials.

Universal Service

The Communications Act of 1934, as well as legislation in most states, has spoken of the need to create and maintain universal telephone service. This generally has been interpreted to mean there is a need to keep local rates affordable. There has long been a contention by many parties that local rates have been subsidized by toll services. Support for this belief has spread and intensified as the size of the SPF factor grew and, over time, allocated increasing amounts of NTS plant to the interstate jurisdiction. Since the cost of NTS plant typically does not vary with usage, many contend that allocating these costs on the basis of usage leads to economic inefficiency. Others contend, however, that toll services should pay part of the cost of NTS plant for two reasons.[18] First, it can be argued that the NTS plant is necessary for the origination and termination of toll traffic and thus, there is an opportunity cost involved. Second, it is argued that the NTS plant has been engineered to meet the higher standards needed for toll services. Thus, it is costlier than would be the case if the plant were built to carry only local services. Since some of the access charge proposals suggest shifting all or part of the interstate NTS costs to the end user, driving up the cost of service for light toll users, the potential impact on universal service becomes a major question.

Bypass

A growing source of concern to regulators and telephone companies is the alleged threat of bypass. Bypass is a phenomenon whereby customers meet their telecommunication needs without using the local exchange companies, i.e., they bypass the existing network. Technological change has enabled viable bypass through such methods as microwave systems and satellite communications. At the present time,

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[18]See for example: William H. Melody, "Cost Standards for Judging Local Exchange Rates" presented at the Thirteenth Annual Conference of The Institute of Public Utilities, Williamsburg, Virginia, (December, 1981) or Richard Gabel, William Melody, Bob Warnek, and Bill Mihuc, "The Allocation of Local Exchange Plant Investment to the Common Exchange and Toll Services on The Basis of Equalized Relative Cost Benefits," a research paper supported by the Kansas Corporation Commission (May, 1983).

bypass is used typically by large users of interstate toll services. The potential for bypass of local exchange facilities could grow in the future through such systems as local private networks, cellular radio and cable systems, as well as the microwave and satellite systems.

Bypass is a concern to local telephone companies and regulators because a relatively few customers provide a relatively large percentage of toll revenues. Thus, the loss of a few large customers could significantly increase the revenue requirement for all remaining customers.

Bypass can be viewed as a source of competition and as such is a legitimate and natural development in a market that has been opened to competition. However, to the extent that bypass occurs or is economically feasible only because the competing telephone company services are incorrectly priced (i.e., priced over their costs), then the bypass is not economically efficient. In this case, there is not a true market test of whether the bypass system is viable in a competitive market. The difficulty, of course, is in determining the "correct" price of telephone services, especially when there is jointly used plant, the costs of which are not sensitive to usage. The subscriber loop, used for origination and termination of both toll and local calls, is asserted to be a prime example of this type of cost.

AT&T Divestiture

The AT&T divestiture agreement has many facets, but chief among them is an intent to reduce the ability of any company to use its control over local exchange facilities to restrict competition in other markets. This led to a series of requirements regarding the interconnection of interexchange carriers with the BOCs. The BOCs are to draw new, larger, exchange boundaries and to restrict their service offerings to telecommunications services within these boundaries and to provide exchange access services for interexchange carriers.[19] The BOCs are required to phase-in the offering of equal exchange access facilities to all carriers, but cannot refuse to offer access that is either inferior or superior to that received by AT&T at appropriately lower or higher prices.

The divestiture agreement also required that the existing division of revenues process be terminated at the time divestiture occurs. It is to be replaced by a series of unbundled, cost-based charges. An interexchange carrier may only be charged for access services which are actually used. While tariffs must be cost-based, they may include cost-justified price differentials reflecting differences in the quality of access received. The charges for origination or termination of traffic must be equal, per unit of traffic, for all interexchange carriers.

The FCC decision on access charges needs to be compatible with the provisions of the divestiture agreement if the implementation of both the divestiture and the FCC access charge order are to proceed in a timely fashion.

The FCC received comments from many parties on the four proposals for charging for NTS costs. In addition, most parties filed reply comments in response to the first round of comments. These responses reflected many differing views. A representative sampling of the responses is contained in the next section.

Responses to the Fourth Supplemental Notice

Approximately 70 organizations including telephone companies, interexchange carriers, federal government agencies, state regulatory

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[19] These new exchange areas are called LATAs-local access transport areas.

commissions, consumer groups, and large users filed comments in response to the four access charge proposals and other issues raised in the Fourth Supplemental Notice. There was substantial disagreement as to the preferred method of charging for NTS plant and somewhat less disagreement over the other issues. The Pure 2 approach tended to attract support from more groups than did any one of the other proposals, though many supporters urged alterations such as allowing a transition period.

The following subsections summarize a sampling of the various viewpoints.

Small Telephone Companies

Several small telephone companies filed comments, as did the Rural Electrification Administration (REA) and the Rural Telephone Coalition (RTC), both of which represent the interests of small and rural telephone companies. The Rural Telephone Coalition is composed of the National Telephone Cooperative Association, the National REA Telephone Association, and the Organization for the Protection and Advancement of Small Telephone Companies.

The small companies participating and represented in these proceedings are typically located in rural or semirural areas with low population densities. For example, the comments of Haviland et al. (a group of seven small telephone companies in Kansas and Oklahoma) report that there is no municipally incorporated territory with a population greater than 3,000 in the areas served by those companies,[20] and Central Oklahoma Telephone Company reports it has 1,200 customers with 3,200 stations and net investment, as of June 1982, of approximately $4.1

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[20]Haviland Telephone Company et al., "Comments," FCC CC Docket 78-72, "In the Matter of MTS and WATS Market Structure," Fourth Supplemental Notice of Inquiry and Proposed Rulemaking, p. 1.

million.[21] The small companies typically have few large business customers, and consequently they are less concerned with bypass than they are with the loss of individual subscribers through reduced commitment to universal service. Several companies report that their customers are typically on fixed incomes and typically make few toll calls. Studies of two small midwestern telephone companies, as reported in the comments of the Rural Telephone Coalition, indicate that two-thirds of the customers in each company make either zero or one interstate call in a month.[22]

The small and rural companies are characterized by high maintenance and construction costs, and this, together with the low population densities, means that their non-traffic sensitive costs are higher than those of large companies, operating in predominantly urban areas. In addition, the NTS costs vary substantially among the companies. For example, a small company in North Dakota has an <u>interstate</u> non-traffic sensitive revenue requirement per loop per month of $12.42 compared to $35.02 for a small company in Oklahoma. These are both significantly higher than the Bell system average of $7 to $8 per loop per month. In addition, these two companies have high <u>intrastate</u> NTS revenue requirements (the North Dakota company is $10.21 while the Oklahoma company is $10.91 per loop).[23] Using these two companies as an example, it is readily understandable that small companies were in general agreement that an access charge such as Pure 2, levied on subscribers, could have a serious negative impact on the number of customers who continued to subscribe to telephone service.

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[21]Central Oklahoma Telephone Company, "Reply Comments," FCC CC Docket 78-72, "In the Matter of MTS and WATS Market Structure," <u>Fourth Supplemental Notice of Inquiry and Proposed Rulemaking</u>, p. 2.

[22]Rural Telephone Coalition, "Comments," FCC CC Docket No. 78-72, "In the Matter of MTS and WATS Market Structure," <u>Fourth Supplemental Notice of Inquiry and Proposed Rulemaking</u>, p. 30.

[23]Ibid., p. 16.

The small telephone companies and their representatives generally favor uniform, nationwide averaged access charges. This is a logical position in light of their higher costs, smaller customer bases, and the wide disparity in costs among companies. Some companies support the concept of a flat rate for NTS plant, but want the charge levied on the carriers. Haviland et al., and Ketchikan Public Utilities support a minutes of use charge for access, such as Pure 1, but would modify the Pure 1 proposal to allow for an alternative for the truly dedicated private line, which does not access the switched network.

These companies favored pooling and supported a new intra-industry group to administer the access charge. Most of these companies suggested that the intra-industry group should not include AT&T or other interexchange carriers.

The predominant concern of these companies was the retention of universal service, and they viewed Pure 2 as a significant threat. They pointed out that subscribers in the metropolitan areas also benefit from universal service. Many reported that the cost of administering Mixed 2 is prohibitive for small companies. Also, some parties argued against a discounted access charge for OCCs and further stated that if such a discount is granted it should apply only to plant for which the costs, in fact, are lower. They further believed that competition should not be promoted at the expense of universal service. Some parties made the point that the threat of bypass can be handled under the FCC's section 214 authority, under which interexchange carriers acquire certificates for operation.

There was general agreement among these parties that: one, further data and analysis are needed before a decision is reached; two, that these proceedings should be consolidated with the Joint Board proceedings; and three, de-averaged access charges would reduce universal service and would retard the development of competition in rural or sparsely populated areas.

Large Telephone Companies

The large telephone companies tended to favor the Pure 2 approach, though there were some exceptions. The large companies are more concerned with the bypass threat and this is one reason they favor Pure 2. In addition, many argued that Pure 2 is the only economically efficient pricing method. AT&T supported Pure 2 but is concerned about the impact on universal service and consequently argued for a transition procedure. Rochester Telephone Company supported Pure 2 and felt there is only a limited threat to universal service. GTE supported the Pure 2 approach but would exclude CPE and inside wiring from the end-user charges. Also, GTE saw little need for a long transition period and supported either no transition period or one of three years or less. Southern New England Telephone and Cincinnati Bell both supported Pure 2 and both seek a long transition period.

United Telecommunications favored Mixed 2 over the other three proposals but felt it would have an adverse impact on multiline users and would reduce the number of lines they buy. United proposed an alternative access charge, a customer selecting tariff. This would contain several combinations of flat and usage charges and the customers would choose the plan that fit their communications use.

State Public Utility Commissions

Eighteen state commissions filed comments separately on the FCC notice, and referring to themselves as the Western states, submitted a joint filing on behalf of Idaho, Montana, Nebraska, New Mexico, South Dakota, Utah, and Wyoming. The commissions represented in the nineteen comments filed, had varying opinions about the proposed four access charge plans, and were more in agreement on the issues of aggregation and bypass.

Most of the state commissions were unable to support any of the four options, and some urged that a Joint Board be convened to conduct further analysis before an access charge decision is made. Two states favored Mixed 1 and three supported Mixed 2, though New York favored three modifications to Mixed 2 which would allow peak, off-peak, and business-residence differences to be recognized, and which would set the usage sensitive access charge on a per minute rather than per message basis. Three other state commissions, while not fully supporting any of the options, said that if a choice must be made they would support Mixed 2, while five others would support Mixed 1 as an interim measure.

The chief concern of the state commissions was universal service, and all rejected Pure 2 as an option. They also generally agreed on the need for greater analysis of the impact of each choice and the need for a transition period if any drastic change is made. Most of the state commissions stated that the threat of bypass should not be a major factor in determining the access charge structure, since the extent of bypass varies among the states. One state believes bypass should be prohibited. Many states support uniform nationwide rates, though the Western states, along with California, Florida, and Kansas voiced support for aggregating costs at the state level rather than nationwide.

Kansas believed that a uniform national access charge would protect against such impacts as extreme cost shifts, but could result in more bypass. They believe that aggregation at the state level is a reasonable compromise.

Missouri maintains that system bypass should not be a major factor in the choice of an access charge plan, as technology has already improved to a stage where bypass of the local network is economically practical.

New York contends that far too large an issue has been made about bypass, while Nevada believes that bypass should be prohibited. Vermont states that rates could vary to reflect the threat of bypass.

The Western states maintain that the FCC is not equipped to perform a "uniform nationwide approach," as they would not serve all markets equally. The proper allocation of local system costs will not be uniform among all states or exchanges.

California believes that changes should be aggregated as each state determines to be appropriate. This would better meet the individual and different state needs and could reflect the differing degrees of bypass. They say that any disparity among the states could be resolved by the establishment of a high cost factor.

Florida also believes that state regulators should set and implement access charges, and that a successful access plan must be highly sensitive to the bypass potential.

Other Common Carriers and Resellers

The OCCs and resellers generally favored a Pure 2 approach, though some favored modifications to Pure 2. One typical source of concern was the current unequal access facilities. Southern Pacific Communications suggested a ten year phase-in, as this would ameliorate the effects on consumers and could also correspond to the phase-in of equal access facilities. MCI and US Telephone supported Pure 2 only when equal access facilities were available. The Association of Long Distance Telephone Companies supported Pure 2, arguing that this would eliminate today's double payment of access charges by resellers. American Sattelite supported Pure 2 and stated that the access charge on end users would help eliminate AT&T's advantage over OCCs.

Business Telecommunications Corporation argued for a modified Pure 2 and said that the access charge should apply to all interexchange carriers on an equal basis. They further stated that there should be contributions to the local exchange from bypassers. Satellite Business Systems wanted costs assigned to cost causers and stated that additional charges should be levied against interexchange carriers which have advantageous access facilities. They argued for a premium charge on AT&T of not less than 31 percent relative to charges against OCCs. They further suggested that the FCC assert jurisdiction over all jointly-used access facilities, and give the states oversight regarding the flat charges for access.

Other Groups

The National Association of State Utility Consumer Advocates (NASUCA) is opposed to Pure 2 as it believes this option will put all of the NTS costs on the local rate payers. They look upon Mixed 2 and Pure 1 somewhat more favorably; however, they believe both of these access charge plans have some drawbacks.

NASUCA supports Mixed 1, but sees there being a problem in the fact that the weighted allocation factor used to assign the NTS cost burden to private lines is too low. NASUCA contended that information developed before a number of state commissions has shown that private line NTS costs should be higher than the same costs of the public switched network, on a relative basis. Thus, NASUCA believed that the Commission must ensure that the full interstate NTS costs associated with private lines are recovered by the exchange companies.

As regards bypass, NASUCA maintained that access charges should not be kept artificially low. If and when substantial bypass begins to occur, then access charges may be lowered.

Regarding aggregation, NASUCA saw advantages of both nationwide aggregation and of disaggregation. It suggested as a compromise, aggregation on a state-by-state basis to be administered by the states.

The U.S. Department of Justice believed that the FCC should put into effect an access charge plan as soon as possible. However, any plan that would greatly alter the existing interstate rate structure should be implemented cautiously. The Justice Department selected Pure 2 as the best of the four choices, as judged on the basis of efficiency.

The Justice Department further believed that bypass systems which are more efficient than the local exchange should be encouraged, and therefore no ban on bypass should be passed. However, the Department believed that pricing policies that do not reflect marginal cost and demand elasticities may induce inefficient bypass, and this bypass should not be encouraged.

The Justice Department saw advantages and disadvantages of aggregation and maintained that whichever method is chosen, AT&T should not administer the access charge plan, nor should the FCC undertake to sponsor the creation of an organization to do the administering. The arrangements to sponsor the administration of access charges should be privately initiated.

The Federal Executive Agencies recommended the adoption of a modified Mixed 2 plan, but also find the Pure 2 plan acceptable as it is the most economically efficient and the most likely to prevent bypass, since each customer would simply pay for the cost he incurs on the system. However, they did recommend modifications to the Pure 2 plan before it is implemented. First, they recommended that access costs be broken down by major service categories. Following this they recommended that a cost-based nationwide average access charge be developed for each customer class within each category of service.

The Federal Executive Agencies supported the adoption of uniform nationwide access charges because they would be easier to administer. However, they do concede that nationwide averaging could be economically inefficient.

Finally, the Federal Executive Agencies supported the use of weighted averages of the rates of return.

The U.S. Department of Commerce supported the use of Mixed 2 as an interim plan until a system could be developed which would minimize pricing distortions and guarantee reasonable prices for local services. They believed that none of the four proposed plans is adequate when addressing these issues.

The Department of Commerce also maintained that nationwide averaging would create severe pricing distortions and suggests partial de-averaging as an alternative.

The Access Charge Order

The Third Report and Order released February 28, 1983 details the access charge plan decided upon by the FCC. The access charge plan contains three major categories of charges: the end-user charge, a carrier common line charge, and traffic sensitive charges. The plan calls for ultimately allocating the subscriber loop cost to the end user in a flat rate charge. The end-user charge would be phased in over a seven-year period, beginning January 1, 1984. In the first year a minimum of $4 per line must be collected as a flat rate charge from business customers and at least $2 per line must be collected as a flat rate charge from residential customers. The remaining requirement of $2 per line per residential customer may be collected either as a flat charge or a usage charge, with the only constraint being that the ratio of business flat charge to residential flat charge cannot exceed 2:1. At the end of five years, all interstate subscriber loop costs must be allocated to the end user in either flat charges or a combination of flat and usage charges. At the end of seven years all end-user charges must take the form of a flat charge.

The carrier common line charge, to be collected from interexchange carriers, will consist of several parts. In the first year it will include the interstate CPE component, the interstate inside wiring component, a premium access fee charged AT&T for its superior quality of interconnection, a universal service fund factor and the residual interstate subscriber loop costs which are not collected from end users. The amount of residual subscriber loop costs will decline each year for five years until the entire amount has been transferred to the end-user charge. The interstate CPE component was frozen as of January 1, 1983 and will be phased out over a five-year period ending December 31, 1987. The interstate inside wiring component will decline over time until it is nonexistent, since the FCC ordered the ten-year amortization of embedded inside wiring. The premium access charge is set at $1.4 billion for the first year and it is anticipated that this will quickly be reduced as equality of interconnection becomes more widely available. The universal service fund factor will remain in the carrier's common line charge and is designed to alleviate the burden of end-user charges in those areas with higher-than-average subscriber loop costs.[24]

A final change with respect to interstate non-traffic sensitive plant relates to central office equipment. Under the existing separations process, parts of the central office equipment are considered to be non-traffic sensitive. The FCC order places these costs with the costs to be recovered through traffic sensitive charges. Consequently, only subscriber loop non-traffic sensitive costs are collected through the end-user and carrier's carrier charges.

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[24]Under the Joint Board decision, SPF was frozen at the January 1982 level and this factor will be used for the next two years. At the end of that time the high cost factor will be phased-in and thus the universal service fund will be initiated.

The traffic sensitive charges will be charged to the interexchange carriers on the basis of usage and consist of nine elements. These are line termination, local switching, intercept, information, operator assistance, common transport, dedicated transport, special access, and billing and collection. The order identifies the costs that are to be allocated to each element, and specifies the way in which each interstate service will be charged for the use of the various elements.

The access charge order does not precisely reflect any one of the four proposals, but it is a variation on the Pure 2 proposal. The transition period and the flexibility offered by a combination of flat and usage based end-user charges were thought, by the FCC, to help reduce any threat to universal service. The universal service fund, collected from interexchange carriers, is also designed to ease the burden on local rate payers. It is the FCC belief that by ultimately collecting all subscriber loop costs from the end users, the threat of uneconomic bypass is alleviated and the problem of price discrimination among services will be removed. In addition, the FCC feels that this access charge will promote efficient use of the network and aid the growth of competition in the interexchange markets.

The reaction to the FCC order was mixed. The large companies and OCCs were generally pleased with the decision because after the transition the customer would pay all non-traffic sensitive subscriber loop costs. The state commissions, consumer advocates, and other state political leaders were typically opposed to the end-user charge. This charge is being implemented on top of projected cost increases due to the divestiture, and cost increases due to new depreciation methods, the expensing of station connections, the deregulation of CPE, inflation, and other factors. As a result, intense concern about universal service is being voiced by many parties. In addition, there is the perception of some that the access charge ruling has been made to enhance competition and that competition should not be attained at the expense of universal service.

A major result has been the introduction of several bills in Congress to either alter the FCC decision or to devise alternative methods for ensuring universal service. Several of the proposed legislative actions are summarized in the following section.

The FCC also has reconsidered its Third Report and Order. On July 27, 1983 the FCC altered the original decision in several ways.[25] Of primary interest with respect to this present study is a change in the end-user charge. Initially the end-user charge will be $2 per line for residences and $6 per line for business lines. Ultimately, however, the end user will still be charged the full cost of subscriber loop plant. Other changes include a $2 per line charge for centrex users, a $25 per line charge for resellers and other forms of special access, and a redefinition of certain types of private line.

On October 18, 1983 the FCC suspended the access charge implementation until April 5, 1984, and possibly later. The delay was ordered to allow more time to examine the massive tariff filings resulting from this docket.

Congressional Initiatives

The congressional reaction to the FCC decision has been quite strong, with many members concerned about whether their constituents can afford telephone service. Several bills have been introduced in response to the FCC order.[26] The goal of all of these bills was the preservation of universal service, though the bills varied in their

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[25]"Memorandum Opinion and Order," FCC 83-356, released August 22, 1983.

[26]The bills examined by the NRRI include H.R. 3364, H.R. 3365, H.R. 3366, H.R. 3440, H.R. 3522, H.R. 3569, H.R. 3602, H.R. 3621, H.R. 3647, H.R. 3671, H.R. 3809, S. 1382, S. 1626, S. 1660, and S. 1677. These bills were introduced in the First Session of the 98th Congress over a period of time from May 25, 1983 to August 4, 1983.

approaches to this goal. Many bills cited other goals in addition to universal service, such as economic efficiency, compensation for all costs related to exchange access, and equity among interexchange carriers, customers, and others who benefit from the availability of exchange access services.

The bills typically revoked the FCC decision in FCC CC Docket No. 78-72 and required the commission to formulate new access charges. Some bills, e.g., H.R. 3522, H.R. 3364, and S. 1626 specifically required an allocation of non-traffic sensitive costs to interstate interexchange carriers while others spoke more generally to the need to have access charges which recover all costs associated with access to the local exchange network. Typically, the bills established a universal service fund to defray part or all of exchange company costs in excess of either 110 or 115 percent of the national average. In most cases, contributions to the fund came from surcharges or interexchange carriers. In some cases, contributions to the fund also come from charges levied on those bypassing the local loop, while in other bills bypass was prohibited.

Two bills, S. 1382 and S. 1677 did not speak specifically to a need for new access charges, but instead provided other mechanisms for the preservation of universal service. S. 1677 established a Universal Lifeline Telephone Service Fund for the purpose of maintaining universal service through the provision of lifeline rates. Contributions to the fund would come from toll carriers and those bypassing the local loop. The fund would be distributed to local exchange carriers for the purpose of defraying 50 percent of the lifeline subsidy, i.e., 50 percent of the difference between the cost of basic telephone service and the lifeline rate. To qualify for payments from the fund, the exchange carrier's lifeline rate must be offered pursuant to the state commission's mandate and must be directed to persons in need of such a subsidy. S. 1382 gives the FCC the responsibility to see that rates for basic telephone service do not exceed 110 percent of the national average for such service and leaves it to the FCC to devise a mechanism for achieving this goal.

The two bills receiving the most attention (as of September, 1983) were H.R. 3621, introduced by Chairman Wirth of the House Telecommunications Subcommittee and Chairman Dingell of the House Energy and Commerce Committee, and S. 1660 introduced by Senator Robert Packwood, Chairman of the Senate Commerce, Science, and Transportation Committee.

S. 1660 (Packwood) had among its objectives the provision of universal basic service at reasonable rates to rural and residential subscribers, and the assurance that all providers of telecommunications services share in the costs of providing universal service. This bill invalidated the FCC access charge order and established guidelines for a new system of access charges. It established a Universal Telephone Service Joint Board which would establish charges for the retention of universal service. These charges would be levied on all interLATA carriers as well as all other providers of interLATA services and private systems connecting directly or indirectly with the local exchange network. These charges would be used to reimburse local exchange companies for 90 percent of the costs of residential services which exceed the national average by more than 110 percent. Costs in excess of 250 percent of the national average would be reimbursed 100 percent. The bill further provided for a $100,000 fine for those who bypass the local network for the purpose of avoiding access charges. The FCC was given jurisdiction over all interLATA toll services and access charges, including intrastate and interstate, though the FCC has the option to transfer this jurisdiction to the states.

H.R. 3621 (Dingell-Wirth) had similar goals to the Packwood bill. However, it specifically revoked the FCC decision in FCC CC Docket No. 78-72 and utilized the current separations procedures until new access charge tariffs were designed. The new charges must be levied not only against interexchange carriers, but also against anyone providing access facilities or services comparable to those provided by exchange companies unless such services are not available from exchange companies. A Universal Service Fund would be established to defray the non-traffic sensitive costs of a local exchange company which exceed 115 percent of the national average. The amount of reimbursement would increase as the increment of NTS costs over the national average increases. The Universal Service Board would determine the schedule of payments, and the funds would come from a surcharge on all interstate carriers and customers who directly or indirectly connect with the local network, as well as on bypassers of interstate services. A $50,000 fine would be levied against bypassers who failed to notify the FCC, state commission, and carriers of their bypass activities. Jurisdiction over the access charges would be delegated to state commissions as long as they complied with federal rules. Jurisdiction with respect to depreciation and investment for all exchange plant, including that used jointly for interstate services would be given to state commissions.

An amended version of the Wirth bill, renumbered H.R. 4102, was passed by the House committee. This amended version prohibited end-user charges on residential and single line business customers. It also retained state jurisdiction over intrastate toll services. A substitute bill, H.R. 4295, was passed by the House of Representatives on November 10, 1982. This substitute bill was identical to H.R. 4102 except that bypassers who certify they have no connection with the local exchange system and have no intention of connecting with the local exchange company for back-up purposes will not be subject to the surcharge on bypassers.

A revised version of the Packwood bill (S. 1660) was passed by the Senate committee. It calls for a two-year moratorium on end-user charges. It further authorizes the FCC, in cooperation with state commissions, to study the original access charge proposal and report back to congress before the moratorium expires. This bill has not yet been scheduled for a floor vote by the Senate.[27]

Summary

The FCC access charge proceedings created enormous controversy. Two social policy goals were seemingly placed in conflict with each other, and inadequate data were available to resolve the controversies. The goal of universal service has long been a tenet of regulatory policy. Access to a telephone is generally considered essential to the well-being of individual citizens, and the establishment of a nationwide telephone network is viewed as important for the nation's economic growth and national defense. At the same time, the United States economy is built on a belief in the free market system, and the consequent encouragement of competition whenever possible. The current advancements in telecommunications technology have made competition a viable alternative for some markets which were previously regulated monopoly markets.

The FCC has ruled that there will be open entry in the market for interstate services and has restructured the pricing of exchange company services used to originate and/or terminate interexchange communications. The FCC believes this restructuring will not only aid the development of competitive forces, but will also retard the growth of uneconomic bypass, thus, in the long run, aiding the goal of universal service. Other parties including state regulatory commissions, small telephone companies, and many other public interest groups feel the access charge, as adopted by the FCC, will cause significant numbers of subscribers to drop off the network, and consequently the demise of universal service. The number and thrust of the bills introduced in Congress illustrate the depth and breadth of the reaction to the FCC decision.

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[27]As of November 16, 1983.

A major difficulty in evaluating the FCC decision has been a lack of relevant data and other information. Little definitive evidence of the scope of bypass, the reasons for bypass, and the impact of bypass has been made available. In addition, usage and elasticity data needed to evaluate the access charge impact on universal service has been available only to a limited degree. Finally, the cost data necessary to define cost-based prices is generally not available for several reasons. These include the fact that, historically, telephone accounting has not been done on a functional basis and the fact that the existence of numerous common costs creates severe definitional problems.

CHAPTER 3

A SIMULATION MODEL AND EXPERIMENTAL DESIGN

In this chapter, the Simulation Model for Access Charges (SMAC) and experimental design for this study are presented. SMAC was implemented in a general purpose cost allocation program developed by the NRRI. The program is called an Interactive Cost Allocation System (ICAS) and the reader is referred to appendix C for a description and sample run of this program.

In this study, SMAC is used to compute the change in average exchange revenue requirement per line for both typical residential and business lines. Also computed by SMAC is an estimate of the percentage of subscriber lines dropped from (or added to) service by the local network due to the price changes implied by the change in exchange revenue requirements. All of these changes are presumed to be due to the FCC-imposed end-user access charge and a corresponding shift in usage sensitive toll prices. However, the magnitude of the effects on local prices and drop-off of the new FCC policy are influenced by a number of economic and policy parameters incorporated in SMAC. To examine the direction and extent of this influence, SMAC is used experimentally to compute its estimates while systematically varying its parameters according to an experimental design known as an orthogonal fractional factorial design. These experimental results are presented in chapter 4.

As has been mentioned in earlier chapters, much of the concern about access charges involves the general impacts of these charges on basic exchange ratepayers and particularly the impact on universal service. There is little doubt that the prices of almost every type of telecommunication service will undergo substantial change over the next several years. The direction of these changes is already well understood. For instance, average interstate message toll service (MTS) rates are expected to decline[1] and in some cases force a concomitant decrease in intrastate MTS rates.[2] The flat or fixed charges for telephone service will increase.[3] What is generally not known are the magnitudes of these price changes, how they might vary from jurisdiction to jurisdiction, and how the ratepaying public might adjust to these changes. Some estimates of magnitudes have been made,[4] but they are based primarily on how NTS costs are recovered under the FCC's new pricing policy. More complete and accurate estimates of magnitudes are needed, such as those that incorporate institutional and regulatory constraints (i.e., separations process and revenue requirement formulas) as well as the traditional economic factors such as price elasticities and cost functions. The difficulty with this approach is that the literature does not contain the current, reliable estimates of price elasticities and cost functions needed for such estimation studies. Especially absent from the literature are these data on a state-by-state or even a regional basis. (See appendix D for a review of literature on telephone demand and appendix E for a review of literature on telephone usage.) What is more readily available and more reliable are accounting figures and the Separations Manual (Manual).

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[1]See, for example, Telecommunications Reports 49 no. 28 (July 18, 1983): pp. 11-12 where it was reported that the FCC had estimated a 15 percent reduction in interstate MTS rates.

[2]Ohio Bell Telephone Company has filed for a 40 percent decrease in intraLATA MTS rates, for example.

[3]Substantial increases in such rates have been proposed in Ohio, Missouri, and New Mexico, to name a few.

[4]"NARUC Testifies in House Oversight Hearings On Universal Telephone Service Costs - Testimony of Eric J. Schneidewind, Chairman of Michigan Public Service Commission," NARUC BULLETIN No. 13-1983, March 28, 1983, pp. 16-21.

Using the Manual as a guide and accounting information from BOCs as a data base, a reasonable 12-month approximation to the month-by-month separations process currently implemented by the Bell System was modeled in ICAS. This approximation to the separations process is a prominent feature of the larger system model (SMAC) that also includes, as exogeneous variables, the economic factors mentioned earlier. By making economic factors exogenous variables in SMAC, the problem of not having reliable information about them is avoided. Economic factors, modeled in this way, become experimental factors. In the absence of information about the values of these factors, different values can be experimented with in order to determine the importance and effect of the factor on basic exchange revenue requirements and drop-off. Further, this approach can help determine which combination of economic factors may result in doubling or tripling of basic exchange revenue requirements and which combinations are likely to result in lesser increases. Of course, this approach will leave to the individual state commission the problem of determining which combination of economic factors best describes their situation in order to assess the implications of the experimental results for its state. An advantage of this approach of experimenting with a simulation model is that at the end of this study there will still remain as a permanent research tool, the simulation model, with which further experimentation is possible. Furthermore, since the simulation model is programmed using the general purpose cost allocation computer package ICAS, the assumptions of the present simulation model can be changed relatively easily, especially as new information becomes available.

The sections of this chapter that follow contain detailed descriptions of SMAC and a discussion of the experimental plan that was used to examine the effects of various economic and policy factors.

The Simulation Model: An Overview

We begin with an overview of the simulation model showing four areas where the modeling effort was concentrated and showing the interconnection of these areas. This is followed by detailed descriptions of each area.

Figure 3-1 is a schematic representation of the four main modules of SMAC. The term module refers to a submodel resulting from the modeling effort in one of the four areas. A description of the functions of each module is shown in figure 3-1 follows:

1. Accounting, Cost, and Separations Module (ACS): This module accepts, as initial input, annual accounting and usage figures for a company operating in a particular state at a particular point in time. Additional input about new levels of interstate and intrastate usage are subsequently fed back to the module and used to update accounting inputs and separations. The output of the module is an intrastate revenue requirement.

2. Interstate Toll Usage Module (ITU): Based on exogenous inputs and an estimate of curtailment in the number of lines in service, this module estimates a resultant amount of interstate usage in the state under consideration. This information is fed back to the Accounting, Cost, and Separations Module.

3. Intrastate Toll Revenue and Usage Module (ITR&U): Based on exogenous inputs and an estimate of curtailment in the number of lines in service this module estimates both a resultant amount of intrastate toll usage and a resultant amount of revenues generated from intrastate toll. The Intrastate usage estimate is fed back to the Accounting, Cost, and Separations Module while the revenue figure is passed on to the Basic Exchange Rate and Service Curtailment Module.

4. Basic Exchange Rate and Service Curtailment Module (BERSC): This module receives the intrastate revenue requirement figure from the Accounting, Cost, and Separations Module and an estimate of intrastate toll revenues from the Intrastate Toll Revenue and Usage Module together with other exogenous input values. These are combined to obtain a revenue requirement for basic exchange service which is converted to an estimate of the change in average revenue requirement per line

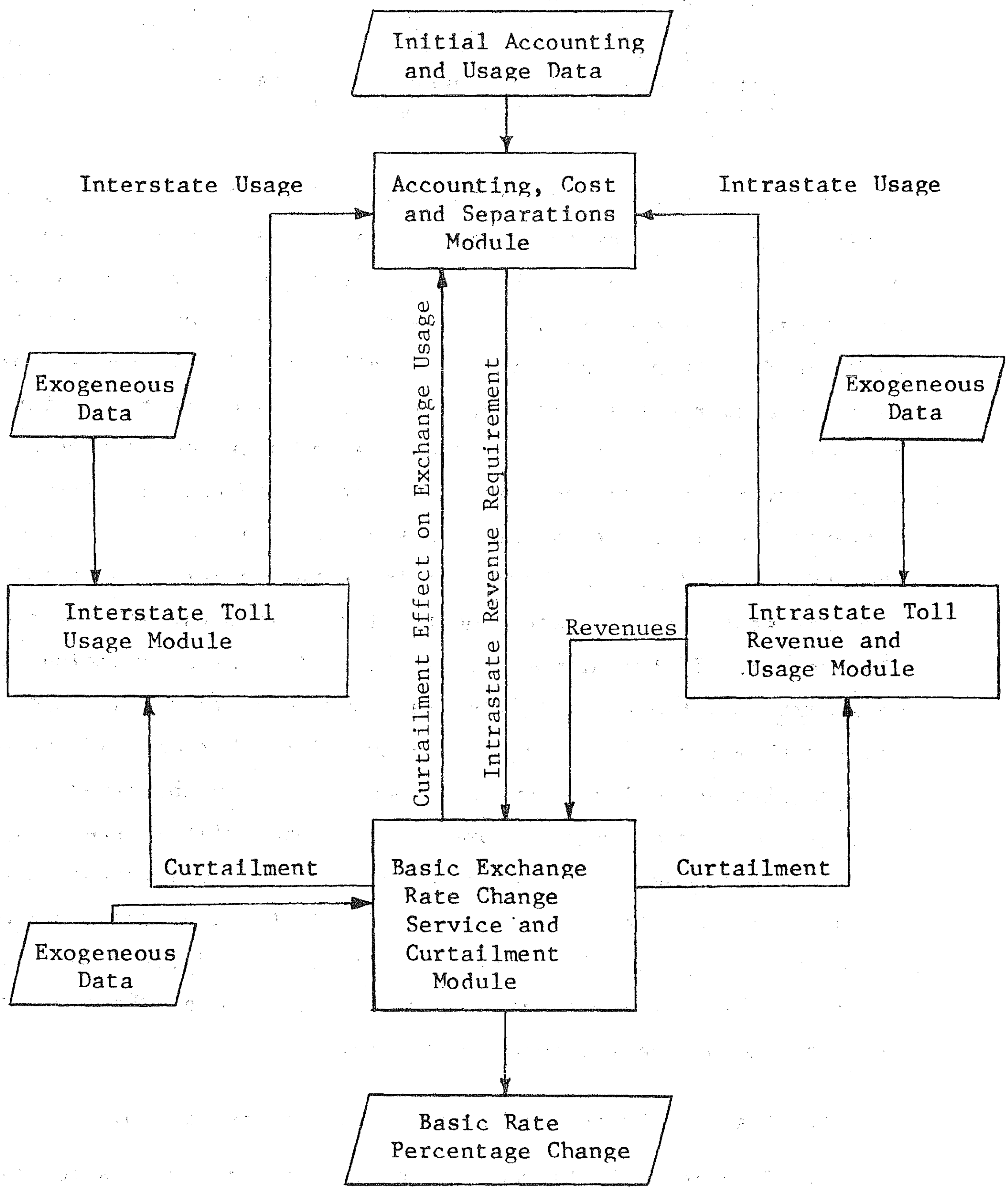

Fig. 3-1 Schematic overview of the Simulation Model for Access Charges

determined separately for business and residential customers. These changes in average revenue requirement are based on numbers of lines in service after curtailment of the number of lines in use because of the price increases. An aggregated curtailment estimate is fed back to the other three modules.

As will be seen in examining figure 3-1, the Accounting, Cost, and Separations Module, using a 1982 accounting data base and usage figures as well as information fed back to it from the other modules, computes an intrastate revenue requirement which is passed on to the Basic Exchange Rate Change and Service Curtailment Module. Access charges to interstate carriers are not explicitly considered at this point since the only concern is the effect that the end-user access charges have on basic service cost for end users and any consequent reduction in universal service. It is possible that in some states the revenues from the FCC-approved access charges to interstate carriers will not match the interstate revenue requirement not recovered through the end-user flat charge. If the mismatch is a shortfall, the calculations in SMAC would not pass the costs to the state jurisdiction nor attempt to recover them through additional end-user flat charges. If the mismatch is a surplus the calculations also would not pass the benefit to state jurisdiction nor attempt to lower the end-user flat charges. In fact, we have not amassed the data needed to compute the amount of a mismatch given the assumed interstate rates. If, in the long run a company cannot get FCC approval for carrier charges that fully recover the interstate revenue requirement as determined through the separations process, one of the following must result:

1. There would be established a subsidy mechanism.

2. Changes would be made in the separations process to lower the interstate revenue requirement (bringing further pressure on local rates).

3. Cost control measures by the operating companies would lower all revenue requirements including interstate.

4. Local companies would become financially distressed.

5. The FCC would institute individual rate proceedings for each carrier.

These are possible but highly speculative futures; they involve primarily the interstate jurisdiction. In this study we are primarily concerned with modeling the intrastate jurisdiction, thus, no attempt was made to compute revenues from interstate access charges.

A different situation for the intrastate toll portion of the model can be noted in figure 3-1. In this case the Intrastate Toll Revenue and Usage Module computes both intrastate toll usage and revenues. The usage figure is needed as input to the separations calculations and the revenue is needed as input to the Basic Exchange Rate Change and Service Curtailment Module. The computation of usage and revenues is made using standard supply-demand relationships to make incremental adjustments to the baseline 1982 usage and revenue figures. The conceptual problem with this is that, in 1982, telephone companies using traffic agreements and a settlements process shared the revenues for intrastate toll that came from direct charges to users, i.e., revenues derived from a final good. In most states the main place for regulatory intervention was in the setting of prices for final goods. When access charges are implemented, the revenues will come from direct usage charges to users as well as from access charges to carriers. There may continue to be some sharing of the revenues among companies through a settlements process depending upon the amount of pooling either permitted or required by the particular state commission. Nonetheless, the setting of prices for access will be an important new means of regulatory intervention into the intermediate goods market that did not previously exist except, perhaps, to a limited degree in ENFIA-type agreements[5]. Since these more direct prices in the intermediate goods market do not officially exist now (nor did they exist in 1982) it was not possible to model

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[5]Here, for example, a final good is MTS, while an intermediate good is a local distribution service termed access.

these two markets separately. Instead, we model them as a continuing single market.

In the absence of divestiture, a single market could, in fact, continue to exist. Even with divestiture, single LATA states conceivably could continue to maintain a single market, but in either case, states may decide to embrace competition in state toll markets and require the establishment of that second, intermediate goods market. In such a case, the single-market model used herein would have to be thought of as a model of a composite of the two markets that would exist. While this is not an ideal situation for analysis, no better model can be devised until divestiture takes place and these second markets are established.

Finally, in figure 3-1, the Basic Exchange Rate Change and Service Curtailment Module uses the intrastate revenue requirement and state toll revenues input to it from other modules together with other fixed data to compute a change in basic rates including the FCC's flat user charge. Also computed by this module is the amount of drop-off of customer lines and the consequent effect on usage. These usage effects are fed back to the other modules as indicated in figure 3-1.

A "solution" to SMAC is best characterized by the condition that final results of all calculations are stable and internally consistent. To illustrate what this means, consider a situation in which intrastate toll rates are changed. This action would lead to a change in intrastate toll usage and revenues. These quantities are then fed to the Accounting, Cost, and Separations Module and the Basic Exchange Rate and Service Curtailment Module respectively. Presumably the results of these usage and revenue changes will be a change in intrastate revenue requirement, basic rates, and perhaps some curtailment of service. This curtailment will again change the intrastate toll usage and revenues as well as interstate and exchange usage, all of which again affect separations and basic exchange rates, thus beginning another cycle. To obtain a solution then, a sufficient number of cycles must be computed so that these reverberative effects are eliminated and the results stabilized. At this point, the results will be internally consistent in the sense that the estimated usages are indeed the same as those used for separations, and the revenues will exactly equal the intrastate revenue requirement. A notational convention used throughout this chapter consists of indicating with a superscript the different values obtained for any single variable in different cycles. Thus, X^j represents the value for the variable X after being updated j times (i.e. in the j-th cycle), X^o represents the original value of X before any updating has occurred. A solution, as defined above, is found when enough cycles have been computed so that $X^{j+1} = X^j$ for all variables "X" affected in each cycle.

The next four subsections contain detailed descriptions of the four modules, including a schematic of each module, a statement of the modeling assumptions, a list of the requisite mathematical equations, and a list of the exogenous variables. In these descriptions, some exogenous variables will be called factors (often preceded by the word "economic"). The use of the word factor has special meaning in this context. It refers to variables that will be systematically fixed to two or more values as part of the experimentation done with the simulation model. The experimentation plan is given later in this chapter, but the objective of this plan is to be able to estimate the independent effects of certain of the factors on basic exchange rates and universal service.

Interstate Toll Usage Module

The economic factors assumed to affect the interstate minutes of use (MOU) in a given state are changes in prices, own-price elasticity, and the number of subscribers in the system. The symbols representing the three economic factors that are exogenous inputs to this module are:

I = fractional change in interstate toll rates,

η_i = own-price elasticity of demand for subscriber line MOU of interstate service,

D_i = the average interstate MOU per curtailed line relative to the average for all lines.

Other inputs to this module consist of one that is an exogenous parameter (symbol is U_i^o) giving the 1982 interstate subscriber line MOU for the state whose situation is being simulated, while the other is the curtailment, given as a fraction of the number of lines in service at the end of 1982. The latter has the symbol F^j representing its j-th updated value that is provided by the BERSC module.

The output of this module is U_i^j, i.e., the j-th computed estimate of interstate subscriber line MOU, and it reflects the result of current values of economic factors and the j-th computed estimate of the curtailment fraction.

The equation to compute U_i^j is given in equation (3.1).

$$U_i^j = U_i^o \,(1+I)^{\eta_i}(1+D_i F^j) \qquad (3.1)$$

Some assumptions are implicit in equation (3.1). First, it is assumed that in the aggregate the cross-elasticity of demand for interstate toll service relative to the prices for state toll and basic exchange service is negligible, except perhaps, for that elasticity due to the complementary nature of local exchange service and interstate toll service. Instead of modeling the complementary nature of any of the services as a source of cross-elasticities, we instead attempted to model a direct effect of drop-off from the local exchange on toll and exchange usage. That involved introducing the experimental factors D_i, D_s, and D_e. D_i appears in equation (3.1) while the other two appear in subsequent equations. Second, for large users there is the possibility of substituting CCSA or FX services for MTS (either state or interstate). Since CCSA and FX are not explicit components in SMAC, the modeling assumption is that the own-price elasticity of the MTS services are aggregate values that reflect consumption patterns due to both the utility for toll calling and the potential for substituting these alternative services. Finally, it is assumed that for the range of price changes considered in SMAC, the demand curve for interstate toll has a convex shape typical of constant own-price elasticity of demand. These modeling assumptions lead to $U_i^o(1+I)^{\eta_i}$ as a calculation intended to model the effect of interstate toll's own-price change, while that result is modified further by multiplication by $(1+D_iF^j)$ in order to model the effect of drop-off. Figure 3-2 gives a logic diagram for the Interstate Toll Usage Module. The major components in this figure show the input of exogenous factors and parameters, the input of the j-th cycle estimate of the fraction of drop-off determined by another module and the j-th cycle estimated usage output. The circles represent connections to similar entities in the figures in other sections.

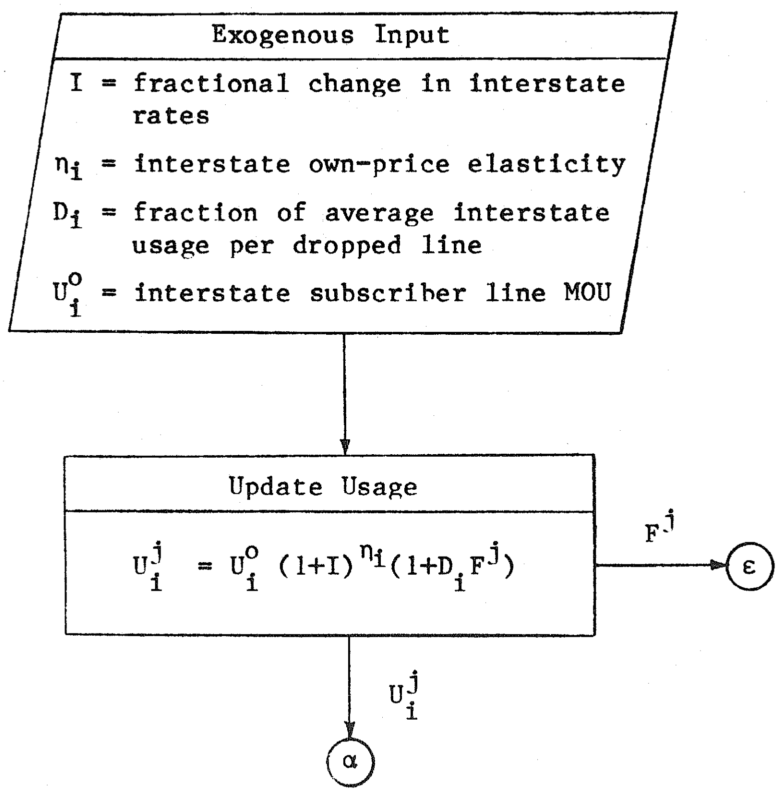

Fig. 3-2 Schematic of Interstate Toll Usage Module

Intrastate Toll Revenues and Usage Module

The economic factors assumed to affect the intrastate (state) toll revenues and MOU in a given state are similar to those affecting interstate usage. Specifically they are changes in prices, own-price elasticity of demand, and the number of subscribers in the system. The symbols representing these factors in this module are:

S = fractional change in state toll rates,

η_S = own-price elasticity of demand for subscriber line MOU of state toll service,

D_S = the average state MOU per curtailed line relative to the average for all lines.

Other inputs to this module consist of two exogenous parameters (symbols are U_s^o and R_s^o) giving the 1982 state subscriber line MOU and state toll revenues for the state whose situation is being simulated. Another input to this module is the curtailment in the number of lines in service at the end of 1982. This latter parameter is F^j, which is also input to the Interstate Toll Usage Module.

The two outputs of the module are updated estimates of state toll usage in subscriber line MOU and an updated estimate of state toll revenues derived from usage sensitive rates. The term update used in this context means the values are updated to the current cycle number, j.

The equation to update state toll usage is (3.2) and it has an identical structure to equation (3.1) which is used to update interstate toll usage.

$$U_s^j = U_s^o(1+S)^{\eta_s}(1+D_s F^j) \qquad (3.2)$$

The equation used to update revenues is equation (3.3).

$$R_s^j = \frac{R_s^o}{U_s^o}(1+S)\ U_s^j \qquad (3.3)$$

In equation (3.3), R_s^o/U_s^o is the average revenue per MOU. Multiplying by (1 + S) computes the new average revenue per MOU to reflect a general price change S and, finally, multiplying by the j-th cycle MOU, U_s^j, computes the j-th cycle total state toll revenues, R_s^j, derived from usage sensitive charges.

Assumptions similar to those embodied in equation (3.1) are embodied in equation (3.2). Namely, neither interstate nor exchange calls are substitutable for a state toll call; the indirect income effect on state toll calls of price changes of other telecommunication service is negligible; and the direct effect of drop-off from the local exchange on state toll is not negligible but is unknown and thus becomes an experimental factor. Equation (3.3) uses average revenues as a proxy for average price.

Figure 3-3 is a schematic model of the Intrastate Toll Revenues and Usage Module and shows the input of exogenous factors and parameters and displays the sequential requirement that usage be updated (to j-th cycle) first then revenues are updated. Again, circles represent connections to the diagrams of other modules.

Basic Exchange Rate and Service Curtailment Module

The economic factors assumed to directly affect the exchange rates are the prices charged for interstate user access, the own-price elasticity of demand for connections to the local network, the amount of curtailment, and the revenue requirement for exchange service. Several symbols are needed to represent the variables used to model the effect on prices of these economic factors. In particular, RR_s^j is the intrastate revenue requirement in the j-th cycle, R_{SPL}^o is the 1982 revenue received from state private line service; R_{CPE}^o is the 1982 revenue received from the rental of customer premises equipment (CPE); R_{MISC}^o is the revenue from other miscellaneous services such as directory advertising, etc; and R_s^j is the state toll revenue as estimated in the

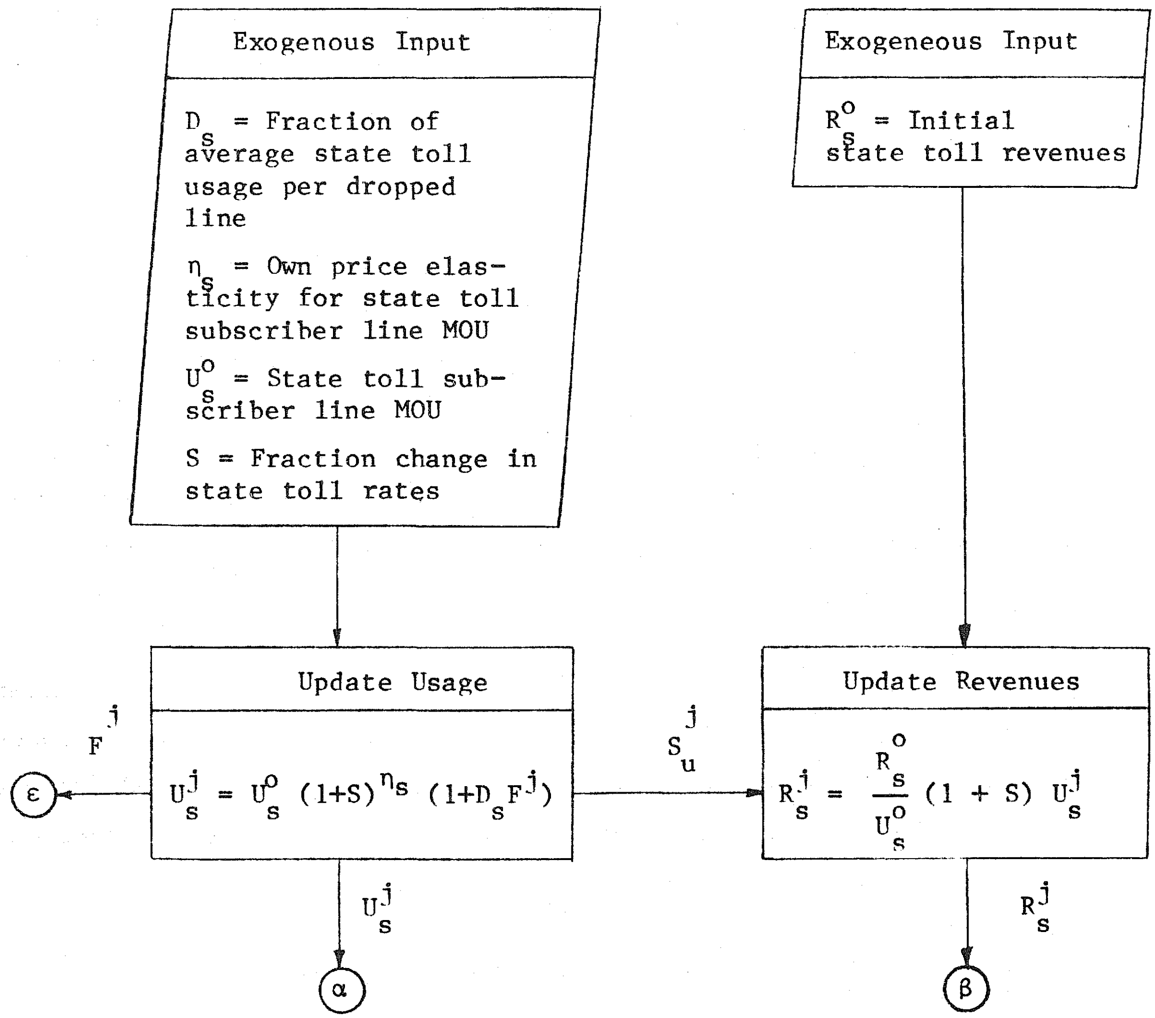

Fig. 3-3 Schematic of Intrastate Toll Revenues and Usage Module

j-th cycle. A revenue requirement for basic exchange service, RR_e^j, is then computed for the j-th cycle as shown in equation (3.4).

$$RR_e^j = RR_s^j - R_{SPL}^o - R_{CPE}^o - R_{MISC}^o - R_s^j \quad (3.4)$$

Implicit in the calculation indicated in equation (3.4) are the assumptions that the exchange revenue requirement is the residual state revenue requirement after deducting the revenues from these other services, and that the state private line, CPE, and miscellaneous revenues will not vary from 1982 levels. A more refined alternate assumption to the latter one is that any deviation in state private line revenues, CPE revenues, and miscellaneous revenues from 1982 levels is exactly opffset by an equivalent deviation in costs as measured by the intrastate revenue requirement. The implications of these assumptions not being true for CPE are discussed in chapter 6.

Once an updated exchange revenue requirement, RR_e^j, is determined, the fractional increase (or decrease) in average revenue requirement per line determined separately for residential and business customers is computed using the following formulas:

$$F_R^j = \frac{\dfrac{RR_e^j}{L_R^j + B \cdot L_B^j} + v_R}{\dfrac{RR_e^o}{L_R^o + B \cdot L_B^o}} - 1 \quad (3.5)$$

$$F_B^j = \frac{\dfrac{B \cdot RR_e^j}{L_R^j + B \cdot L_B^j} + v_B}{\dfrac{B \cdot RR_e^o}{L_R^o + B \cdot L_B^o}} - 1 \quad (3.6)$$

In equations (3.5) and (3.6), L_R^o and L_B^o are initial values for the number of residential and business lines respectively, while L_R^j and L_B^j are the same values updated to the j-th cycle. The updating takes place in other equations in this module. The FCC's flat charges for residence and business access to interstate carriers are v_R and v_B. B is the ratio of average revenues per business line in 1982 to average revenues per residence line in 1982, and is used to convert a business line count into an equivalent residential line count where equivalence is defined in terms of equal average revenues. Finally, the fractional change in local exchange revenue requirements per line is F_R^j for residences and F_B^j for businesses. One may note that although the FCC charge for interstate access is not legally a charge for basic service, it has been included in the calculations indicated by equations (3.5) and (3.6). The reason for this is that, for all practical purposes, it is indistinguishable from a local service charge in terms of its effect on residential or business budgets and on decisions to connect.

The service curtailment part of this module estimates the number of residence lines and business lines that will be in service after the price changes occur and then aggregates these two figures into a composite fraction, F^j, of lines dropped from use in the system. It is assumed that the number of lines in use in the system are affected by price changes[6], and own-price elasticities of demand for connection. In this case the price changes are computed as described above but the elasticities are treated as economic factors. These elasticities are:

η_R = own-price elasticity for the connection of residential customers,

η_B = own-price elasticity for the connection of business customers

Thus, line counts are updated by the following formulas:

$$L_R^j = L_R^o \, (1+F_R^j)^{\eta_R} \qquad (3.7)$$

$$L_B^j = L_B^o \, (1+F_B^j)^{\eta_B} \qquad (3.8)$$

where all symbols have been previously defined. Again, implicit assumptions in equations (3.7) and (3.8) are that connections are unaffected by

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[6] F_R^j and F_B^j are fractional changes in average revenue requirements per line and are used as proxies for fractional changes in prices.

the prices of other goods and services and that the own-price elasticity is constant (over the range of prices being considered).

As a final calculation of this module, the effect of the change in number of lines on exchange usage is computed according to equation (3.9).

$$U_e^j = U_e^o \,(1 + D_e F^j) \qquad (3.9)$$

where U_e^j is the subscriber line MOU of exchange calling in the j-th cycle; U_e^o is the initial usage value; F^j is as previously defined and D_e is the value formed by dividing the average MOU of exchange calling per line for lines dropped from service by the average MOU of exchange calling per line for all lines in service. D_e is an experimental factor in the model since it is unknown what calling patterns will exist for those who drop off the system because of price increases.

Figure 3-4 is a diagram of the Basic Exchange Rate and Service Curtailment Module showing the components of the module and the interconnection of these components. As is readily seen by studying the diagram in figure 3-4, there are two direct ways basic prices are affected. One is through changes in the revenue requirement that trickles down from the other three modules. The second is through changes in the size of the customer base across which the revenue requirement must be spread. This second effect is totally handled within this module but usage changes are fed back to the Accounting, Cost, and Separations Module where they can affect anew the revenue requirement.

The Accounting, Cost, and Separations Module

At the heart of SMAC is the Accounting, Cost, and Separations Module. The components of this module perform three basic functions. First, the book costs for the total company operating in a state are

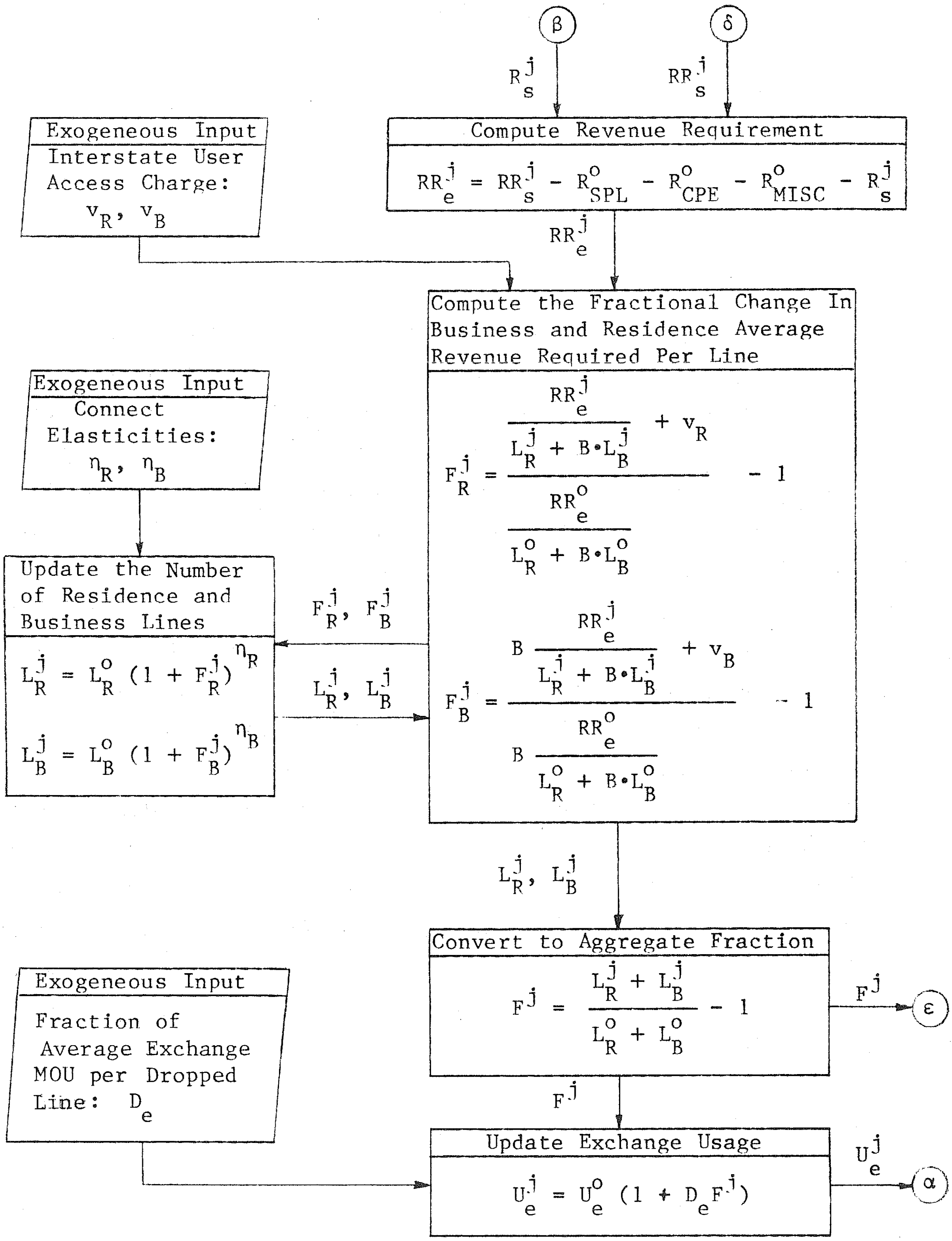

Fig. 3-4 Schematic of the Basic Exchange Rate and Service Curtailment Module

separated between the interstate and intrastate jurisdictions in accordance with the Manual. Second, accounting-cost data for traffic sensitive switching and trunk plant and related maintenance and traffic expenses are adjusted to reflect the potential increases in expenditures in response to increases in toll traffic. Finally, the usage factors used in the separations procedures are updated to capture consumer responses to changes in interstate and state toll charges, implementation of access charges, and changes in the basic exchange rate.

The initial inputs to this module fall into three broad classifications. First, accounting data were requested from five Bell companies that operate in the five states participating in the study. The value of the investment accounts was requested as of June 1982, while the value of the expense accounts was requested as of December 31, 1982. The request for these data was intended to allow simulation of the separation procedures. The second broad classification of initial inputs consisted of relative usage data appropriate for allocating the companys' book costs between the interstate and state jurisdictions. For some accounts or subaccounts, the actual interstate and state apportionment was requested. Third, several elasticities of certain traffic sensitive investment cost with respect to subscriber line MOU were estimated and entered in order to perform an accounting-cost update. These elasticities are treated as experimental factors. Each of these classifications of initial inputs is discussed below in the subsection dealing with the component in which they are used.

The Separation Component

The separations procedures used in SMAC are a hybrid of the procedures contained in the Manual and the Bell System's division of revenue process (DR) as implemented with their Interstate Settlements Information System. The Manual is available publicly. The program documentation, contained in appendix B, provides the details of the separation procedure as implemented in SMAC. Finally, a study by

J. W. Wilson and Associates, gives a detailed discussion of the similarities and differences between the Manual's procedures and the DR procedures.[7] These three sources combined provide an excellent overview of the separation procedures.

Several differences between the instruction specified by the Manual and the DR procedures should be pointed out. Chief among these differences is the treatment of the outside plant accounts (accounts 241 through 244). The DR process aggregates all the 240 series of accounts for a given category of costs while the Manual breaks each account down by cable, cable loading and other costs and then categorizes each account using engineering data applicable to each account. Furthermore, the DR procedures for categorizing costs has been updated to reflect technologically new service and to eliminate TWX. These changes were adopted and the DR procedure for outside plant accounts is used in SMAC.

Other differences between DR procedures and the Manual involved the categorization of some of the revenue accounts (500) and expense accounts (600, 603, 605, 622, 624, 644, and 662). In each case, expediency and availability of data led the research team to employ the DR procedure or to request the interstate-intrastate allocation directly from the company. In some cases (and with some reservation), it was assumed that the usage or engineering data on which the apportionment was based could be inferred from these dollar amounts.

The Central Office Equipment Account (account 221) and the outside plant accounts (accounts 241 through 244) have a substantial impact on the separation of the company's costs. These plant accounts constitute 65 to 70 percent of the undepreciated cost of plant in service (account 100.1) and directly or indirectly determine 45 to 50 percent of the

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[7] J.W. Wilson and Associates, A Study of Jurisdictional Separations to Compare AT&T's Interstate Settlements Information System with the Separations Manual and Division of Revenues Process, (Washington, D.C.: J. W. Wilson and Associates, 1980).

revenue requirement to the intrastate jurisdiction. More importantly, the investment in local dial switching equipment and subscriber line outside plant is approximately 39 percent of plant in service and roughly 60 percent of the investment in central office equipment (COE) and outside plant (accounts 241 through 244). It is evident that the treatment of these costs will weigh heavily on the final outcome of the computer simulation model.

Accounting-Cost Update Component

The accounting-cost update component of the accounting cost and separations module can adjust account totals for toll-related investments and expenses in response to increases in toll traffic. The investments and expenses that would be updated are classified as traffic sensitive (TS). These update procedures and the accounts and cost categories affected by them are covered in this subsection. First, the update of the cost of TS investments is discussed. This is followed by the procedure for the update of investment-related expense accounts. Finally, the update of traffic expenses is covered.

The accounting-cost update for investment is applied to traffic sensitive cost categories of central office equipment (account 221) and outside plant (accounts 241, 242.1, 242.2, 242.3, 242.4 243, and 244). These cost categories were selected by identifying investment in one of these accounts by function and use. For example, outside plant can be categorized as interexchange trunking dedicated only to state toll, interstate toll, or could be jointly used in exchange and toll message service. The cost categories of COE and outside plant updated by the accounting cost update are presented in table 3-1 along with the jurisdictional use of plant. Each of the cost categories identified in the first column are from the Manual. In the second column, the jurisdictional use of the plant is given. Interstate and state uses of plant refer to toll usage, while exchange refers to non-toll use, although it might be interexchange.

TABLE 3-1

COST CATEGORIES OF THE OUTSIDE PLANT AND CENTRAL OFFICE EQUIPMENT ACCOUNTS USED TO DEVELOP THE ACCOUNTING COST UPDATE

Cost Category	Jurisdictional Use of Plant
Outside Plant (241-244)	
Wideband exchange trunk and loop outside plant for wideband message services.	interstate state exchange
Exchange trunk outside plant, excluding wideband, used exclusively for toll message service including WATS or jointly for exchange and toll message service.	interstate state exchange
Interexchange outside plant furnished to another company for interstate use.	interstate
Wideband interexchange outside plant, excluding, interexchange outside plant furnished to another company for interstate use, used for message service.	interstate state exchange
Interexchange outside plant, excluding wideband and interexchange outside plant furnished to another company for interstate use, used exclusively for intrastate message services.	state
Interexchange outside plant, excluding wideband and interexchange outside plant furnished to another company for interstate use, used jointly for message service.	interstate state exchange
Central Office Equipment (221)	
Manual telephone switching equipment--auxiliary service boards--separate intercepting boards.	interstate state
Manual telephone switching equipment--auxiliary service boards--separate rate and route boards that are not included with the cost of toll service boards.	interstate state
Manual telephone switching equipment--separate toll service observing boards.	interstate state
Manual telephone switching equipment--auxiliary service boards--directory assistance calls received over toll directory assistance trunks form operators or customers.	interstate state
Manual telephone switching equipment--switchboards handling both toll and DSA, either combined or having segregated toll and DSA positions in the same line.	interstate state
Dial tandem switching equipment--primarily handling exchange or shorthaul toll traffic or both.	interstate state
Dial tandem switching equipment--which handles significant amounts of long-haul toll traffic incoming or outgoing from a tandem area.	interstate state
Intertoll dial switching equipment, excluding equipment used in the interconnections of swithcing private line trunks or TWX switching plan trunks.	interstate state
Automatic message recording equipment used for the entire duration of the call.	interstate state
Automatic message recording equipment used only momentarily.	interstate state
Toll dialing switching equipment other than that in dial tandem switching equipment, intertoll dial switching equipment, automatic message recording equipment, and toll connecting trunk and completing equipment in local dial switching equipment.	interstate state
Auxiliary service for manual telephone switching equipment--auxiliary service board jointly used for more than one auxiliary service.	interstate state
Manual telephone switching equipment--joint exchange and toll service observing boards.	interstate state exchange
Local dial switching equipment--crossbar, step by step, and EES--traffic sensitive portion only.	interstate state exchange

Source: Authors compilation

The cost categories in table 3-1 for each state were divided into two groups for analytical purposes. First, all switching investment costs for joint-toll use for each state were aggregated. The second group consisted of the aggregate of all other switching and trunking investment costs for each state. These two pieces of information for each state were the dependent variable for two regressions to determine the elasticity of investment costs with respect to subscriber line MOU.

Assuming constant cost elasticities, two log-linear regressions were performed. The first regressed joint-toll switching investment for the five study states on the corresponding toll usage for the same states. The other regression, again, used data from the five study states and fit a log-linear relationship between all other switching and trunking and usage. The details and results of these two regressions are reported in appendix F. Two elasticities were derived from the regression results. One measured the percentage increase in investment expenditure for joint toll switching equipment as a result of a one percent increase in toll subscriber line MOU. Its value was .959. The other elasticity measured the percentage change in investment expenditures for all other traffic sensitive switching and trunking as a result of a one percent increase in toll and exchange subscriber line MOU. Its value was .8. These elasticities (η) are used in the accounting-cost update. With data from only five states to estimate the elasticities, actual values could deviate substantially from the estimates. For this reason, SMAC treats the elasticities as experimental parameters and we use the regression results only to help design the experiments.

The general accounting-cost update formula is given by:

$$K_{ac}^{j} = K_{ac}^{o}\left(\frac{U^{j}}{U^{o}}\right)^{\eta} \qquad (3.10)$$

where K_{ac}^{j} is the dollar value recorded in cost category c of account a in cycle j; K_{ac}^{o} is the initial dollar value recorded in cost category c of account a; U^{j} is the value of the appropriate subscriber line MOU in cycle j; U^o is the initial value of the appropriate subscriber line MOU; and η is the appropriate elasticity of investment expenditures with respect to subscriber line MOU.[8] The updated usage figures U^j are from the Interstate Toll Usage Module, the Intrastate Toll Revenue and Usage Module, and the Basic Exchange Rate and Service Curtailment Module.

The accounting-cost update formula was applied to each cost category listed in table 3-1. The resulting updated investment expenditures were then distributed to the jurisdictions by the separations component of this module and used to update maintenance expenses.

The update of maintenance expense was relatively more straightforward. It was assumed that maintenance on outside plant (accounts 602.1, 602.2, 602.3, 602.4, 602.5, 602.6, and 602.7) and central office equipment (accounts 604 and 610) is proportional to the investment expenditures on each type of plant. Thus, the update formula was given by:

$$\frac{E_a^o}{\sum_c K_{ac}^o} \left(\sum_c K_{ac}^j \right) = E_a^j \qquad (3.11)$$

where E_a^o is the initial value for expense account a, K_{ac}^o and K_{ac}^j are as defined above, and E_a^j is the new value for expense account a. The summation over all cost categories c for account a for K_{ac}^o and K_{ac}^j yields the initial and updated total amounts for account a, respectively. These updated values for maintenance expenses are separated between jurisdictions by the separations components of the module.

A procedure similar to that used for maintenance expenses was employed to update the depreciation expenses for the outside plant and COE subaccounts of account 608. The updated values of the subaccounts

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[8]The use of SLU minutes of use as a proxy for busy-hour usage over an interval of time assumes the relationship between the design busy-hour capacity and the average hourly usage of such plant is constant across the five study states.

of account 608 are separated between jurisdictions by the separations component of this module.

The update of traffic expenses involved a regression of the general traffic supervision (account 621) and operators' wage (account 624) expenses on joint toll and exchange usage as measured by subscriber line MOU. This regression yielded an elasticity of these expenses with respect to subscriber line MOU. The details and results of this regression are reported in appendix F. This elasticity (η) is used in the following update formula:

$$E_a^j = E_a^o \left(\frac{U_i^j + U_s^j + U_e^j}{U_i^o + U_s^o + U_e^o} \right)^{\eta} \qquad (3.12)$$

where E_a^j and E_a^o are the update and initial amounts for account a, where a is either account 621 or 624. The U_i^o, and U_s^o, and U_e^o are the initial subscriber line MOU for interstate, state, and exchange, respectively, and the U_i^j, U_s^j and U_e^j are the same for cycle j, respectively. η is the appropriate elasticity for traffic expenses. Its value is .616. These updated traffic expense accounts are separated between jurisdictions by the separations component of this module.

The Usage Factor Update

The usage factor update component of the accounting cost and separations module revises usage-related allocation factors for changes in interstate, state, and exchange usage. The purpose of this component is to allow the separation of a company to reflect changes in usage that are caused by the imposition of access charges, associated changes in toll rates, and concomitant changes in basic local exchange rates. In this subsection, this update procedure is covered. First, the basic formulas are presented. Following this presentation, assumptions concerning the use of subscriber line MOU as a proxy for usage in this usage factor update are discussed.

The usage factor update component consists of two basic formulas and their compliments. One formula is used to revise allocation factors applied to joint toll costs, while the other revises joint toll and exchange costs. The formula for toll-related investments and expenses is given by

$$f_s^j = \frac{1}{1 + \left(\frac{1}{f_s^o} - 1\right) \frac{U_i^j}{U_i^o} \frac{U_s^o}{U_s^j}} \qquad (3.13)$$

where f_s^j is the revised allocation factor for state jurisdictional costs; f_s^o is the initial allocation factor for state jurisdictional costs; U_i^j is the updated SLU minutes of use for interstate toll service, while U_i^o is the initial value for interstate toll usage; and U_s^j is the updated SLU minutes of use for state toll service, while U_s^o is the initial value for state toll usage. The updated subscriber line MOU are input from the interstate and state usage update modules. The revised allocation factor for the interstate jurisdictional costs (f_i^j) is given by the compliment of f_s^j; that is

$$f_i^j = 1 - f_s^j \qquad (3.14)$$

The revised allocation factors f_i^j and f_s^j are applied to the appropriate toll-related investments and expenses.

The formula for joint toll and exchange investments and expenses is given by

$$f_{se}^j = \frac{1}{1 + \left(\frac{1}{f_{se}^o} - 1\right) \frac{U_i^j}{U_i^o} \cdot \frac{U_s^o + U_e^o}{U_s^j + U_e^j}} \qquad (3.15)$$

where f^j_{se} is the revised allocation factor for state jurisdictional costs; f^o_{se} is the initial allocation factor for state jurisdictional costs; and U^j_e and U^o_e are, respectively, the updated and initial subscriber line MOU for exchange service. U^j_e is an input from the exchange usage module. The U^j_i, U^o_i, U^j_s, and U^o_s are as previously defined. The revised allocation factor for the interstate jurisdictional costs (f^j_i) is given by the compliment of f^j_{se}; that is:

$$f^j_i = 1 - f^j_{se} \tag{3.16}$$

The revised allocation factors f^o_i, f^o_s, and f^o_{se} are applied to investments and expenses classified as joint toll and exchange costs.

The initial allocation factors f^o_i and f^o_{se} are calculated from two sources, depending on the information received in the data request submitted to the five Bell companies. For some accounts or cost categories, the usage information specified by the Manual was requested directly. In this case, the initial allocation factor is formulated from this information. For other accounts and cost categories, the use information specified by the Manual was not directly obtained. Instead, the dollar amount allocated to the interstate jurisdiction and the total dollar amount for an account or cost category was requested. The residual amount is applied to the state jurisdiction. From this information, the fraction of the total dollars for a given account or cost category that is allocated to interstate is assumed to reflect the relative usage data that are specified by the Manual. In this case, the allocation factors f^o_s and f^o_{se} are the ratio of dollars left for the state jurisdiction to the total amount in an account or cost category.

The use of subscriber line MOU as a proxy for all measures of usage entails evoking a few reasonable assumptions. The primary assumption is that changes in usage are spread evenly throughout the switching and trunking network. This means that traffic units, minutes of use, dial equipment minutes of use, toll messages, and number of connections that are used for allocating switching costs are assumed to increase in the same proportion as subscriber line MOU. Similarly, conversation-minute-miles and minutes of use that allocate trunking costs are also assumed to increase in the same proportion as subscriber line MOU. In addition to this primary assumption, it was necessary to assume that calling patterns did not change. In other words, only the increased or decreased frequency of calls along fixed paths affected the allocation procedure. These basic assumptions enabled the simulated allocation of costs to the interstate and state jurisdiction to respond to changes in subscriber line MOU.

A schematic model of the Accounting, Cost, and Separations Module is presented in figure 3-5. This shows the components of the module and the interconnection of these components. As can be observed, the separation of the accounting costs can be altered in four ways. The first three changes are due to the interaction of the usage factor update component with the other three modules of SMAC. The fourth is due to the accounting cost update component. The output of this module is the revenue requirement for the state jurisdiction.

Experimental Design

Before discussing the experimental design intended to study the response of SMAC to the various experimental factors, it is useful to summarize these experimental factors. One may recall that these factors were represented as exogeneous variables in SMAC as presented in the preceding sections. Not specifically identified earlier as an experimental factor is the "state." Each state has associated with it all the initial accounting and usage values needed by SMAC. The state-to-state variability among these data may very well have a significant effect on the simulation results. Thus, the state is an experimental factor with a nominal rather than ordinal value. In table 3-2 are listed all the experimental factors, an indication of which module(s) they appear in, and whether they are qualitative or quantitative variables.

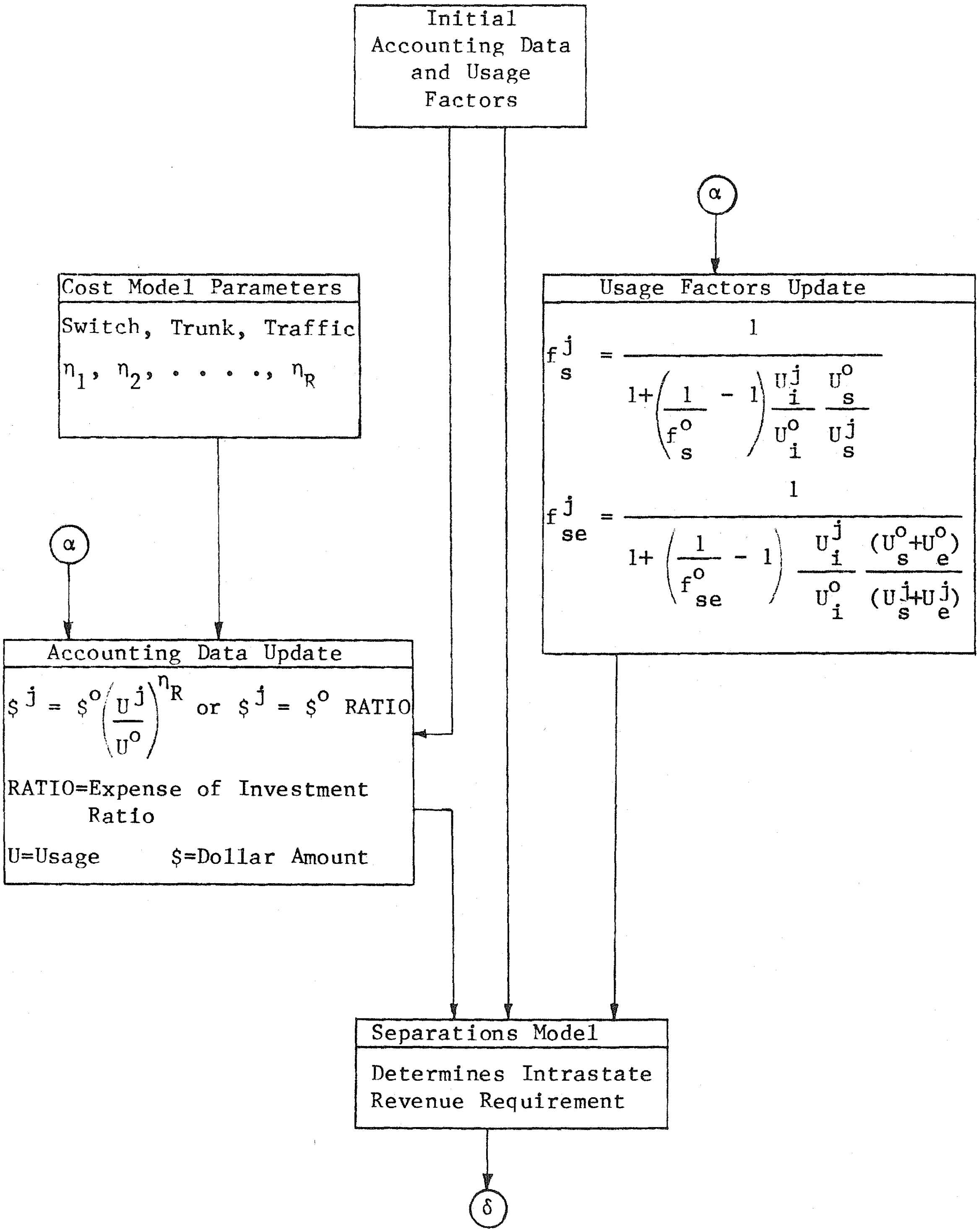

Fig. 3-5 Schematic of the Accounting, Cost, and Separations Module

TABLE 3-2

EXPERIMENTAL FACTORS IN SMAC

Factor Symbol	Description	Module	Type
none	State	ALL	Qualitative
I	Fractional change in interstate MTS rates	ITU	Quantitative
S	Fractional change in state MTS rates	ITR & U	Quantitative
η_i	Own-price elasticity for interstate MTS	ITU	Quantitative
η_S	Own-price elasticity for state MTS	ITR & U	Quantitative
η_R	Own-price elasticity for residential connection	BERSC	Quantitative
η_B	Own-price elasticity for business connection	BERSC	Quantitative
D_i	Fraction of average interstate MOU per dropped line	ITU	Quantitative
D_s	Fraction of average state MOU per dropped line	ITR & U	Quantitative
D_e	Fraction of average exchange MOU per dropped line	BERSC	Quantitative
none	Overcapacity in traffic sensitive toll-related plant	ACS	Qualitative

Source: Authors' Assumptions

One of the principal impacts of access charges about which there is great concern is their effect on the price of local service. This includes the fixed charge to users for interstate access as levied by the FCC in FCC CC Docket No. 78-72 and later modified in reconsideration. Although this user access charge is not legally a local service charge, it is, for all practical purposes, indistinguishable from a local service charge. As state commissions deal with changes in the local exchange revenue requirement, it is important to know what information to seek and what effects state regulatory policy can have on the expected impact. To answer these questions it is helpful to establish an empirical relationship between the change in local exchange revenue requirement and the set of experimental factors listed above in table 3-2. This is the objective of the experimental plan.

The Factorial Design

Among the most efficient classes of experimental designs are those termed orthogonal designs.[9] A large subclass of orthogonal experimental designs are called factorial designs in which all experimental factors are made to vary independently of each other. Since the experimental factors listed in table 3-2 can vary independently of each other in SMAC, a factorial design is both appropriate and efficient. However, there is a large number of experimental factors (i.e., the 11 factors listed in table 3-2), and if each factor, except the state factor, is set to only two different values (two-level experiment) while the state is set to five levels, then a full factorial design would require 5,120 experimental observations. Such an experiment would have been enormously expensive to run and to analyze. Therefore, the strategy used by the research team was to combine factors where possible and through a sequential process of running and analyzing very small (8 observations) orthogonal fractional factorial designs in one state only, arrive at a good design consisting of 16 observations. This final design was then replicated in each of the other four states.

In order to describe the final experimental design, a standard notation is used where capital letters are arbitrarily assigned to the final experimental factors. Table 3-3 lists the new factor notation for all the factors except state. Each of these factors was assigned two levels as indicated in the table. Since the replicate run in each state was to consist of 16 observations, and since the newly-defined factors totaled 6 in number, the replicates were each to be a 2^{6-2} fractional factorial design. The final design selected was the principal fraction of those that result from confounding with the mean the interaction

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[9]Efficiency here refers to obtaining the maximum amount of information from a given number of experimental observations. See, for example, C. Radhakrishna Rao, Linear Statistical Inference and Its Applications (N.Y.: John Wiley & Sons, Inc., 1965), pp. 193-194.

TABLE 3-3

FINAL EXPERIMENTAL FACTORS AND THEIR LEVELS

Factor	Description	Corresponding SMAC Variable(s)	Factor Level[1] Low	High
A	Average price change in state MTS	S	.05	-.15
B	Own-price elasticity for state MTS	η_s	-1.1	-.5
C	Average change in interstate SLU MOU	I	-.2	-.1
		η_i	-1.1	-.5
D	Own-price elasticity for connection of both business and residence customers	η_B	-.04	-.175
		η_R	-.025	-.125
E	Usage profile for lines that are dropped. A factor combining D_i, D_s and D_e.	D_i	0	.75
		D_s	0	.75
		D_e	1.0	.5
F	Status of capacity of TS plant and expenses[2]	η	0	.959
		η	0	.800
		η	0	.616

[1]The low and high settings for the factors A, B, . . ., F were obtained by setting the corresponding SMAC variables to the values indicated in the column.

[2]A generic symbol (η) was used in the text description of the procedures for updating TS costs. In fact, there are three cost elasticities used to update cost. When F is low it may be interpreted to mean enough spare capacity in TS equipment is available to handle all usage changes without adding capacity. This condition is modeled by setting the cost elasticities to zero.

Source: Authors' Assumptions

terms ACDF, CDE, AEF.[10] The aliases produced by this confounding scheme are given in appendix G.

Examination of table 3-3 reveals that low and high designations do not necessarily correspond to the natural order of the numbers used for variable settings. In experimental design methods, low and high are arbitrary designations. The research team elected to assign the labels according to their subjective opinion of whether the values would result in lower local rates or higher local rates. It should also be pointed out that the C, D, E, and F each resulted from combining original experimental variables into single factors. In these cases, the particular combinations of settings used for low and high were selected for various but specific reasons given in the next several paragraphs. Consider first, C, which combined I and η_i. Since I and η_i can only affect local rates in an indirect way in SMAC (i.e., by causing a change in interstate subscriber line MOU), it made sense to think of the new factor as simply a change in that usage. Thus, of the four possible combinations of I, and η_i derived from two levels for each, the two combinations that produced the highest and lowest changes in interstate usage were selected.

In the case of factor D in table 3-3, there was no good reason to allow η_B and η_R to vary independently, although it was certainly possible to do so. By having η_B and η_R both set to low levels or both set to high levels simultaneously one can still examine the effect of own-price elasticity for connection although losing the ability to determine the effect of each independently. It was felt that business customers who often have multiple lines and have available to them more

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[10]Confounding with the mean implies that estimates of the mean will actually estimate it plus or minus the effects of those terms confounded with it. The assumption usually is that the higher order interaction terms will have negligible effects so that confounding is not hurtful. The confounding scheme actually defines four mutually exclusive 1/4th fractions and the principal fraction is the one containing the combination having all factors set at low values.

alternative ways of communicating than residential customers, would be more sensitive to price changes when determining their line needs than residential customers. For this reason higher absolute values for η_B were selected than were selected for η_R at both ends of the range. Studies of connect elasticities are almost nonexistent but the most widely known values are in the range of -.1 to -.15 and the values used for η_R and η_B suggest a composite business-residence elasticity of approximately -.03 at the low end and -.14 at the high end for all of the five study states.[11] Appendix H summarizes some elasticity studies available in the current literature. This literature guided our choice of elasticity values given in table 3-3.

In the case of E, the combination of values for D_i, D_s, and D_e that were designated for high and those that were designated for low were selected so as to cause the largest effect on local rates. The research team felt that E was probably not a very important factor (in terms of having large effect), thus it was reasoned that if its high and low values were selected to cause the largest possible effect and that effect proved negligible then this would confirm the original suspicions. It is worthwhile at this point to note the interpretations of the high and low settings for factor E. E is basically defined as a usage profile for lines that are dropped. This means that when $D_i = D_s = 0$, and $D_e = 1.0$, as in the low case, that the average dropped line carried no interstate or state toll traffic and carried an amount of local exchange traffic equal to the average of all lines in service. When $D_i = D_s = .75$, and $D_e = .5$ as in the high case, then the average dropped line carried an amount of interstate and state toll traffic equal to 75 percent of the average of such traffic carried by all lines in service while carrying only 50 percent as much local exchange traffic as the average of all lines. While neither of these two profiles is

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[11]The values vary somewhat from state to state because of slightly different mixes of business and residential customers.

particularly realistic in the sense of one being able to find a real population of curtailed customers with these usage profiles, they are extreme points of the expected feasible region of usage profiles, and factorial experiments necessarily require observations at extreme points.

Finally, in the case of factor F, it is a qualitative factor which indicates with its low and high settings that there is sufficient capacity to handle any additional toll traffic or there is not sufficient capacity. Said another way, it is that at the low level of F, TS costs are not sensitive to traffic and at the high level of F, TS costs are sensitive to traffic. These two qualitative levels of the factor F are implemented in SMAC by either having traffic sensitive costs grow as described in the section on the Accounting, Cost, and Separations Module or having the traffic sensitive costs remain invariant to traffic changes by setting the cost elasticities described in that section to zero.

The combinations of factor levels that correspond to the 16 observations made in each state are listed in table 3-4. The case numbers in column 1 are consistent with those used throughout the next chapter which presents the experimental results and analysis.

In addition to the 16 runs making up the fractional replicate, a 17th run was made with factor levels set to produce the largest possible effect on local rates. The particular combination of factor levels that produced this largest effect was discovered through the initial experimentation on the one state that began the sequential design process mentioned earlier. This "worst case" scenario was not used to estimate individual factor effects because a 17th observation would spoil the balanced, orthogonal design obtained in 16 observations. A "best case" scenario was also located through initial experiments but is naturally a part of the 16-observation replicate.

TABLE 3-4

THE 2^{6-2} FRACTIONAL FACTORIAL REPLICATE USED IN EACH STUDY STATE

Case #	Factor A	B	C	D	E	F
1	H	H	L	L	L	H
2	H	H	H	L	H	L
3	L	H	H	L	H	H
4	L	H	H	H	L	L
5	H	H	H	H	L	H
6	H	H	L	H	H	L
7	L	H	L	H	H	H
8	L	H	L	L	L	L
9	H	L	L	L	L	H
10	H	L	H	L	H	L
11	L	L	H	L	H	H
12	L	L	H	H	L	L
13	H	L	H	H	L	H
14	H	L	L	H	H	L
15	L	L	L	H	H	H
16	L	L	L	L	L	L

Source: Authors' Design

The results of these 17 runs and an analysis are presented in the next chapter. In addition, several runs were made for three of the five states: Colorado, South Carolina, and Vermont. These runs are referred to as "what if" scenarios and are used to examine certain questions about future FCC end-user access charges, the newly-adopted allocator of NTS plant, and local measured rates. The experimental design, alterations to SMAC, and results of these "what if" scenarios are discussed in the last sections of the next chapter.

The Verification and Calibration of SMAC

SMAC was verified and calibrated prior to the 17 runs made in each of the five states and the "what if" scenario runs made in three of the states. The process consisted of making a "baseline" run for each state using the 1982 accounting and usage values that had been requested from the BOCs. For these baseline runs, the experimental parameters were set so as to not cause any changes in rates, usage, or number of lines in service. Thus, the main function of SMAC in these baseline cases was only to simulate the 1982 jurisdictional separations. Verification consisted of comparing the expenses, taxes and plant investment for the state jurisdiction as computed by SMAC with the corresponding actual jurisdictional quantities. In four of the five states the simulated values typically deviated from the actual values by less than 1 percent and never more than 2 percent. In the case of Michigan, there was greater difficulty in securing a reliable data base of 1982 figures and the best baseline run that could be obtained had a maximum error of 6.7 percent which occurred in the state allocation of the plant investment. The size of any error in plant accounts is reduced by approximately 75 percent when a revenue requirement calculation is made. Thus, even in the Michigan case the size of the error is well within acceptable limits. The main source of the differences between the SMAC-computed jurisdictional separations and actual jurisdictional separations is most likely explained by the fact that SMAC simulates separations using accounting and usage data that are annual figures. Actual separations are computed monthly using monthly accounting and usage figures. The verification data were annual figures obtained by aggregating the monthly actuals.

Calibration consisted of determining the rate of return which, when used with the verified jurisdictional rate base, expenses and taxes, would produce an intrastate revenue requirement equal to actual 1982 intrastate revenues. This necessarily produced an exchange revenue requirement equal to exchange revenues.

All subsequent experimental runs then computed percent changes in usages, revenues, and local rates relative to the corresponding base amounts obtained in these calibrated baseline runs.

Summary

This chapter has presented the details of SMAC. The four major components of the model compute the following:

1. A new state jurisdictional revenue requirement using a model of the separations process and given 1982 BOC accounting and usage figures, as well as new levels of interstate toll usage, state toll usage, and exchange usage.

2. A new interstate toll usage estimate given an average price change and own-price elasticities of demand.

3. A new state toll usage and revenue estimate given an average price change and own-price elasticity of demand.

4. A new exchange revenue requirement per business and residential line and percent drop-off of these lines, given the results of the components 1 and 3 listed above, given the own-price elasticity of demand for connections to the network, and given the per line user access charge imposed by the FCC.

The principal results of this model are the percent change in the average exchange revenue requirement per business and residential line as well as the percentage drop-off. The results are presumed to be influenced by the following parameters.

1. All the accounting and usage values that are specific to a given state operation of a BOC,

2. the fractional change in interstate toll rates,

3. the fractional change in state toll rates,

4. the own-price elasticity of demand for interstate toll,

5. the own-price elasticity of demand for state toll,

6. the own-price elasticity of demand for residential connection,

7. the own-price elasticity of demand for business connection,

8. the fraction of average interstate toll usage per dropped line,

9. the fraction of average state toll usage per dropped line,

10. the fraction of average exchange usage per dropped line,

11. several cost-elasticities for traffic sensitive toll-related plant.

The experimental plan also presented in the chapter, calls for grouping these parameters into six factors. A two-level fractional factorial experimental design was specified for each of the five study states. This experimental design is intended so that the main effects of the factors and some interactive effects on the exchange revenue requirement per line and on percentage drop-off can be estimated. The six experimental factors are as follows:

1. average price change in state toll,
2. own-price elasticity of demand for state toll,
3. average change in interstate toll usage,
4. own-price elasticity of demand for connection,
5. usage profile for lines that are dropped,
6. status of the capacity of TS plant.

Finally, the procedures and results of a process to verify and calibrate SMAC were discussed.

CHAPTER 4

EXPERIMENTAL RESULTS

In this chapter are presented the results of the experiments with SMAC that were described in chapter 3. The dependent variables analyzed are the percent change in exchange revenue requirement per residential and business line, and the percent of lines dropped (or added). The effect on these response variables of the six factors (A, B, C, D, E, and F) and their interaction effects are examined in two ways. First, the effects are assumed to be state-specific and in this case, the 16 experimental runs for each state are analyzed independently from the 16 runs in each of the other states. Second, the 16 runs for the 5 states are combined into an 80-run data set. This composite data set is analyzed to determine what the state effect is relative to all other effects and to determine the extent to which the results are state-specific. Drop-off is analyzed only the second way. In addition to these analyses, the results of "what if?" scenario runs are presented and discussed. The purpose of the chapter is to present the numerical conclusions of the aforementioned analyses. We do not draw broad conclusions on policy issues, as that task is left until chapter 6 where conclusions are based not only on the experimental results, but are also based on the information in chapter 2 and the theoretical results of chapter 5.

The State-Specific Analysis of the Experimental Results

In this section are presented the results and analyses of the experimental runs in each state. The analysis will consist of standard general linear model techniques independently applied to each of the five study states. Some baseline results are given first.

As a first approximation to the effects on local rates for the first year of access charges, one can easily compute the direct effect that adding an interstate fixed charge to local service revenues has on average local revenues.[1] Such a calculation was made for each study state and the results are shown in table 4-1. SMAC adds to this direct effect the indirect and additional effects caused by usage changes, drop-off, and price and revenue changes for other services.

Note that this direct effect varies over a limited range from 13 percent to 20 percent for residences depending upon the base amount of revenues already collected in the particular state. Except for Vermont and Michigan, the effect on business revenues is one to three percent less than the effect on residential revenues. In Vermont and Michigan the percentage effect on business rates is larger than for residential rates. Again, these differing effects are due to differences in the 1982 base amounts among the states. In the study states, except Vermont and Michigan, the average revenue per business line is more than three times the average revenue per residential line so that with the user access fees being in a ratio of 3:1 they have a lesser percentage effect on business rates.

In contrast to the direct effects given in table 4-1, it can be seen in table 4-2 that indirect and additional effects can introduce considerable variability in the final percentage change in local rates.

In South Carolina and Vermont, the direct effect is much closer to the worst case effect than it is to the best case effect. The opposite

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[1]While an interstate fixed charge is not officially a charge for local service, it is in the abstract, and probably in the eyes of consumers, not different than a local service charge.

TABLE 4-1

DIRECT EFFECT OF INTERSTATE FIXED CHARGE ON
AVERAGE LOCAL REVENUES PER BUSINESS AND RESIDENTIAL LINE PER YEAR

Column State	(a) 1982 Average Local Revenue Per Residential Line Per Year	(b) 1982 Average Local Revenue Per Residential Line Per Year Plus Proposed $24 Per Year Interstate End User Charge	(c) Percent Change in (b) Over (a)	(d) 1982 Average Local Revenue Per Business Line Per Year	(e) 1982 Average Local Revenue Per Business Line Per Year Plus Proposed $72 Per Year Interstate End User Charge	(f) Percent Change in (e) Over (d)
Colorado	$120	$144	20	$385	$457	19
Michigan	158	182	15	317	389	23
Missouri	148	172	16	537	609	13
S. Carolina	190	214	13	622	694	12
Vermont	125	149	19	348	420	21
Average	$148	$172	16[1]	$442	$514	16[1]

[1]Weighted average with weights determined from columns (a) and (d), respectively.

Source: Authors' Calculations

TABLE 4-2

EXTREME CASES OF DIRECT, INDIRECT AND ADDITIONAL EFFECTS ON AVERAGE LOCAL REVENUES PER RESIDENTIAL AND BUSINESS LINE PER YEAR

State	Percent Change in Residential Rate			Percent Change in Business Rate		
	Best Case (Run #8)	Direct Effect (col. (c), Table 4-1)	Worst Case (Run #17)	Best Case (Run #8)	Direct Effect (col. (f), Table 4-1)	Worst Case (Run #17)
Colorado	17	20	43	16	19	41
Michigan	11	15	24	19	23	31
Missouri	14	16	31	11	13	28
S. Carolina	6	13	15	5	12	15
Vermont	-1	19	25	0	21	26
Average[1]	9.4%	16.6%	27.6%	10.2%	17.6%	28.6%

[1]Arithmetic mean.

Source: Authors' Calculations

is true in the other three states. If the best case results are caused in large part by parameters that are under the control of the state commission, then the commissions in South Carolina and Vermont would have greater opportunity to mitigate the direct effects while the commissions in the other three states would need to be careful not to exacerbate the situation in their states. But, before such a conclusion could be drawn, one must first determine which factors are the main contributers to the variability in results between the best case and the worst case. This is the main objective of the analysis that follows of the 16 orthogonally constructed simulation runs in each state.

Tables 4-3 through 4-7, collectively, show the raw data and results of the 17 experimental runs for all 5 study states. The first 16 run numbers correspond to the case numbers listed in table 3-4 of the previous chapter. In these 5 tables run number 17 is the worst case scenario while run number 8 is the best case scenario. It should be noted in all these tables that there is almost a constant difference between the column of numbers designated "Percent Change in Res." (Residence) and the column designated "Percent Change in Bus." (Business). This means that any factor or interaction of factors affecting residential rates will affect business rates in the same way.

Tables 4-8 through 4-12 give the analytical results obtained independently in each state. A standard form of analysis applied to the data in tables 4-3 through 4-7 was used to estimate the main factor and interactive effects.[2]

Listed in the first column of tables 4-8 through 4-12 are all the main factors in the experimental design and the only two factor interactions that proved to be important. All other interaction terms proved

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[2]The main factor and interactive effects are computed by Yates algorithm as found in, for example, G.E.P. Box, W.G. Hunter, and J.S. Hunter, Statistics for Experimenters (New York: John Wiley & Sons, 1978), p. 323.

TABLE 4-3

INDEPENDENT AND DEPENDENT VARIABLE VALUES FOR THE SEVENTEEN SIMULATION RUNS IN COLORADO

Run No.	Independent Factors												Dependent Variables			Run No.
	A	B	C		D		E			F			% Increase Avg Local Rev		% Dropoff	
	s	η_s	i	η_i	η_R	η_B	D_i	D_s	D_e	η_1	η_2	η_3	Bus.	Res.		
1	-0.15	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	31.7	33.0	-0.8	1
2	-0.15	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	27.9	29.1	-0.7	2
3	0.05	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	27.2	28.4	-0.7	3
4	0.05	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	22.8	24.1	-2.9	4
5	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	38.5	39.8	-4.5	5
6	-0.15	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	27.3	28.6	-3.4	6
7	0.05	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	28.7	30.0	-3.5	7
8	0.05	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	15.6	16.9	-0.4	8
9	-0.15	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	27.7	28.9	-0.7	9
10	-0.15	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	22.7	24.0	-0.6	10
11	0.05	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	28.5	29.8	-0.7	11
12	0.05	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	24.5	25.8	-3.1	12
13	-0.15	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	33.7	34.9	-4.0	13
14	-0.15	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	21.2	22.5	-2.7	14
15	0.05	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	30.3	31.6	-3.7	15
16	0.05	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	17.2	18.5	-0.5	16
17	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	41.3	42.6	-4.8	17

Source: Authors' Calculations

TABLE 4-4

INDEPENDENT AND DEPENDENT VARIABLE VALUES FOR THE SEVENTEEN SIMULATION RUNS IN MICHIGAN

Run No.	Independent Factors												Dependent Variables			Run No.
	A	B	C		D		E			F			% Increase Avg Local Rev		% Dropoff	
	s	η_s	i	η_i	η_R	η_B	D_i	D_s	D_e	η_1	η_2	η_3	Bus.	Res.		
1	-0.15	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	25.9	18.4	-0.6	1
2	-0.15	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	28.3	20.8	-0.6	2
3	0.05	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	19.1	11.6	0.4	3
4.	0.05	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	22.5	15.0	-2.2	4
5	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	29.8	22.3	-3.0	5
6	-0.15	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	30.5	23.0	-3.1	6
7	0.05	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	20.3	12.8	-1.9	7
8	0.05	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	18.7	11.2	-0.4	8
9	-0.15	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	20.8	13.3	-0.4	9
10	-0.15	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	22.3	14.7	-0.5	10
11	0.05	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	20.8	13.3	-0.4	11
12	0.05	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	24.6	17.1	-2.4	12
13	-0.15	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	24.1	16.5	-2.4	13
14	-0.15	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	23.4	15.9	-2.3	14
15	0.05	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	22.3	14.8	-2.2	15
16	0.05	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	20.6	13.1	-0.4	16
17	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	31.4	23.9	-3.2	17

Source: Authors' Calculations

TABLE 4-5

INDEPENDENT AND DEPENDENT VARIABLE VALUES FOR THE SEVENTEEN SIMULATION RUNS IN MISSOURI

Run No.	Independent Factors												Dependent Variables			Run No.
	A	B	C		D		E			F			% Increase Avg Local Rev		% Dropoff	
	s	η_s	i	η_i	η_R	η_B	D_i	D_s	D_e	η_1	η_2	η_3	Bus.	Res.		
1	-0.15	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	21.8	24.7	-0.6	1
2	-0.15	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	20.2	23.0	-0.6	2
3	0.05	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	17.2	20.1	-0.5	3
4	0.05	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	15.6	18.4	-2.2	4
5	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	26.9	29.7	-3.4	5
6	-0.15	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	20.2	23.1	-2.7	6
7	0.05	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	18.0	20.8	-2.4	7
8	0.05	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	10.6	13.5	-0.3	8
9	-0.15	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	18.3	21.2	-0.5	9
10	-0.15	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	15.9	18.7	-0.5	10
11	0.05	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	18.1	21.0	-0.5	11
12	0.05	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	17.1	19.9	-2.3	12
13	-0.15	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	22.9	25.7	-3.0	13
14	-0.15	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	15.2	18.1	-2.1	14
15	0.05	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	19.3	22.2	-2.6	15
16	0.05	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	12.0	14.8	-0.4	16
17	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	28.4	31.2	-3.5	17

Source: Authors' Calculations

TABLE 4-6

INDEPENDENT AND DEPENDENT VARIABLE VALUES FOR THE SEVENTEEN SIMULATION RUNS IN SOUTH CAROLINA

Run No.	Independent Factors												Dependent Variables			Run No.
	A	B	C		D		E			F			% Increase Avg Local Rev		% Dropoff	
	s	η_s	i	η_i	η_R	η_B	D_i	D_s	D_e	η_1	η_2	η_3	Bus.	Res.		
1	-0.15	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	15.7	16.8	-0.4	1
2	-0.15	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	14.5	15.6	-0.4	2
3	0.05	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	10.6	11.7	-0.3	3
4	0.05	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	9.6	10.7	-1.3	4
5	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	18.9	20.2	-2.4	5
6	-0.15	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	14.7	15.7	-1.9	6
7	0.05	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	11.2	12.3	-1.5	7
8	0.05	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	6.5	7.5	-0.2	8
9	-0.15	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	11.8	12.9	-0.3	9
10	-0.15	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	9.9	11.0	-0.3	10
11	0.05	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	11.9	12.9	-0.3	11
12	0.05	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	11.2	12.3	-1.5	12
13	-0.15	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	14.5	15.6	-1.9	13
14	-0.15	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	9.3	10.3	-1.3	14
15	0.05	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	12.7	13.8	-1.7	15
16	0.05	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	7.9	9.0	-0.2	16
17	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	20.0	21.0	-2.5	17

Source: Authors' Calculations

TABLE 4-7

INDEPENDENT AND DEPENDENT VARIABLE VALUES FOR THE SEVENTEEN SIMULATION RUNS IN VERMONT

Run No.	Independent Factors												Dependent Variables			Run No.
	A	B	C		D		E			F			% Increase Avg Local Rev		% Dropoff	
	s	η_s	i	η_i	η_R	η_B	D_i	D_s	D_e	η_1	η_2	η_3	Bus.	Res.		
1	-0.15	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	18.3	16.9	-0.4	1
2	-0.15	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	16.8	15.4	-0.4	2
3	0.05	-0.5	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	9.4	8.0	-0.2	3
4	0.05	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	5.9	4.5	-0.6	4
5	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	24.1	22.7	-2.7	5
6	-0.15	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	13.3	11.9	-1.5	6
7	0.05	-0.5	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	6.7	5.4	-0.7	7
8	0.05	-0.5	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	-0.0	-1.4	0.0	8
9	-0.15	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.959	0.616	0.800	12.6	11.3	-0.3	9
10	-0.15	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.0	0.0	0.0	9.3	8.0	-0.2	10
11	0.05	-1.1	-0.1	-0.5	-0.025	-0.040	0.75	0.75	0.50	0.959	0.616	0.800	11.3	10.0	-0.3	11
12	0.05	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.0	0.0	0.0	8.4	7.1	-0.9	12
13	-0.15	-1.1	-0.1	-0.5	-0.125	-0.175	0.0	0.0	1.00	0.959	0.616	0.800	17.9	16.5	-2.1	13
14	-0.15	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.0	0.0	0.0	4.2	2.9	-0.4	14
15	0.05	-1.1	-0.2	-1.1	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	9.1	7.7	-1.0	15
16	0.05	-1.1	-0.2	-1.1	-0.025	-0.040	0.0	0.0	1.00	0.0	0.0	0.0	2.3	1.0	0.0	16
17	-0.15	-0.5	-0.1	-0.5	-0.125	-0.175	0.75	0.75	0.50	0.959	0.616	0.800	26.2	24.8	-2.9	17

Source: Authors' Calculations

TABLE 4-8

ANALYSIS OF THE CHANGE IN BUSINESS AND RESIDENTIAL RATES IN THE COLORADO BOC

Factorial Linear Model Symbol	Description	Linear Model[1] Coefficients Given as Percentage Change in Average Local Revenue Requirements: Res.	Bus.	Percent Contribution of Linear Model Term to Total Sum of Squares
M	Mean (or constant term)	28.36	27.09	---[2]
A	Average price change in state MTS	2.25	2.25	13.7
B	Own-price elasticity for state MTS	.83	.83	1.9
AB	Interaction of A & B	1.63	1.63	7.2
C	Average change in interstate subscriber line MOU	1.61	1.61	7.0
D	Own-price elasticity for connections	1.83	1.84	9.1
E	Usage profile of dropped lines	-.10	-.10	0.0
F	Status of capacity of TS plant	4.71	4.71	60.1
r	All other interaction terms, pooled (residual)	---[2]	---[2]	1.0
				100.0

[1]The linear model is based on a data coding scheme that uses -1 when a factor is set low and +1 when a factor is set high.
[2]Not applicable.

Source: Authors' Calculations

TABLE 4-9

ANALYSIS OF THE CHANGE IN BUSINESS AND RESIDENTIAL RATES IN THE MICHIGAN BOC

Factorial Linear Model Symbol	Description	Linear Model[1] Coefficients Given as Percentage Change in Average Local Revenue Requirements: Res.	Bus.	Percent Contribution of Linear Model Term to Total Sum of Squares
M	Mean (or constant term)	15.85	23.37	---[2]
A	Average price change in state MTS	2.26	2.26	41.2
B	Own-price elasticity for state MTS	1.02	1.02	8.4
AB	Interaction of A & B	1.98	1.97	31.5
C	Average change in interstate subscriber line MOU	.56	.56	2.5
D	Own-price elasticity for connections	1.32	1.31	13.9
E	Usage profile of dropped lines	.01	.01	0.0
F	Status of capacity of TS plant	-.49	-.49	1.9
r	All other interaction terms, pooled (residual)	---[2]	---[2]	.6
				100.0

[1]The linear model is based on a data coding scheme that uses -1 when a factor is set low and +1 when a factor is set high.

[2]Not applicable.

Source: Authors' Calculations

TABLE 4-10

ANALYSIS OF THE CHANGE IN BUSINESS AND RESIDENTIAL RATES IN THE MISSOURI BOC

Factorial Linear Model Symbol	Description	Linear Model[1] Coefficients Given as Percentage Change in Average Local Revenue Requirements		Percent Contribution of Linear Model Term to Total Sum of Squares
		Res.	Bus.	
M	Mean (or constant term)	20.93	18.08	---[2]
A	Average price change in state MTS	2.09	2.09	29.4
B	Own-price elasticity for state MTS	.73	.73	3.6
AB	Interaction of A & B	1.37	1.37	12.6
C	Average change in interstate subscriber line MOU	1.13	1.16	8.6
D	Own-price elasticity for connections	1.31	1.32	11.4
E	Usage profile of dropped lines	.06	.07	0.0
F	Status of capacity of TS plant	2.24	2.23	33.8
r	All other interaction terms, pooled (residual)	---[2]	---[2]	.6
				100.0

[1]The linear model is based on a data coding scheme that uses -1 when a factor is set low and +1 when a factor is set high.
[2]Not applicable.

Source: Authors' Calculations

TABLE 4-11

ANALYSIS OF THE CHANGE IN BUSINESS AND RESIDENTIAL RATES IN THE S. CAROLINA BOC

Factorial Linear Model Symbol	Description	Linear Model[1] Coefficients Given as Percentage Change in Average Local Revenue Requirements: Res.	Bus.	Percent Contribution of Linear Model Term to Total Sum of Squares
M	Mean (or constant term)	13.02	11.94	---[2]
A	Average price change in state MTS	1.75	1.74	32.0
B	Own-price elasticity for state MTS	.80	.78	6.5
AB	Interaction of A & B	1.53	1.51	24.2
C	Average change in interstate subscriber line MOU	.71	.70	5.3
D	Own-price elasticity for connections	.85	.84	7.5
E	Usage profile of dropped lines	.11	.09	0.1
F	Status of capacity of TS plant	1.51	1.49	23.7
r	All other interaction terms, pooled (residual)	---[2]	---[2]	0.7
				100.0

[1]The linear model is based on a data coding scheme that uses -1 when a factor is set low and +1 when a factor is set high.
[2]Not applicable.

Source: Authors' Calculations

TABLE 4-12

ANALYSIS OF THE CHANGE IN BUSINESS AND RESIDENTIAL RATES IN THE VERMONT BOC

Factorial Linear Model Symbol	Description	Linear Model[1] Coefficients Given as Percentage Change in Average Local Revenue Requirements: Res.	Bus.	Percent Contribution of Linear Model Term to Total Sum of Squares
M	Mean (or constant term)	9.24	10.59	---[2]
A	Average price change in state MTS	3.97	3.96	40.9
B	Own-price elasticity for state MTS	1.21	1.20	3.8
AB	Interaction of A & B	2.35	2.35	14.4
C	Average change in interstate subscriber line MOU	2.28	2.28	13.6
D	Own-price elasticity for connections	.59	.59	0.9
E	Usage profile of dropped lines	.59	.59	0.9
F	Status of capacity of TS plant	3.07	3.07	24.6
r	All other interaction terms, pooled (residual)	---[2]	---[2]	.9
				100.0

[1]The linear model is based on a data coding scheme that uses -1 when a factor is set low and +1 when a factor is set high.
[2]Not applicable.

Source: Authors' Calculations

to be insignificant and were pooled together as shown in the last row of the table. Because the experiment was orthogonal, the coefficients in both the third and fourth columns are independent of one another. It should also be noted that although there were some differences between each value in the third column and the corresponding value in the fourth column, these differences are clearly insignificant except for the mean (M). This bears out the earlier observation that the percent change in business and residence local service rates differed by a constant. Hence, the percentage contribution column of these tables gives only the percentage contribution for a model of business rates because the similar figures for a model of residential rates will have almost identical values to the ones given. To explain this last column more thoroughly, it gives the percentage of the total variability in the percentage change in local business rate data that can be explained by each of the main factor effects or the two-factor interactive effect. Because the data come from an orthogonal experiment, the percentage contribution for each row is independent of the contributions made by the other rows. This property of orthogonal designs facilitates the identification of important factors and the identification of an appropriate linear model.

The coefficient of determination (R^2), which measures the goodness of fit of a model to a given set of data,[3] is easily computed by adding the percentage contributions for each possible term represented in a model.[4] Thus, an analyst can use the figures in the last column of these tables to evaluate the trade-off between a model with a few terms and one with more terms and an increased value of R^2. In examining the results presented in tables 4-8 through 4-12 it appears that Vermont is

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[3]A.S. Goldberger, Econometric Theory (New York: John Wiley and Sons, 1964), p. 160. In this report we express R^2 as a percent.

[4]In this context we use the word "term" to mean any element in the analytical model which would otherwise be referred to as "factor or interaction term."

the only state in which factor E (usage profile of dropped lines) has a substantial effect, thus warranting its retention in a linear model. A linear model for Vermont which contains the terms A, B, AB, C, D, E, and F will fit the data with an R^2 of 99.1 percent. If one excludes E from the model, an R^2 of 98.2 percent would result, and in this case, it might also make sense to exclude D (own-price elasticity for connection), making the R^2 = 97.3 percent. Thus, a model containing only five parameters (one of which is an interaction of two others) can explain (or predict) 97.3 percent of the variability in the Vermont data. In the other states, virtually no loss in R^2 occurs by excluding E from the analytical model, but a substantial loss occurs if D is also excluded. Since values of R^2 in the 98-99 percent range are generally considered quite good, it would seem appropriate to conclude for all states that, on the average, E (usage profile of dropped lines) is not an important determinant of average local revenue changes. Although D also does not appear important in Vermont, retaining it in the model of local revenue changes for Vermont is worthwhile in order to have a model structure that is common to all the states.

There are several additional observations that can be made about the results given in tables 4-8 through 4-12. The ones presented here are not an exhaustive list. Without exception the three most important terms in each state's analytical model account for over 75 percent of the variability in the data. However, the three terms that are most important differ among the states. Table 4-13 shows the three most important terms in all the states. As can be seen in table 4-13, Colorado and Michigan were most different from the other states with respect to which terms are among the three most important. Colorado, with the highest average increase for local service, would naturally expect to experience the highest additional effect due to own-price elasticity for connection. That, indeed, is what has happened in the Colorado case, thereby lifting D over AB to the third most important spot. Michigan and Missouri also have relatively high and roughly equal average increases for local service. Thus, they also have a relatively important D, but, in the case of Michigan, F (status of capacity of TS plant) has virtually no impact, making D more important, while in Missouri, F is the more important term of the two.

TABLE 4-13

THE THREE MOST IMPORTANT FACTORS AND THEIR INTERACTION TERMS BY STATE

State	Factors and Interaction Terms A	AB	D	F
Colorado	1		1	1
Michigan	1	1	1	
Missouri	1	1		1
South Carolina	1	1		1
Vermont	1	1		1

[1]Indicates one of the three most important terms.

Source: Authors' Calculations

In all five states, A (average price change in state MTS) is either the most important or second most important term. Factor A does represent a parameter over which the state commissions have direct control, but A also interacts significantly with B (own-price elasticity of demand for state toll) which is not a parameter under the control of the state commissions. By using the coefficients for A, B, and AB found in table 4-12, it can be seen that in Vermont the decision to raise or lower state toll rates can cause a 13 percent swing in average local rates if own-price elasticity for state toll is -.5 and a swing of only about 3 percent if the elasticity is -1.1. In South Carolina, these same swings are 5.5 percent and 0.5 percent if the elasticity is -.5 and -1.1, respectively. The other states fall somewhere between these two and in all cases local rates decrease with an increase in state toll rates regardless which of the two elasticities is used.

F (status of capacity of TS plant) is a factor that accounts for the most variability in the data for two states and the second most variability in two states. It is relatively insignificant in Michigan where it accounts for less than 2 percent of the variability. When F is low it is interpreted to mean that no new traffic sensitive plant is required to handle any of the additional toll traffic resulting from decreased toll prices. When F is high, the investment in traffic sensitive toll plant is made to grow according to the three cost elasticities given in table 3-3. Investment in TS exchange plant was held constant regardless what happened to exchange traffic on the theory that access charges for toll service could not result in increased exchange traffic and a reduction in exchange plant would not result from minor reductions in exchange usage. Thus, for all runs in the five study states when F was high, only new toll-related investment was introduced, and when F was low, no such new investment was introduced. Under ideal and equitable conditions, increased investment in toll related equipment due to toll traffic increases would not result in higher rates for local service. But, in the experimental runs of four of the five states, results show a range of the average increase in local rates of as much as 9.4 percent (in Colorado) to 3 percent (in South Carolina), which was due to moving F from low to high. Michigan experienced a slight (1 percent) local service price reduction as the average effect of moving F from low to high. This reduction may be due to more favorable allocation to interstate of some costs allocated on the basis of the investment that grows if F is high. The opportunity for a more favorable allocation is created by Michigan having the lowest relative interstate subscriber line MOU of the five states and the only state with more state toll MOU than interstate MOU.

It was difficult to precisely determine the reasons for increased toll traffic causing higher local rates when TS plant capacity is not sufficient to handle the additional toll load. The research team has formulated three possible reasons for the phenomenon. They are:

1. Verification of SMAC consisted of obtaining an accurate jurisdictional separations for 1982. In the experiments, the separations process was updated to reflect new traffic and investment conditions resulting from access charges

and other pricing changes. It was not possible to perform a similar verification of this updating process, only logic checks were possible. Thus, modeling distortions could have contributed to the seemingly inequitable phenomenon of toll usage causing local rate increases.

2. The jurisdictional allocation of traffic sensitive plant and related costs according to relative usage factors as is prescribed in the Manual does not sufficiently attribute costs to the causer of those costs and thereby underallocates the new investment to the interstate jurisdiction.

3. Pricing changes in state toll rates could result in a noncompensatory relationship between increased revenues and costs.

If the third listed reason was the case, one would expect one or all of the interaction terms AF, BF, and ABF to be significant. The experiments gave no indication that AF, BF, or ABF were significant. Given the research team's considerable confidence in the allocation updating procedures used in SMAC, and given the lack of significant interaction terms, one is drawn to the second listed reason. While the evidence in these experiments is clearly not strong enough to conclude absolutely that the cost allocations for TS costs suggested in the Manual do not reflect a cost-causative relationship, it certainly does suggest that as a hypothesis. Richard Gable, et al., have been investigating TS cost allocations and suggest that, at present, services share unequally in savings achieved by the scope economies inherent in jointly used TS plant.[5] In any case, the hypothesis that growth in TS plant due to increased toll usage causes increases in local rates deserves further examination on a state-by-state basis.

Return now to factors A, B, and their interaction AB. Factor A is the price change in intrastate toll rates. It represents one of the few

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[5]R. Gabel, W. Melody, R. Warnek, and W. Mihuc, "The Allocation of Local Exchange Plant Investment to the Common Exchange and Toll Services on the Basis of Equalized Relative Cost Benefits," a research paper supported by the Kansas Corporation Commission (May 23, 1983).

areas left to the state commissions where the impact on local rates of the FCC user access charge could be affected. In fact, one may recall from table 4-13 that A is the only factor that was one of the three most important factors in all five study states. Factor B is the own-price elasticity for intrastate toll and while not very important in and of itself, its interaction with A was one of the three most important effects in every state except Colorado. Basic economic theory states that if own-price elasticity is elastic, a price decrease would increase usage and revenues; and if the elasticity is inelastic, a price increase would decrease usage and increase revenues. In either case if the revenue increase is not offset by similar cost increases, then local rates, if based on the revenue requirement residual, would decrease. The value of the elasticity is the principal determinant of an appropriate pricing policy given some policy objective. However, with the institutional constraints imposed by jurisdictional separations and given pricing changes in the interstate toll markets one will find that an elasticity number other than 1 is the principal determinant of the appropriate pricing policy. This issue is now examined for each of the five states by first converting some of the factorial linear model results given in tables 4-8 through 4-12 into equations involving continuous variables. To do this, let y represent the percentage change in average local revenue requirements per residential line, and let x_1 and x_2 be the continuous variables representing the fractional change in the price of intrastate toll and own-price elasticity for intrastate toll, respectively. Using these symbols, an equation of the form of (4.1) is developed for each state.

$$y_j = K_j + a_{j1} x_1 + a_{j2} x_2 + a_{j12} x_1 x_2 \qquad (4.1)$$

In equation (4.1) the subscript j represents the state that the equation applies to, K_j is a constant whose value represents the effect on average local revenue requirement per line of all other factors other than A, B, and AB, and a_{j1}, a_{j2}, and a_{j12} are state specific coefficients. In appendix H, values for the parameters a_{j1}, a_{j2}, and a_{j12} in each state are computed using the results in tables 4-8 through 4-12. These parameter values are given in table 4-14.

TABLE 4-14

PERCENT CHANGE IN AVERAGE LOCAL REVENUE REQUIREMENT (y) AS A FUNCTION OF FRACTIONAL CHANGE IN STATE TOLL PRICES (x_1) AND OWN-PRICE ELASTICITY (x_2)

j	State	Equation
1	Colorado	$y_1 = K_1 - 66.5\ x_1 + 33.3\ x_1x_2$
2	Michigan	$y_2 = K_2 - 75.4\ x_1 + 66.0\ x_1x_2$
3	Missouri	$y_3 = K_3 - 57.4\ x_1 + 45.7\ x_1x_2$
4	South Carolina	$y_4 = K_4 - 58.3\ x_1 + 51.0\ x_1x_2$
5	Vermont	$y_5 = K_5 - 102.4\ x_1 + 78.3\ x_1x_2$

Source: Authors' Derivations

As can be seen in table 4-14, the coefficient of x_1 is negative, while the coefficient of x_1x_2 is positive. We adopt here the convention of always stating elasticities as positive values so that given a positive value for the elasticity x_2, the sign of the net coefficient for x_1 can be positive or negative depending upon the magnitude of x_2's value. In fact, there is a value for x_2 in each state which makes average local rates insensitive to price changes in intrastate toll. These points of insensitivity for the five states appear in table 4-15.

As shown in table 4-15, a price increase in intrastate toll rates benefits local rates over a range of state toll own-price elasticities that extends above 1 (i.e., above the point where revenues are decreased with a price increase). The reason for this is that price increases reduce intrastate traffic and thereby increase the allocation of TS costs to the interstate jurisdiction. If the elasticity is less than 1, a double benefit occurs for local rates when state toll prices are increased. One benefit comes from the cost allocation resulting from the reduced traffic and the other comes from increased state toll revenues. The policy implications of this result are discussed more fully in chapter 6.

TABLE 4-15

OWN-PRICE ELASTICITY AT WHICH THE AVERAGE INTRASTATE TOLL PRICE HAS NO EFFECT ON AVERAGE LOCAL REVENUE REQUIREMENT

State	Own-Price Elasticity
Colorado	+2.00
Michigan	+1.14
Missouri	+1.26
South Carolina	+1.14
Vermont	+1.31

Source: Authors' Calculations

One may also note in table 4-15 that Colorado has the largest range of elasticity values over which price increases for state toll can benefit local rates. Yet, from the results given in table 4-8, a move to increase intrastate toll rates has a relatively small effect compared to the effect of the factor F (status of capacity of TS plant).

Taking Colorado and South Carolina as two examples with extreme results as shown in tables 4-14 and 4-15, the effects of various levels of x_2 (own-price elasticity for state toll) on the local revenue requirement, given x_1 = +.15, + .075, 0, -.075, -.15, are shown in figures 4-1 and 4-2.

In these figures, each straight line labelled with a value for x_1, (fractional price change for intrastate toll) represents a plot of the percentage change in average local revenue requirement as a function of the own-price elasticity of intrastate toll. As an example, consider the case of Colorado, figure 4-1. If the own-price elasticity for state toll is 1, a price decrease in state toll of 7.5 percent will result in more than a 2 percent increase in average local revenue requirement (obtained by using the curve labeled x_1 = -.075). If the toll prices are increased by 15 percent, a decrease in local requirements of about 5 percent can be seen using the curve labelled x_1 = .15 and a horizontal axis value of 1.

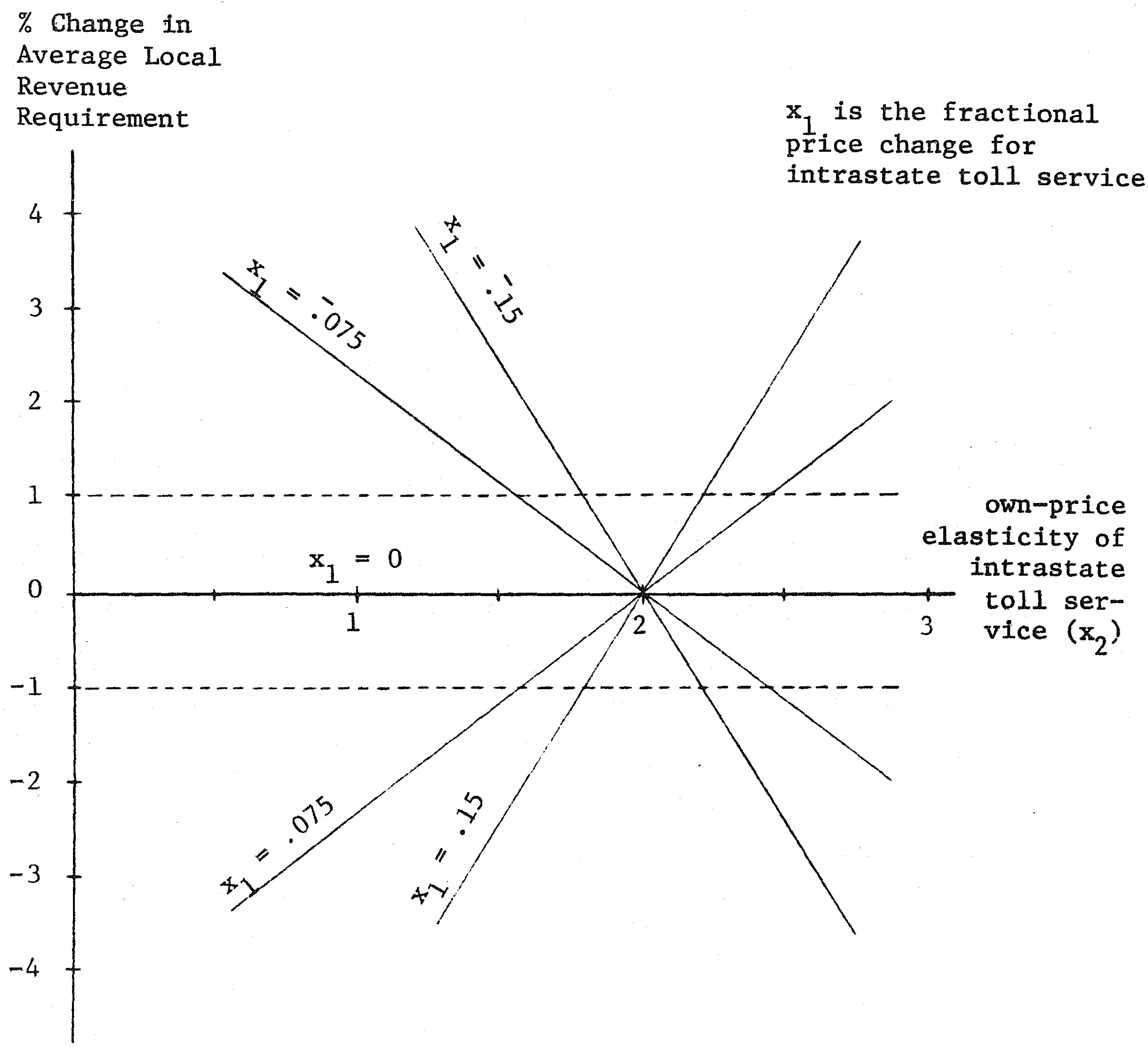

Fig. 4-1 Percent change in average local revenue requirement in Colorado as a function of state toll own-price elasticity (x_2) and state toll price changes (x_1)

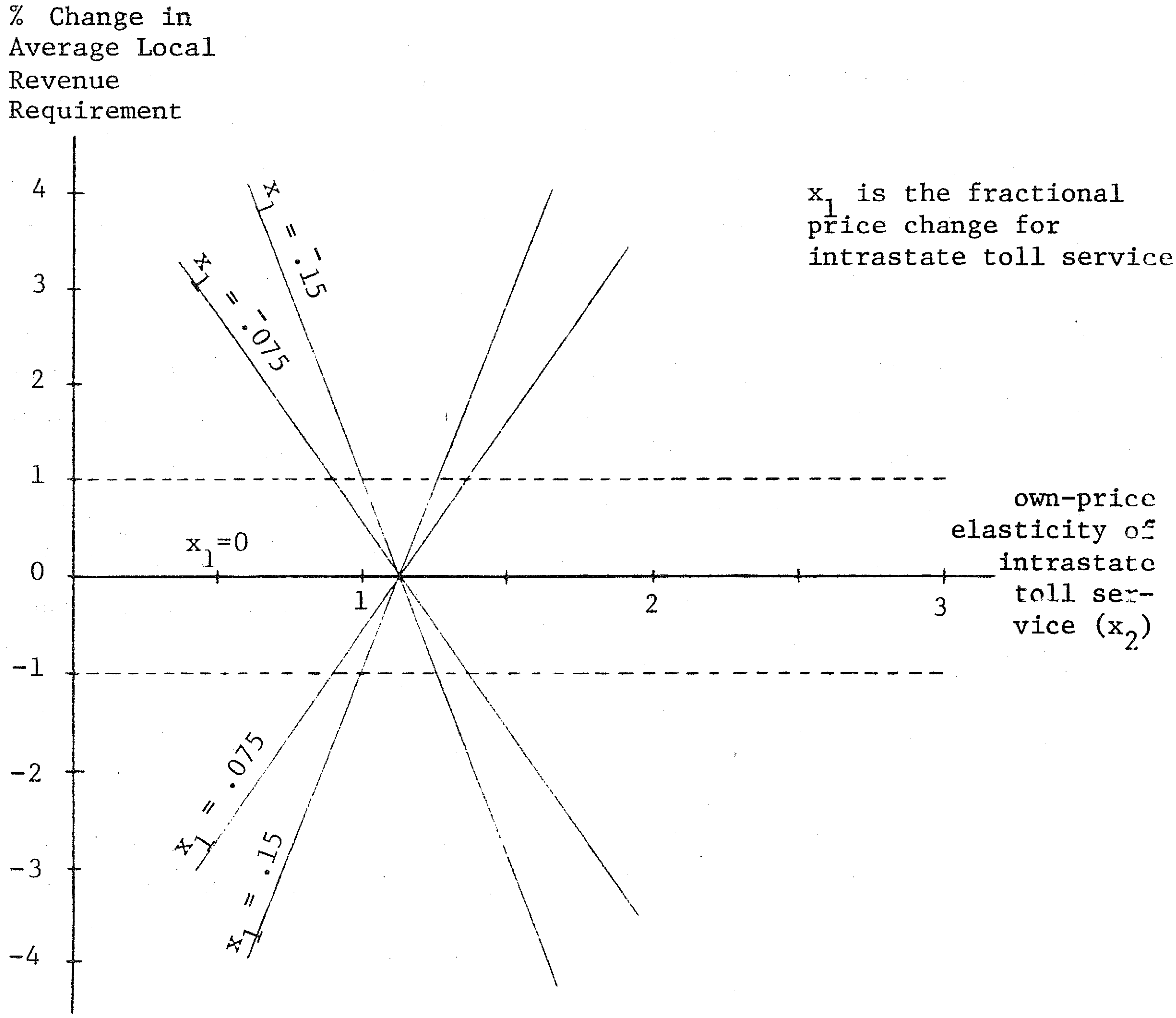

Fig. 4-2 Percent change in average local revenue requirement in South Carolina as a function of state toll own-price elasticity (x_2) and state toll price changes (x_1)

In figure 4-1 it is seen that in Colorado for own-price elasticities ranging from 1.8 to 2.2, less than a 1 percent effect on the average local revenue requirement can result from state toll price changes up to 15 percent. The similar range of elasticities in South Carolina is 1.1 to 1.4, as seen in figure 4-2.

The reader should be cautioned that conclusions drawn from the equations above involve either extrapolation beyond points actually observed or interpolation between the observed points. Thus, the results should be taken as indicative of the given situation as opposed to accurate in an absolute sense. One can generally expect interpolated values to be better than extrapolated values.

Also in appendix H, is the calculation of coefficients for a continuous variable x_3 replacing the factor C. With x_3 representing the fractional change in interstate toll usage, it is apparent by examining table 4-16 that increased interstate toll usage has the effect of reducing the average local revenue requirement. This reduction is due to increased usage causing an allocation of more TS costs to the interstate jurisdiction.

TABLE 4-16

COEFFICIENTS GIVING THE RATE OF CHANGE IN THE PERCENTAGE CHANGE IN AVERAGE LOCAL REVENUE REQUIREMENTS WITH RESPECT TO A FRACTIONAL INCREASE IN INTERSTATE USAGE

State	Coefficient of X_3
Colorado	-13.2
Michigan	- 4.6
Missouri	- 9.3
South Carolina	- 5.8
Vermont	-18.7

Source: Authors' Calculations

As shown in table 4-16, Vermont's local revenue requirements are helped most by increased interstate usage with an 18.7 percent decrease occurring if interstate traffic doubles.

Summary

In this section, baseline calculations were presented showing the direct effect of the FCC-proposed $2 and $6 monthly end-user access charge on local revenue requirements. Both direct and indirect effects of a move to access charges on local revenue requirements were shown to be substantially influenced by the following factors and interaction terms:

A	Average price change in state MTS
B	Own-price elasticity for state MTS
AB	The interaction term of A and B
C	Average change in interstate toll subscriber line MOU
D	Own-price elasticity for connections
F	Status of capacity of TS plant

In some cases the influence of these factors causes a large increase over the direct effect and in other cases the direct effects are partially mitigated by the indirect effects. There was no case where the first year of access charges would double or triple local revenue requirements per line. The factors and interaction terms tending to be the most important (in terms of having the greatest influence on local revenue requirements) in some or all of the five study states were A, AB, D, and F. Factor E (usage profile of dropped lines) was generally found to be unimportant. The importance of factor F and the lack of importance of interaction terms AF, BF, and ABF suggested that the separations process as applied to TS plant does not sufficiently attribute costs to the causer of those costs and thereby underallocates new investment to the interstate jurisdiction.

The importance of factor A, factor B, and their interaction AB were further investigated. It was found that exchange local revenue requirements would decrease with an increase in the price of state toll service even when the own-price elasticity of the toll service is in the neighborhood of 1.15 (2.00 for Colorado).

Even though an elasticity greater than 1 would cause a toll rate increase to decrease revenues, it would also decrease traffic and result in more costs being allocated to the interstate jurisdiction.

Finally, the factor C (average change in interstate subscriber line MOU) was replaced by a continuous variable to examine its rate of impact on local revenue requirements. In all five states, C resulted in a decrease in the exchange revenue requirement due to the effect it has on cost allocations.

Analysis of the Composite Set of Five State Experimental Runs

Discussed in this section are the comparisons among states that make use collectively of the SMAC results from all five states. First, state differences with respect to the relationship of the independent variables (factors and their interaction terms) and percent change in average local revenue requirement for residential line (Res.) are examined. Due to the almost perfect correspondence of residence and business results, the business results are not examined. Second, a description of the differences across states in the relationship of the independent variables and percent drop-off is given.

Percent Change in Average Local Revenue Requirements for Residential Subscribers (Res.), as the Dependent Variable

Table 4-17 shows the average Res. along with the estimates of the effects for each of 7 (of the 15 possible) effects, for each state. The last column in table 4-17 shows the effects "fitted" to the data consisting of averages over states, for each independent variable combination. Differences among the states are evident for each effect, but the greatest difference is attributable to the effect F (status of capacity of TS plant).

TABLE 4-17

THE EFFECTS ON AVERAGE LOCAL REVENUE REQUIREMENTS PER RESIDENTIAL LINE OF THE INDEPENDENT VARIABLES (IN PERCENTAGES)

Effect Symbol	Description	Vt.	Mo.	State Colo.	S.C.	Mich.	Average Across States
M	Mean, or average	9.24	20.93	28.36	13.02	15.85	17.48
A	Average price change in state MTS	3.97	2.09	2.25	1.75	2.26	2.46
B	Own-price elasticity for state MTS	1.21	0.73	0.83	0.8	1.02	0.92
AB	Interaction of A,B	2.35	1.37	1.63	1.53	1.98	1.77
C	Average change in interstate subscriber line MOU	2.28	1.13	1.61	0.71	0.56	1.26
D	Own-price elasticity for connection	0.59	1.31	1.84	0.85	1.32	1.18
E	Usage profile of dropped line	0.59	0.06	-0.19	0.11	0.01	0.13
F	Status of capacity of TS plant	3.07	2.24	4.71	1.51	-0.49	2.21
	Percent of total variation within column accounted for by the listed effects	99.1	99.4	99.1	99.3	99.4	99.3

Source: Authors' Calculations

Table 4-18 shows the results of the analysis of variance of the 80 Res. values obtained from the 16 SMAC runs in each of the 5 states. The effects are separated into two groups. The first group consists of the 7 variables in the model listed in table 4-17. The second group consists of the remaining 8 effects made up of the higher order interaction terms. Some discussion is warranted in the interpretation and use of the values in the last column of table 4-18.

Three models for estimating Res. are:

Model 1: Res. = $(M)_i$, i.e., the percentage change in local revenue requirement per residential line, Res., is equal to a constant, $(M)_i$, for a given state i $(i=1,2,\ldots,5)$.

Model 2: Res. = $(M)_i \pm A \pm B \pm AB \pm C \pm D \pm E \pm F$, i.e., the percentage change in local revenue requirement per residential line, Res., is equal to a constant, $(M)_i$, for any given state i plus (or minus) the seven variable effects A, B, AB, C, D, E, and F which are averaged over the five states. The effect is added if a factor is high and subtracted if the effect is low, while the interaction AB is added if A and B are both high or both low and subtracted if one is high and one is low.

Model 3: Res. = $(M)_i \pm (A)_i \pm (B)_i \pm (AB)_i \pm (C)_i \pm (D)_i \pm (E)_i \pm (F)_i$, i.e., the percentage change in local revenue requirement per residential line, Res., is equal to a constant, (M)i, for any given state i plus (or minus) the seven variable effects $(A)_i$, $(B)_i$, $(AB)_i$, $(C)_i$, $(D)_i$, $(E)_i$, and $(F)_i$ which are computed for a given state i. When to add or subtract is described under Model 2.

Thus, the difference between Model 1 and the other two is that Model 1 assumes the seven variable effects are irrelevant for predicting Res. Model 2 assumes the seven variable effects are relevant but the same for all states, while Model 3 assumes these variable effects are relevant but different from state to state.

TABLE 4-18

INTERSTATE COMPARISONS FOR THE CHANGE
IN RESIDENTIAL LOCAL REVENUE REQUIREMENTS

Source	Sum of Squares Reduction Due to Listed Factors	d.f.	Percent of Total Contribution[1] to R^2
State average differences	3532.67	4	66.30
All (15) variables	1444.29	15	27.11
[7 variables][2]	[1433.47]	[7]	[26.09]
[8 variables][3]	[10.82]	[8]	[.21]
The Interaction of All Variables with State Differences	351.13	60	6.59
[Intersection of 7 Variables with State Differences]	[347.44]	[28]	[6.52]
[Interaction of 8 Variables with State Differences]	[3.69]	[32]	[.07]
Total, adjusted for grand average	5328.08	79	100

[1]Coefficient of determination, in percent.

[2]Variables A, B, AB, C, D, E, F (see table 4-17). Brackets are used to denote a partition of the preceding unbracketed item in the same column.

[3]These eight variables are the remaining two- and three-factor interaction terms that correspond to the remaining eight degrees of freedom in each state.

Source: Authors' Calculations

TABLE 4-19

R^2, IN PERCENT, FOR THREE DIFFERENT MODELS ESTIMATING INCREASES IN AVERAGE RESIDENTIAL LOCAL REVENUE REQUIREMENTS

Model	Components in Model	R^2, in percent
1	State average differences	66.3% (of the 100% accounted for)
2	State average differences, plus 7 effects same for all states	66.3 + 26.9 = 93.2%
3	State average differences, plus 7 effects specific to each state	93.2 + 6.52 = 99.72%

Source: Authors' Calculations

Considering the total variation of the 80-element raw data set, how well each model estimates Res. is measured by the contributions to R^2 of the various components listed in table 4-17 is shown in table 4-19.

This last figure, 99.72 percent is not surprising, since from table 4-17, it can be seen that if a different model is used for each state, the value of R^2 is always in excess of 99 percent. What is surprising is that R^2 decreases only a small amount, down to 93.2 percent, when all effects of the seven independent variables are assumed common to all states (Model 2 above). The biggest single effect is seen to be simple average differences (in Res.) from state to state.

Percent Drop-off, as the Dependent Variable

Displayed in table 4-20 are the computed effects of the major explanatory variable, own-price elasticity for connection, computed separately for each state. Included is the percent of total variation accounted for by the elasticity effect. With the exception of Vermont, the elasticity is noted to account for in excess of 88 percent of the total variation for each state.

TABLE 4-20

EFFECT OF OWN-PRICE ELASTICITY ON DROP-OFF, BY STATE
(IN PERCENT)

State	Effect of Own-Price Elasticity, D	Percent Contribution of Effect D to Total
Vermont	.52	47.9
Missouri	1.05	93.3
Colorado	1.43	91.7
South Carolina	.70	88.4
Michigan	.99	93.0
All	.94	89.1

Source: Authors' Calculations

Table 4-21 is an analysis of variance of the entire five-state data set, along with the percent contribution to total variation of each source identified. Factor D (connect elasticity) is noted to account for 67.12 percent of the total variation, with average state differences of drop-off accounting for an additional 14.72 percent. That is, a simple model involving a state-specific average value and an effect (common to all states) for variable D, would account for 67.12 + 14.72 = 81.84 percent of the total variation. Unlike the profile of variation in the case of local revenue requirements for residential subscribers in

TABLE 4-21

ANALYSIS OF VARIANCE FOR DROP-OFF

Source of Variation	Sum of Squares	d.f.	Percent Contribution of the Source
Average differences of states	15.36	4	14.72
The (15) variables, common to all states	78.64	14	75.37
[Variable D effect]	[70.03]	[1]	[67.12]
Different variable effects in all states	10.34	60	9.91
Total	104.34	79	100.00

Source: Authors' Calculations

which average state differences were substantial, average state differences account for much less than the effect of one independent variable, D. This result suggests that it is important for a commission to know the value of the connect elasticity because it is by far the most important determinant of drop-off. The policy implications of this result are discussed more fully in chapter 6.

Summary and Conclusions

The analyses in this section have shown the following: 1) the influence of the differences among the states on the percentage change in local revenue requirements for both residential and business lines due to access charges is greater than the influence of all the other experimental variables taken singly or collectively; 2) the influence of the interactive effect of the state differences and the other experimental variables is only marginally important (only 6.5 percent contribution to R^2). This result has implications about the transferability of this study and is discussed in chapter 6; 3) the percentage of drop-off is, not surprisingly, heavily influenced by the connect elasticity. It is surprising, however, that drop-off is only minimally influenced by the other variables. The state-to-state differences had the second most important effect in this case. Of course, the extent to which connect elasticities also differ from state to state, is an additional extent to which drop-off will occur nonuniformly across states.

Analysis of "What If" Scenarios

The plethora of changes in the market for telecommunications that begins January 1984 and continues over the next six-year period can either exacerbate or attenuate the impact of the $2 and $6 interstate access charges. Divestiture, changes in separations procedures, CPE phase-out, the amortization of inside wiring, and the scheduled changes in access charges will be occurring simultaneously. With the proper information, the impact of all these changes can be evaluated. However, without a set of divested books and other information regarding inside wiring, the relative magnitude and direction of the effects of divestiture, CPE phase-out, and the amortization of inside wiring cannot be confidently estimated. On the other hand, the relative magnitude and direction of changes in local exchange rates due to changes in access charges and separations can be forecasted with the NRRI's present data base and model given its assumptions. The impact of these two changes on local exchange rate are analyzed in this section. In addition, the effect of local measured rates on drop-off and the average customer's bill is examined.

It is believed that the impact of changes in the separation of NTS costs will be relatively important in some of the study states. As mentioned elsewhere, the Joint Board in FCC CC Docket No. 80-286 proposes several changes in separations procedures, particularly that part dealing with the allocation of non-traffic sensitive costs. In this docket, it is proposed that the subscriber plant factor (SPF) be phased out over a four-year period beginning in 1986. In its place, the Joint Board proposes an allocation to interstate of 25 percent of NTS costs. Further, the Joint Board proposes creation of a universal service fund levied on interexchange carriers. This fund would be used to make payments to high-cost companies. If the cost of a loop for a state is more than 115 percent of the national average for such cost, a state is considered a high-cost state and, therefore, receives payments from the universal service fund. The amount received would increase as the cost in excess of the national average increases. These universal service fund payments can be used to offset either local exchange rates or intrastate toll allocations. For purposes of this analysis it was assumed that they would be used to offset local exchange rates. The way in which this was accomplished in SMAC was to adopt a common practice of using a composite allocation factor consisting of the sum of the 25 percent factor and the percent of NTS costs covered by the universal fund payments, if applicable. This composite allocation factor was used to allocate NTS costs away from the intrastate jurisdiction. The effect of this calculation was to reduce the revenue requirement imposed on local service by the amount of the universal service fund payments. Henceforth, we shall refer to this composite allocation factor as the interstate allocation factor for NTS costs proposed by the Joint Board.

Table 4-22 presents the current value of SPF (column 1), the cost of a loop as a percent of the national average (column 2), the new allocator under FCC CC Docket No. 80-286 (column 3), and the projected changes in the interstate allocation of NTS costs (column 4).

TABLE 4-22

NTS COST ALLOCATIONS

State	(1) SPF	(2) Percent of National Average Loop Costs	(3) SMAC Allocation Factor for NTS Costs under Docket 80-286	(4) Change in Interstate Allocation of NTS Costs
Colorado	.42978	111.00	.25	-.1798
Michigan	.172477	91.18	.25	+.0779
Missouri	.27093	88.93	.25	-.0171
S. Carolina	.2207	130.38	.3108	+.0881
Vermont	.4308	121.10	.2752	-.1607

Source: Letter to Guy Twombly, Chairman, NARUC Staff Subcommittee on Communications, from J. D. Landers, Director, State Regulatory Matters, AT&T, dated July 22, 1985.

Review of this table discloses several facts. First, only two of the five study states--South Carolina and Vermont--are considered high-cost states; their average loop cost is greater than 115 percent of the national average. Gainers and losers from the change in NTS allocation are identified from the information in column 4. A negative change in NTS allocation to the interstate jursidiction means these costs must be recovered from the state jurisdiction. A positive change, on the other hand, implies costs previously recovered from the state jurisdiction will be recovered from the interstate jurisdiction. It is therefore evident that Vermont, a high-cost, high-SPF state, will lose under the new arrangement, while South Carolina, a high-cost, low-SPF state, will gain. Similarly, Colorado, a high-SPF state, loses, while Michigan, with the lowest SPF in the nation, gains. This cursory analysis, while useful, does not disclose the importance of these gains and losses relative to the impact of access charges and all previously analyzed experimental factors.

The Experimental Design

In order to analyze the impact of changes in the separations of NTS costs and the level of access charges, a full factorial experiment was designed. Three experimental factors were considered:

1. The level of the NTS allocation under SPF and FCC CC Docket No. 80-286.
2. The value of the end-user access charge.
3. The level of all previously discussed experimental factors.

Considerations important in setting the high and low values for these experimental factors are discussed below and summarized in table 4-23.

TABLE 4-23

HIGH AND LOW LEVELS FOR THE EXPERIMENTAL FACTORS

Experimental Factor	Low	High
NTS Allocation (see table 4-22)	SPF	Docket No. 80-286
Access Charges		
Residential	$2	$4
Business	$6	$6
All Other Factors	run 8 (best)	run 17 (worst)

Source: Authors' Calculations

The high value for the interstate access charge is at present uncertain. FCC CC Docket No. 78-72 prescribes a phase-in of cost-based access charges for end users that will occur over the next six years. It is assumed in our experiments that the access charge for residential customers will rise to $4, while the access charge to business customers will remain at $6. The results of the analysis presented below will permit interpolation and limited extrapolation of the impacts of local exchange revenue requirements for access charges other than $2 or $4 per month for residential customers.

The experimental factor labelled "all other factors" refers to the values at which the previous six experimental factors are set. The intrastate price change and intrastate own-price elasticity of demand, interstate usage, drop-off elasticities, customer profile, and cost update elasticities are combined into a composite experimental factor. The low value for this composite factor is those values for run 8, which resulted in the "best case" scenario above. The high value is those values for run 17, which resulted in the "worst case" scenario above.

Of the five states studied, it was decided that the impacts of NTS allocations and access charges on local exchange revenue requirements for Colorado, South Carolina, and Vermont would be most suggestive and interesting. Therefore, six additional runs were performed for these three states. Along with runs 8 and 17 from the original analysis, the six runs complete a full factorial experiment which allows the estimation of the independent and interactive effects of proposed changes in access charges and NTS allocations.

The Results

The impacts of the change in NTS allocation vary considerably among the three states and, in each case, are at least as important as the impact of the composite experimental factor. Since the change in the NTS allocation can be forecasted with some certainty, the importance of knowing the intrastate toll own-price elasticities of demand and changing intrastate toll rates accordingly is heightened. In addition, a realistic assessment of the degree of excess capacity as well as knowledge of drop-off elasticities and usage profiles of potential drop-off customers also become increasingly cogent. The effect of increases in the interstate access charge to residential customer is important for all three states. For all three experimental factors only the main effects were important, while interactive effects in each state were negligible. The analysis supporting these conclusions is presented below for each state.

Colorado

The situation in Colorado can only deteriorate with the proposed changes in NTS allocations and access charges. The previous best case (run 8) of a 15.6 percent change in local exchange rates for residential service and 16.9 percent for business now seems unlikely. In fact, the previous worst case (run 17) of 42.4 percent for residential and 43.6 percent for business service now appears to be the best possible outcome if the Joint Board and FCC proposals are fully implemented. Now, the worst possible case with access charges of $4 and $6, the new NTS allocator of .25, and all other factors at their high value can increase residential revenue requirements by 97.8 percent and business revenue requirements by 76.6 percent.

Table 4-24 contains the raw data from the eight "what if" runs of the model for Colorado. Table 4-25 presents the results of the main effects from moving each factor from its lowest to its highest value.

The independent and main effect of moving only the access charge from $2 to $4 for residential service is to add a 21.4 percent increase to the low change in residential rates. This translates to a total change of 37.0 percent in rates for residential service. The change in

TABLE 4-24

INDEPENDENT AND DEPENDENT VARIABLES FOR THE EIGHT
"WHAT IF" SCENARIOS FOR COLORADO

What if Scenario	V_f	NTS Allocator	All Other Factors	Percent Change in Number of Lines in Service	Percent Increase Average Local Revenue		Percent Change in Usage		
					Bus.	Res.	Exchange	State	Interstate
Run 8	2	.42978	Low	-0.4	16.9	15.6	-0.4	-2.4	27.8
Run 17	2	.42978	High	-4.9	43.6	42.4	-2.4	4.6	1.7
Scenario 1	2	.25	Low	-1.0	42.3	43.6	-1.0	-2.4	27.8
Scenario 2	2	.25	High	-7.5	75.0	76.3	-3.8	2.4	-0.5
Scenario 3	4	.25	Low	-1.3	42.5	63.7	-1.3	-2.4	27.8
Scenario 4	4	.25	High	-8.5	76.6	97.8	-4.3	1.5	-1.3
Scenario 5	4	.42978	Low	-0.7	15.7	37.0	-0.7	2.4	27.8
Scenario 6	4	.42978	High	-6.1	43.9	65.1	-3.1	3.5	0.6

Source: Authors' Calculations

the interstate access charge for residential service has an insignificant impact on the rate for business customers and is not reported in table 4-25.

TABLE 4-25

COLORADO:[1]
ANALYSIS OF THE CHANGE IN
BUSINESS AND RESIDENTIAL REVENUE REQUIREMENTS
FOR "WHAT IF" SCENARIOS

Source of Effect	Amount of Effect Given Res.	Bus.
Percentage change in local rates as determined by run 8	15.6%	16.9%
Main effect of access charge	21.4%	0.0%
Main effect of NTS allocator	30.4%	29.1%
Main effect of all other factors	30.4%	30.4%

[1]Only main effects are reported. The interactive effects were not important.

Source: Authors' Calculations

The main effect of moving the NTS allocator from the present SPF of .42978 to FCC CC Docket No. 80-286's proposed value of .25 accounts for a 30.4 percent addition to a the low value of 15.6 percent for residential service and 29.1 percent addition to the low value of 16.9 percent for business service. Thus, the predicted total change in residential and business revenue requirements is 46.0 percent and 45.9 percent, respectively, when the access charge is $2 and the composite experimental factor is set at its low value. The proposed change in the NTS allocator has roughly half again the impact on residential revenue requirements as does the access charge. No similar statement can be made regarding the impact on business revenue requirements.

The main effect of moving the "all other factors" experimental factor from the low to high value was discussed in a previous section (run 8 and run 17 for Colorado). In the context of the present analysis, it is predicted to add 30.4 percent to the low value of the changes in both residential and business revenue requirements bringing these to 46.0 percent for residential and 47.3 percent for business. The change in revenue requirements attributable to this composite experimental factor is at least as important as the change attributable to the NTS allocator. Furthermore, it has approximately half again the impact of the potential change in the interstate access charge for residential customers.

If the FCC approves the Joint Board proposal for allocation of NTS plant, it seems likely that the NTS allocator will be .25 for Colorado in 1989. If the interstate access charges for residential and business service are $4 and $6, respectively, the impact on local exchange revenue requirements is the worst situation encountered of the three states analyzed in this section. The change in residential revenue requirements is 63.7 percent when the composite factor is its best case value, and 97.8 percent when set at its worst case value. The change in business revenue requirements is 42.5 percent when the composite factor is set at its best case value and 76.6 percent when set at its worst case value. The scenario with all factors at their high value results in 8.5 percent of residential and business lines dropping off the system.

The information in table 4-25 was used to derive two equations involving continuous variables that replace factors. This permits interpolation or extrapolation of the results for values of the three experimental factors different from those that were assumed. The equations for residential and business service are as follows:

Residential

$$\Delta R\% = 80.43 + 15.21C + 10.71\ X_1 - 168.65\ X_2 \qquad (4.2)$$

Business

$$\Delta B\% = 101.94 + 15.21C - 168.65\ X_2 \qquad (4.3)$$

where C is the composite factor, X_1 is the interstate access charge, and X_2 is the value of the NTS allocator. The values for the experiment factors assumed above are:

Experimental Factor	Low	High
C	-1	+1
X_1	2	4
X_2	.42978	.25

If these assumed values for X_1 and X_2 appear unreasonable, new values can be used in equations (4.2) and (4.3) to solve for the impact on residential and business revenue requirements. Of course, C is not a continuous variable and should continue to be coded with -1 or +1. Other values for C could be used, but the meaning of those numbers cannot be interpreted.

For example, if the effect of the composite experimental factor is ignored, the predicted change for residential revenue requirements is 81.1 percent and the change for business revenue requirements is 59.7 percent, when the interstate access charges are \$4 and \$6 and the NTS allocator is .25. This example suggests how the Colorado commission can use these equations to explore the consequences of alternative assumptions.

South Carolina

The outlook in South Carolina is favorable as the proposed changes in NTS allocations and access charges take effect. Business customers are likely to experience no more than an 8.9 percent increase in local exchange revenue requirements and possibly a 3.8 percent decline in exchange revenue requirements. Residential customers, on the other hand, can experience anywhere from a 9.9 percent to a 22.6 percent increase in local exchange revenue requirements. This range occurs with interstate access charges of $4 and $6 and the proposed NTS allocator, under FCC CC Docket No. 80-286, of .3108. Total drop-off for business and residential lines will probably not exceed 2.3 percent.

Table 4-26 presents the raw data from the eight "what if" runs of the model for South Carolina. Table 4-27 contains the results of the main effects on average local revenue requirements of increasing each factor from its lowest to its highest value.

The independent and main effect of moving only the interstate access charge from $2 to $4 for residential service is to add 13.3 percent to the low change in residential revenue requirements. This translates to a total change of 20.8 percent in revenue requirements for residential service, accounting for 37.0 percent of the total effect on residential revenue requirements of moving all experimental factors from their low to high value. The change in the interstate access charge for residential service has an insignificant impact on the rate for business service and is not reported in table 4-27.

TABLE 4-26

INDEPENDENT AND DEPENDENT VARIABLES FOR THE EIGHT "WHAT IF" SCENARIOS FOR SOUTH CAROLINA

What if Scenario	V_f	NTS Allocator	All Other Factors	Percent Change in Number of Lines in Service	Percent Increase Average Local Revenue		Percent Change in Usage		
					Bus.	Res.	Exchange	State	Interstate
Run 8	2	.2207	Low	-0.2	6.5	7.5	-0.2	-2.4	27.8
Run 17	2	.2207	High	-2.5	20.0	21.0	-1.3	6.4	3.4
Scenario 1	2	.3108	Low	0.1	-3.1	-2.9	0.1	-2.4	27.8
Scenario 2	2	.3108	High	-1.1	7.7	8.7	-0.5	7.6	4.5
Scenario 3	4	.3108	Low	-0.2	-3.8	9.9	-0.2	-2.4	27.8
Scenario 4	4	.3108	High	-2.3	8.9	22.6	-1.2	6.6	3.6
Scenario 5	4	.2207	Low	-0.4	6.6	20.3	-0.4	-2.4	27.8
Scenario 6	4	.2207	High	-3.6	21.2	34.9	-1.8	5.5	2.6

Source: Authors' Calculations

TABLE 4-27

SOUTH CAROLINA:[1]
ANALYSIS OF THE CHANGE IN
BUSINESS AND RESIDENTIAL REVENUE REQUIREMENTS
FOR "WHAT IF" SCENARIOS

Source of Effect	Amount of Effect Given Res.	Bus.
Percentage change in local rates as determined by run 8	7.5%	6.5%
Main effect of access charge	13.3%	0.0%
Main effect of NTS allocator	-11.3%	-11.3%
Main effect of all other factors	13.1%	13.1%

[1]Only main effects are reported. The interactive effects were not important.

Source: Authors' Calculations

The main effect of moving the NTS allocator from the present SPF of .2207 to FCC CC Docket No. 80-286's prescribed value of .3108 decreases the low change of 7.5 percent in residential revenue requirements by 11.3 percent. Thus, the predicted change in residential revenue requirements is -3.8 percent. The same change of -11.3 percent for business revenue requirements predicts a total change in business revenue requirements of -4.9 percent. The proposed change in the NTS allocator has slightly less effect on revenue requirements for residential service than does the access charge. Thus, even though the change attributable to the NTS allocator is negative, it most likely will not totally offset increases in residential revenue requirements resulting from moving to a $4 access charge.

The main effect of moving the "all other factors" experimental factor from the low to high value was discussed in a previous section (run 8 and run 7 for South Carolina). In the context of the present analysis, this factor is predicted to increase the low value of the change in both residential and business revenue requirements by an additional 13.1 percent. The change in revenue requirements attributable to this composite experimental factor is at least as important as the change attributable to the access charge for residential revenue requirements, and in all likelihood will not be offset by the change attributable to NTS allocation factor. This can be observed by examining the change in residential revenue requirements for scenario 4, which predicts a change of 8.7 percent when the access charge is $2 and 22.6 percent when the access charge is $4. For business revenue requirements, the move of the composite factor from the low to high value is predicted to exceed the change attributable in the NTS allocator.

As before, the information in table 4-27 was used to derive two equations. The equations for residential and business service in South Carolina are:

Residential

$$\Delta R\% = 28.93 + 6.55C + 6.65\ X_1 - 126.72\ X_2 \qquad (4.4)$$

Business

$$\Delta B\% = 41.50 + 6.55C - 126.72\ X_2 \qquad (4.5)$$

C, X_1, and X_2 are the composite experimental factor, the access charge and the NTS allocator, respectively. The values for the experimental factors assumed above are:

Experimental Factor	Low	High
C	-1	+1
X_1	2	4
X_2	.2207	.3108

As before, if the assumed values are thought to be unreasonable by the user, new values can be used in equations (4.4) and (4.5) to solve for the impact on residential and business revenue requirements.

If, for example, the composite experimental factor, C, is ignored, the expected change in residential revenue requirements is 16.2 percent and 2.2 percent for business revenue requirements when the access charges are $4 and $6 and the NTS allocator is .3108.

Vermont

With the proposed changes in access charges and NTS allocations, the changes in local exchange revenue requirements in Vermont will be substantially larger than those predicted in previous sections. It is estimated that with favorable demand and cost conditions, residential ratepayers can be expected to experience a 39.2 percent increase in revenue requirements and business a 23.2 percent increase as a result of instituting only the $4 access charge and the NTS allocation proposed in CC Docket No. 80-286. If demand and cost conditions are unfavorable, the change in local exchange revenue requirements could increase by as much as 72.3 percent for residential and 56.3 percent for business service. Total drop-off of business and residential customers could reach 6.7 percent in these latter circumstances.

Table 4-28 presents the raw data from the eight "what if" runs of the model for Vermont. Table 4-29 contains the results of the main effects from moving each factor from its lowest to its highest value.

The independent and main effect of moving only the access charge from $2 to $4 for residential service is to increase the low change in residential rates by an additional 18.5 percent. This translates to a total change of 17.1 percent. The change in the interstate access

TABLE 4-28

INDEPENDENT AND DEPENDENT VARIABLES FOR THE EIGHT
"WHAT IF" SCENARIOS FOR VERMONT

What if Scenario	V_f	NTS Allocator	All Other Factors	Percent Change in Number of Lines in Service	Percent Increase Average Local Revenue		Percent Change in Usage		
					Bus.	Res.	Exchange	State	Interstate
Run 8	2	.4308	Low	0.03	-0.01	-1.4	.03	-2.4	27.8
Run 17	2	.4308	High	-3.0	26.2	24.8	-1.5	6.1	3.1
Scenario 1	2	.2752	Low	-1.0	23.0	21.6	-0.6	-2.4	27.8
Scenario 2	2	.2752	High	-5.6	54.3	53.0	-2.8	4.0	1.0
Scenario 3	4	.2752	Low	-0.8	23.2	39.2	-0.8	-2.4	27.8
Scenario 4	4	.2752	High	-6.7	56.3	72.3	-3.4	3.0	0.1
Scenario 5	4	.4308	Low	-0.3	0.2	16.2	-0.3	-2.4	27.8
Scenario 6	4	.4308	High	-4.4	28.2	44.3	-2.2	4.9	1.9

Source: Authors' Calculations

charge for residential service has an insignificant impact on the revenue requirements rate for business service and is not reported in table 4-29.

TABLE 4-29

VERMONT:[1]
ANALYSIS OF THE CHANGE IN
BUSINESS AND RESIDENTIAL REVENUE REQUIREMENTS
FOR "WHAT IF" SCENARIOS

Source of Effect	Amount of Effect Given Res.	Bus.
Percentage change in local rates as determined by run 8	-1.4%	0.0%
Main effect of access charge	18.5%	0.0%
Main effect of NTS allocator	25.5%	25.5%
Main effect of all other factors	29.6%	29.6%

[1]Only main effects are reported. The interactive effects were not important.

Source: Authors' Calculations

The main effect of moving the NTS allocator from the present SPF of .4308 to FCC CC Docket No. 80-286's proposed value of .2752 accounts for a 25.5 percent addition to the low value of -1.4 percent for residential service to predict a total change of 24.1 percent in residential revenue requirements. The same addition of 25.5 percent for business rates is expected to result in a total change of 25.5 percent in business revenue requirements. The proposed change in the NTS allocator has roughly 40.0 percent greater impact on residential revenue requirements as does instituting a $4 interstate access charge. No similar statement can be made regarding business revenue requirements.

The main effect of moving the "all other factors" experimental factor from the low to high value was discussed in a previous section (run 8 and run 17 for Vermont). In the context of the present analysis, this factor is expected to increase the low change in both residential and business revenue requirements by an additional 29.6 percent. The change in revenue requirements attributable to the demand and price changes for various telephone services in Vermont is at least as important as the changes attributable to the NTS allocator and at least half again as important as the potential increase due to the interstate access charge.

As previously mentioned, if the Joint Board proposal is approved, it seems likely that the NTS allocator for Vermont will be .2752 in 1989. If the interstate access charges for residential and business are $4 and $6, respectively, the impact of the composite factor on local exchange is substantial. The change in residential revenue requirements is 39.2 percent when the composite factor is at its low value and 72.3 percent when set at its high value. The change in business rates is 23.2 percent when the composite factor is set at its low value and 56.3 percent when set at its high value. This worst case scenario with all factors at their high value suggests that both the combined residential and business drop-off will be 6.7 percent.

As before, the information in table 4-29 was used to derive two equations which permit interpolation or extrapolation of the results for values of the three experimental factors different from those that were assumed. The equation for residential and business service in Vermont are as follows:

Residential

$$\Delta R\% = 64.01 + 14.84C + 9.24\ X_1 - 164.09\ X_2 \quad (4.6)$$

Business

$$\Delta B\% = 84.38 + 14.84C - 164.09\ X_2 \quad (4.7)$$

where C, X_1, and X_2 are the composite experimental factor, the interstate access charge, and the NTS allocator, respectively. The values for the experimental factor that were assumed above are:

Experimental Factor	Low	High
C	-1	+1
X_1	\$2	\$4
X_2	.4308	.2752

If these assumptions are thought to be unreasonable, different new values can be used in equations (4.6) and (4.7) to estimate the impact on residential and business revenue requirements. If, as before, the composite experimental factor, C, is ignored, the predicted change for residential revenue requirements is 55.8 percent and the change for business revenue requirements is 39.2 percent when the interstate access charge is \$4 and the NTS allocator is .2752.

Summary

The most salient result of the analysis of "what if" scenarios is the relative magnitude of the impact that the NTS allocator has on the local exchange revenue requirements. This impact varies considerably from state to state--benefiting South Carolina rate payers while greatly exacerbating the increase in local exchange revenue requirements in Colorado and Vermont. It is further observed that accurate estimates for the six factors used in the analysis of access charges above is at least as important as the change attributable to the NTS allocator and roughly half again as large as the change attributable to the increase in the access charge from \$2 to \$4.

Measured Rates for Local Service

Local measured service rates have been promoted as a rate-making alternative to alleviate the adverse effect access charges may have on the goal of universal service. Under measured rates, telephone subscribers would pay a low flat rate each month and a per-minute-mile and/or per-message charge for local calling. The flat-rate portion along with the interstate access charge would assure a subscriber's access to the local network and toll system. This rate scheme has the potential of furthering the goal of universal service if its implementation encourages additional subscriber lines through a lower basic charge. At the same time, however, a usage charge would probably reduce utilization of the local network, which may offset the gains from additional lines. As a result, the overall impact of measured rates for local service on the average exchange revenue requirements per residential or business line is uncertain. These effects are examined in this section.

The analysis presented here is merely intended to be suggestive of the potential impact of measured rates. The experiment is designed to test the effects of a given rate on the range of possible changes in average revenues per line as defined by the "best" (run 8) and "worst" (run 17) cases from the previous analysis. The numerical results of interest are the percentage change in the exchange revenue requirement per residential line, the percentage change in the number of lines, the revenues recovered through the flat portion of the rate, and the revenue per subscriber line minute of use for exchange service. The discussion is focused on the shift in the range of outcomes as well as the effect on the goal of universal service.

Assumptions and Alterations to the SMAC model

In order to assess the impact of mandatory measured rates, the Basic Exchange Rate and Service Curtailment module of SMAC must be altered to accommodate measured rates. The algorithm for calculating the usage portion of the rate and its impact on exchange usage necessitates changes in equations (3.5) and (3.6) in chapter 3. These equations calculate the fractional change in residential (F_R^j) and business (F_B^j) rates, respectively. Three more equations must be added to the model to calculate the exchange revenue requirements recovered through usage rates, the average revenue per minute, and the percentage change in the exchange revenue requirements per residential line.

Before discussing these changes in SMAC, some implementation costs and structural parameters that are not incorporated in the model must be pointed out. First, the costs of measuring and billing local calls are ignored. These costs of implementation are positive and possibly substantial, and should be investigated. Another important set of values affecting the results of this cursory analysis is the own-price and cross-elasticities of demand for local exchange calling.[5] Two possible changes can occur when measured rates are instituted. One change is the percentage change in exchange usage directly attributable to the measured-service rate. The second is a shift among various possible services by existing subscribers. In particular, high usage customers may substitute away from services subject to the local measured rates. These own-price and cross-elasticities are not modelled directly. Instead, an assumption is made regarding the effect on subscriber line minutes of use, and no subscriber is assumed to be able to shift among services to escape the measured rate.

A basic flat charge of $60 per year for a residential line is assumed to be instituted. The corresponding flat charge per year for a business line is assumed to be $60 multiplied by the ratio of average

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[5]This question has been addressed. See references Bridger M. Mitchell and Rolla Edward Park, "Repression Effects of Mandatory vs. Optional Local Measured Telephone Service," in H. Trebing (ed.), New Challenges for the 1980s. Institute of Public Utilities, East Lansing, Michigan, 1981. Also appears as N-1636-NSF, The Rand Corporation, March 1981. Rolla Edward Park, Bruce M. Witzeklm, Bridger M. Mitchel. "Charging for Local Telephone Calls: Pricing Elasticity Estimates from the GTE Illinois Experiment," the Rand Corporation, R-2635-NSF, 1981. The primary concern regarding these studies is the transferability of the estimates to other service areas.

revenues per business line in 1982 to the average revenues per residential line in 1982. This ratio is B in equations (3.5) and (3.6) of the Basic Exchange Rate and Service Curtailment module. This assumption maintains the 1982 relationship between business and residential rates for each study state.

The \$60 annual charge for residential customers replaces average revenue in equation (3.5) which calculates the fractional change in residential rates (F_R^j). Equation (3.5) becomes:

$$F_R^j = \frac{\$60 + v_R}{\frac{RR_e^o}{L_R^o + B \cdot L_B^o}} - 1 \qquad (4.8)$$

where all terms are as previously defined. Similarly, equation (3.6), which calculates the fractional change in business rates, becomes:

$$F_B^j = \frac{B \cdot \$60 + v_B}{\frac{B \cdot RR_e^o}{L_R^o + B \cdot L_B^o}} - 1 \qquad (4.9)$$

These formulas imply that subscribers make their connect or disconnect decision according to the annual fixed cost of subscription and not with respect to the usage charge.

The impact of the usage charge is on the utilization of a given subscriber line. In order to model the impact of usage rates on subscriber line exchange minutes of use, it was assumed that usage rates for exchange service results in an initial 20 percent decline in exchange subscriber line MOU. This new initial level of exchange usage is used to calculate the initial average revenue per minute of use.

The initial average revenue per minute as well as all subsequent average revenues per minute are computed to assure the residual revenue requirements for exchange is recovered. The initial average revenue per minute is calculated by the following formula:

$$R_u^o = \frac{RR_e^o - (\$60)\ [L_R^j + B \cdot L_B^j]}{(1-.2)\ U_e^o} \tag{4.10}$$

where R_u^o is the initial average revenue per minute and all other terms are as previously defined. Subsequent iterations of SMAC lead to changes in the average revenue per minute. The computational formula for the j-th iteration is given by:

$$R_u^j = \frac{RR_e^j - (\$60)\ [L_R^j + B \cdot L_B^j]}{U_e^j} \tag{4.11}$$

where R_u^j is the average revenue per minute for the j-th cycle and U_e^j is the exchange SLU minutes of use for the j-th cycle after adjustment for the initial 20 percent reduction in subscriber line MOU.

Equation (4.11) discloses three possible sources of change in the average revenue per minute from that calculated initially. First, the number of lines (L_R^j and L_B^j) can change. This affects the revenues recovered from the flat rate portion of the rate. Second, the revenue requirement for exchange service (RR_e^j) can change as SMAC iterates through its various modules. Finally, exchange usage (U_e^j) will change as subscribers add to or drop off the system.

The foregoing changes in the Basic Exchange Rate and Service Curtailment module necessitate the introduction of a new formula to report the fractional change in basic rates for residences. The formula is given by:

$$M_R^j = \frac{\dfrac{(L_R^j + B \cdot L_B^j) \cdot (\$60 + v_R) + R_U^j \cdot U_e^j}{L_R^j + B \cdot L_B^j}}{\dfrac{RR_e^o}{L_R^o + B \cdot L_B^o}} \qquad (4.12)$$

where M_R^j is the fractional change in basic rates for residential subscribers as the result of instituting measured rates. All other terms in equation (4.12) are as previously defined.

The Experiment and Results

It was decided to test the measured-rate scenario for Colorado, South Carolina, and Vermont. Two runs of SMAC for each state were performed. These runs along with the best (run 8) and worst (run 17) cases that were used in the previous section provided the basic data for the analysis.

The results are reported in table 4-30. Measured rates appear to alleviate somewhat the impact of the imposition of the interstate access charge. The improvement is more pronounced for the worst case than for the best case. This is primarily due to the connect elasticities and customer profiles assumed for run 17. In each case, as expected, lines are added rather than dropped. The variation in the percent of lines added in each state can be functionally related to the average revenue per line initially observed for each state. The impact on exchange subscriber line MOU varies among the states. This variation is most likely best explained by the initial portion of total subscriber line MOU represented by exchange subscriber line MOU. Finally, it appears that for the three study states, the average revenue per minute will be around one cent per minute. The variation experienced among the states in the per minute charge is probably best explained by the variation in

TABLE 4-30

RESULTS OF MEASURED RATE SCENARIOS

	Percentage Change in Avg. Rev per Res. Line	Percentage Change in Lines	Average Revenue per Min. in Cents
COLORADO:			
Traditional Rates			
Best (run 8)	16.9	-0.4	--
Worst (run 17)	43.6	-4.9	--
Measured Rates			
Best	15.5	1.1	.73
Worst	28.0	5.2	.96
SOUTH CAROLINA:			
Traditional Rates			
Best (run 8)	7.5	-0.2	--
Worst (run 17)	21.0	-2.5	--
Measured Rates			
Best	3.4	2.4	1.12
Worst	0.9	11.8	1.14
VERMONT:			
Traditional Rates			
Best (run 8)	-1.4	0.0	--
Worst (run 17)	24.8	-2.9	--
Measured Rates			
Best	-2.4	1.4	0.70
Worst	10.2	6.8	0.98

Source: Authors' Calculations

the initial average revenue per line. The range of the per minute charge in all likelihood is related to the effect of additional lines, the effect of relative changes in exchange and toll usages, and the overall impact of the Accounting, Cost, and Separations module.

The impact of mandatory measured rates on the average revenue per residential line varies among the three states primarily according to the variation in the initial average revenue per line. What is of most interest is the dramatic improvement that occurs in the worst case. As pointed out above, the connect elasticities and customer profile assumed for this worst case are primarily responsible. Table 4-31 summarizes values for experimental factors given previously for runs 8 and 17. The higher connect elasticities for both business and residences for run 17 result in a larger number of lines being added than in the case of run 8 with its lower connect elasticities. This results in approximately a fivefold increase in the number of lines added in run 17 over those added in run 8. Offsetting this improvement on the exchange side is the exchange usage for new customers assumed for run 17. However, the toll usage characteristics assumed for each run lessens the impact of the customer profile in both cases. Thus, for Colorado, the reduction of 1.4 percent in the increase in the case of run 8 as opposed to the reduction of 15.6 percent for run 17 can be explained primarily by the connect elasticity for each case. Similar statements can be made about South Carolina's and Vermont's reduction in the expected increase in exchange rates.

The variation in the reduction of the expected increase in the basic exchange rate, as pointed out above, depends primarily on the variation in the initial average revenue per line for 1982. The flat rate plus the access charge resulted in the pattern of reduction in average revenues in table 4-32. The percentage figures are reductions calculated according to equations (4.8) and (4.9). For South Carolina, which has the highest initial average revenue, the 4.1 percent and 20.2 percent decreases in the expected increase in basic rates is best explained by the functional relationship between the decline in the

TABLE 4-31

VALUES OF THE CONNECT ELASTICITY AND CUSTOMER PROFILE

Symbol	Symbol Name	Value for Run 8 Best Case	Value for Run 17 Worst Case
η_R	Residential Connect Elasticity	.025	.125
η_B	Business Connect Elasticity	.040	.175
D_e	Fraction of Average Exchange User	1.0	.5
D_i & D_s	Fraction of Average Toll User	0	.75

Source: Authors' Assumptions

TABLE 4-32

VARIATION IN THE REDUCTION IN THE FIXED COST PER LINE

State	Percent Change in the Fixed Cost of a Line	
	Bus.	Res.
Colorado	-31.4	-30.2
South Carolina	-55.9	-56.9
Vermont	-37.9	-39.2

Source: Authors' Calculations

fixed cost of a line of approximately 56 percent and the connect elasticity. This can be compared with Vermont, which experiences approximately a 38.0 percent decline in fixed cost, which translates only to a 1.0 percent and 14.6 percent drop in the expected increase in basic exchange rates.

This same relationship between the measured rate scheme assumed for this experiment and the initial average revenue per line directly explains the variation in the lines added to the system. As expected, South Carolina, Vermont, and Colorado can be ranked with respect to percentage of lines added by the same ranking evidenced in table 4-32.

As previously pointed out, the average revenue for an exchange minute of use is about one cent among the three study states. There is, of course, variation among the states. Colorado has the lowest average revenue per minute with a range of 7.3 to 9.6 mills. South Carolina has the highest average revenue with a range of 1.12 to 1.14 cents. This result could be anticipated. With a uniform flat rate portion of $5 per month, differences in the average revenue per line would be reflected in the usage rate. Thus, Colorado, a low-cost state, would experience a low average revenue per minute, while South Carolina, a high-cost state, would yield a high average revenue per minute.[6] This explanation is in harmony with the results for Vermont. Here the range is from 7.0 to 9.8 mills and that state has an average revenue per line similar to that of Colorado.

It is of interest to note the tight range in average price per MOU between the best and worst cases for measured rates. They are a range of 1.3 mills for Colorado, .2 mills for South Carolina, and 1.8 mills

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[6]These low-cost, high-cost designations are based on which state would currently qualify for the high-cost factor proposed by the Joint Board to distribute universal service fund awards as opposed to any real assessment of the cost of service in these states.

for Vermont. The size of the range is apparently related to the percent change in the number of lines, the percent change in exchange usage, the portion of total usage that is exchange, and the impact of a shift in the jurisdictional costs due to these usage changes.

Summary

Local measured rates seem to alleviate the impact of access charges. The improvement is more pronounced for the worst case (run 17) than for the best case (run 8). This result is best explained by the connect elasticities assumed for each case. A five dollar per month flat charge for residential customers in Colorado, South Carolina, and Vermont results in a per exchange subscriber line MOU charge of approximately one cent in each state. The observed variation of this per minute charge among the three study states can be explained by the variation in the average exchange revenue requirement per line and the exchange portion of total subscriber line MOU.

Summary of Empirical Findings

This chapter has been long and complex, ranging widely over many topics and analyses. Each section contains a summary, yet it seems appropriate to pull together in one place and to highlight what seem to us to be the most salient empirical findings of all our experiments with SMAC. Such is the purpose of this section.

The federally-imposed end-user access charge of $2 per month for residential subscribers and $6 per month for business subscribers has the direct effect of raising local revenue requirements. Across the five study states these increases range from 13 percent to 20 percent for residences and 12 percent to 23 percent for businesses when computed on the basis of average revenues. However, the imposition of the end-user access fee will most likely be accompanied by changes in prices for all toll services. All these changes, together with the public's reaction to them, will act through the separations process and other ways to cause indirect effects on average local exchange revenue requirements. The range of effects expanded when indirect effects were included. This new range was from a 1 percent decrease to a 43 percent increase in residential revenue requirements. The similar range for businesses was from 0 percent to 41 percent. The range within each state for either business or residence is narrower than these, but tends to be 15 percent except for South Carolina where it is closer to 10 percent, and Vermont where it is 25 percent.

Much of the analysis was aimed at determining what factors were important in causing these ranges. Table 4-33 shows the numerical results of this effort for all the study states.

One will note that the factor E (usage profile of dropped lines) is not included in the results. This is because its contribution to explaining the variability in the data was negligible.

Factor F (status of capacity in TS toll plant) was important in all states, although marginally so in Michigan. This result raised questions about the allocation of TS plant in the separations process. It seems unlikely, based on the study results, that the allocation attributes growth in TS plant to the services causing it.

Factor A (change in state toll rates), together with its interaction with factor B (own-price elasticity for state toll) was an important factor in all states. The results indicated that local revenue requirements would benefit from increasing state toll prices five percent and damaged by decreasing state toll rates. This is especially so if state toll demand is inelastic, but is still true for some range of elastic demands. In fact, extrapolation of the study results suggests that in order to protect local rates, state toll prices could be increased as long as the own-price elasticity for toll is less than 2.00 in Colorado, 1.14 in Michigan and South Carolina, 1.26 in Missouri, and 1.31 in Vermont.

TABLE 4-33

SUMMARY OF THE EFFECTS ON AVERAGE LOCAL REVENUE REQUIREMENTS OF THE SIX MOST IMPORTANT EXPERIMENTAL VARIABLES DURING THE FIRST YEAR OF IMPLEMENTATION OF PROPOSED ACCESS CHARGES (IN PERCENT)

State	Average Increase in Local Revenue Requirements Over the 16 Experimental Runs	Influence of Important Variables on the Increase in Local Revenue Requirements[1]					
		A State Toll Rates	B Own-Price Elasticity State Toll	AB Interaction Term of A and B[2]	C Increase in Inter-State Toll Usage	D Connect Elasti-cities	F Status of TS Toll-Related Capacity
Colorado	28.4	±2.3	±0.8	±1.6	±1.6	±1.8	±4.7
Michigan	15.9	±2.3	±1.0	±2.0	±0.6	±1.3	∓0.5
Missouri	20.9	±2.1	±0.7	±1.4	±1.1	±1.3	±2.2
S. Carolina	13.0	±1.8	±0.8	±1.5	±0.7	±0.9	±1.5
Vermont	9.2	±4.0	±1.2	±2.4	±2.3	±0.6	±3.1
Average Over States	--	±2.5	±0.9	±1.8	±1.3	±1.2	±2.2

[1]The (±) indicates the value should be added if the factor is set high and subtracted if it is set low. Do the opposite if the symbol is (∓). The definitions of high and low are summarized as follows: A low = increase rates 5%; B low = 1.1; C low = 27.8% increase; D low = .025 Res. and .045 Bus.; A high = decrease rates 15%; B high = .5; C high = 5.4% increase; D high = .125 Res. and .175 Bus.; F low = sufficient capacity for increased toll traffic; F high = insufficient capacity for increased toll traffic.

[2]The interaction term is added if A and B are both low or both high, and subtracted otherwise.

Source: Table 4-17

An increase in interstate toll traffic can reduce local revenue requirements because interstate markets pay a larger share of the cost of existing telephone plant. This assumes, of course, that no TS plant would need to be added because of the traffic. For example, a doubling of interstate traffic (an extrapolation) would decrease local revenue requirements by 13.2 percent in Colorado, 4.6 percent in Michigan, 9.3 percent in Missouri, 5.8 percent in South Carolina, and 18.7 percent in Vermont.

The own-price elasticity for connection to the local network (factor D) also proved important because of drop-off causing local revenue requirements to be spread over fewer lines. However, as expected, the real importance of D was in determining the amount of drop-off. What was surprising was that it accounted for about 90 percent of the variability in the amount of drop-off in four of the states. In Vermont it only accounted for 48 percent of the variability. Thus, in each state except Vermont, only about 10 percent of the variability in drop-off could be attributed to the same factors that influenced local revenue requirements. While keeping local rates low is the primary method of controlling drop-off, it appears to have minimal effect and drop-off due to access charges will differ greatly from state to state if connect elasticities differ greatly from state to state.

The range of drop-off percentages experienced in the initial 17 experimental runs are summarized in table 4-34. As indicated, the largest part of each range is due to the connect elasticity, which varied from .04 to .14 in the 17 experimental runs.

The composite analysis of all 5 study states showed that state differences made by far the largest contribution to the variability of results in the 80 experimental runs. These state differences accounted for two-thirds of all variability. The 7 variables (A, B, AB, C, D,

TABLE 4-34

PERCENTAGE OF LINES DROPPED FROM SERVICE
DUE TO THE FIRST YEAR OF ACCESS CHARGES,
BEST AND WORST CASES

State	Best Case	Worst Case
Colorado	0.4	4.8
Michigan	0.4	3.2
Missouri	0.3	3.5
South Carolina	0.2	2.5
Vermont	0.0	2.9

Source: Tables 4-3 through 4-7

and F) collectively accounted for only 25 percent of the total variability and an interaction between state differences and the 7 variables accounted for only 6.5 percent of the variability. As a result of this last statistic, a model consisting of the state-specific average effects and the average variable effects common to all states (listed in table 4-33) is reasonably good and able to explain 92.4 percent of the variability in the data effects. This has implications for the transferability of study results to other states and companies.

The effect of the proposed change in the NTS allocator and the effect of an end-user access charge of $4 per month for residential subscribers in three of the five study states were examined in the "what if" scenarios. Also, a preliminary analysis of mandatory local measured rates suggested that such rates might help to maintain universal service.

A summary of the results is given in table 4-35. As is readily seen, the effect on local revenue requirements of the proposed change in the NTS allocator will be widely divergent across states. It is also the case that moving from a $2 per month to a $4 per month residential end-user charge will increase revenue requirements an amount generally in excess of two-thirds the increase due collectively to the other experimental factors previously examined.

TABLE 4-35

A SUMMARY OF THE MAJOR RESULTS OF THE "WHAT IF" ANALYSES

State	Additional Change in Local Residential Revenue Requirements Due to $4 End-User Access Charge	Additional Change in Residential and Business Local Revenue Requirements Due to Proposed NTS Allocator		Change in Residential and Business Local Revenue Requirements Due to All Variables Previously Studied		Average Price Range Per Subscriber Line MOU for Measured Rates with a $5 Residential Flat Charge and a Business Premium Times $5 Flat Charge for Business
		Res.	Bus.	Res.	Bus.	
Colorado	21.4%	30.4%	29.1%	30.4%	30.4%	.73 to .96¢
S. Carolina	13.3%	-11.3%	-11.3%	13.1%	13.1%	1.12 to 1.14¢
Vermont	18.5%	25.5%	25.5%	29.6%	29.6%	.70 to .98¢

Source: Tables 4-25, 4-27, 4-29, and 4-30

CHAPTER 5

SOME ECONOMICS OF TELEPHONE ACCESS PRICING

This chapter is concerned with the pricing of access to local exchanges for the purpose of long-distance calling, particularly with the ultimate structure of prices that will emerge after the expected five-to-seven-year transition period.[1] During this period prices will be designed so as to minimize adjustment costs associated with discontinuities due to sharp price increases and regulatory actions designed to cope with changing patterns of revenue responsibility. According to the Federal Communications Commission, after the adjustment period, access to local networks will be priced on the basis of costs. The flat price will be paid by end users at rates that will satisfy the FCC's "goals of universal service, nondiscrimination, network efficiency, and prevention of uneconomic bypass."[2]

Technology and the Policy Desiderata

There are at least three major characteristics of telephone networks that bear upon the achievement of the above objectives. First, the technology of telephone networks permits economical interconnection to competing vendors of the same service. Thus, unlike the case of most regulated utility services, there exists a realistic possibility of

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[1]Federal Communications Commission, Third Report and Order "In the Matter of MTS and WATS Market Structure," CC Docket 78-72, Phase I, FCC mimeo 82-579, February 28, 1983, p. 3, Section 4.

[2]Ibid., pp. 11 and 34.

viable competition in both the toll and local network services. In the local market, cellular radio networks are being currently introduced in some major cities and there are plans for their introduction in many more.

Second, the telephone network provides a variety of services using plant and other resources in common.[3] Yet, there is no clear agreement as to what the contribution of each service to the costs of the network and its operation is or ought to be. The popular belief is that toll services contribute a disproportionately large share of total network revenues. At a May 23, 1983 meeting in Kansas City, Richard Gabel released data that suggest a different direction of subsidy flow, partly due to a different means of allocating switching costs.[4]

The allocation of switching costs based on stand-alone costs allocates fewer dollars to the majority-use service and more dollars to the minority-use services than would have been allocated by relative use. In general, for most switching machines used in common for exchange service, state message toll service (MTS), and interstate MTS, the exchange service is the majority-use service while state MTS and interstate MTS are minority-use services. The difference in allocation between stand-alone and relative use is illustrated by an example in the Gabel, et al. study, in which the authors consider a $10,000 switching machine in which state MTS and interstate MTS accounted for 4.0 percent and 5.9 percent of the traffic respectively while exchange accounted for 90.1 percent of the traffic. Had three stand-alone facilities been built to carry the traffic of these three services it

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[3]The services are not "joint" in the economic sense, since they can be provided in a wide variety of proportions using the particular configuration of the plant and other resources.

[4]Richard Gabel et al., "The Allocation of Local Exchange Plant Investment to the Common Exchange and Toll Services on the Basis of Equalized Relative Cost Benefits," a research paper supported by the Kansas Corporation Commission, May 23, 1983.

was estimated in the study that the costs would be $9,500 for exchange traffic, $2,000 for state MTS, and $2,500 for interstate MTS for a total cost of $14,000. Since the single switching machine costs $10,000, a savings of $4,000 or 28.6 percent is achieved by not building the stand-alone system. The allocation based on stand-alone costs proposed in the study suggested that all services should share equally in the savings by having their allocated common costs equal to 28.6 percent less than their stand-alone costs. These results are shown in table 5-1, in which column B is 71.4 percent of column A. Column B shows much higher allocations to the minority-use services than does column C, which is based on relative use.

TABLE 5-1

COMPARISON OF COST ALLOCATION OF SWITCH INVESTMENT ON THE BASES OF STAND-ALONE AND RELATIVE USE COSTS

Service Category	Investment Allocation Based On Stand-Alone Cost		Relative Use
	(A)	(B)	(C)
Local Exchange	$ 9,500	$ 6,786	$ 9,010
State MTS	2,000	1,428	400
Interstate MTS	2,500	1,786	590
	$14,000	$10,000	$10,000

Source: Based on Richard Gabel, mimeo, May 23, 1983

Third, telephone networks generate consumption externalities, in the sense that the value to a consumer of having access to a network depends on the size as well as composition of the group that has access to the same network.[5] For example, the larger the group with access, the greater the chance that a person will receive a telephone call with a valuable message.

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[5]Robert D. Willig, "The Theory of Network Access Pricing," in Harry M. Trebing, ed., Issues of Public Utility Regulation (East Lansing: Michigan State University Public Utilities Papers, 1979), pp. 109-152.

In light of these characteristics of telephone networks, the purpose of this chapter is to examine factors that determine the extent to which the FCC's pricing goals are achievable individually and simultaneously. The viability and internal consistency of these goals depends on local conditions in each service area. In the absence of detailed data describing these conditions, this chapter presents an economic argument based on game theory. The theory itself is set forth in appendix A.

Before proceeding further it is important to focus on some ambiguities concerning the meaning of each of the stated FCC goals. The most common interpretation of the universal service goal is in terms of the existence of direct access at affordable prices to the telephone network for all households. Of course, it is possible to narrow this interpretation in terms of the directness of the access and the range of telephone services to be provided. For example, the presence of a public telephone within a short distance of every residence would assure some measure of universal service. Indeed, there is a wide range of network configurations that could be interpreted as accomplishing this.

The goals of nondiscrimination and network efficiency are more difficult to characterize. Discrimination exists when identical consumers, in terms of their relationship to the network, are treated differently. Presumably the relevant relationship to the telephone network is in terms of cost causation. As was already indicated above, the process of cost causation is often difficult to measure. The existence of discriminatory prices is interpreted sometimes as resulting in subsidies, or transfer payments, among the telephone company's customers. Network efficiency can be interpreted in engineering terms, in relation to the size and range of services, or in economic terms, in relation to patterns of resource use.

According to the FCC, the concept of <u>uneconomic</u> bypass is associated with the transition period and with access prices that are not optimal in an economic sense. Economically optimal prices may generate bypass when a cheaper alternative is available, but since the phenomenon would be associated with economically optimal prices it cannot be considered undesirable. On the other hand, considerations other than economic efficiency might warrant the prevention of bypass.

In some sense this entire chapter and appendix A is concerned with the phenomenon of bypass. In the appendix we use game theory to distinguish economic from uneconomic bypass. In appendix A, the first section provides the game-theoretic framework for analyzing access pricing issues. The section is intended for readers not familiar with game theory as a tool of economic analysis. A simple cost-sharing analysis that abstracts some relevant aspects of access pricing and focuses attention on the interrelationships among the FCC objectives is in the second section of appendix A. In addition, the second section presents a welfare game analysis that incorporates some information on customers' characteristics. This type of information is typically not included in cost-sharing games. The purpose of the second section is to suggest the conditions that need to be present in order to make economically efficient access charges feasible.

Policy Conclusions From the Game Theory Model

The fundamental problem that the design of access charges needs to resolve is the assignment of common costs. Such costs are associated with all multiproduct production processes and typically these costs are assigned without regard to cost causation. In the case of access to the telephone network the threat of bypass makes a pricing policy that is detached from the process of cost causation infeasible. Indeed, perhaps the most significant aspect of the FCC's four stated objectives is the direction that they set for designing access charges. Up to now the burden of supporting the telephone network was distributed through a political process and on the basis of the relative usage of the network by various services and by the potential rate of growth of those services. It has been argued by some that as a result local service was priced 50 percent below marginal cost and long distance service was priced two to three times above marginal cost.[6] In the absence of competition, these prices were sustainable.

While such ratios of price to marginal cost might seem to imply that economic welfare has been lost, insufficient data exist to support such a conclusion. Most notably there is no consensus on cost measurement in the telephone industry. The Bell Companies use Long Run Incremental Costs (LRIC) and Embedded Direct Cost in most states, using study methods that are sometimes individually adapted to the particular state and service. The Federal Communications Commission required AT&T to use a historical cost causation version of fully distributed cost in place of LRIC, but then changed to a fully distributed cost system based on relative use.

There have been efforts to modify the Uniform System of Accounts to support a uniform costing standard, but the General Accounting Office now reports that these efforts seem to have been for the most part abandoned,[7] and the Uniform System of Accounts will remain a financial accounting system only, albeit a more modern one.

As we show in appendix A however, the creation of economically optimal access charges requires detailed knowledge of the costs of supplying the various services of a telephone system. The concept of

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[6] J. Rohlfs, "Economically Efficient Bell-System Pricing," Bell Laboratory Discussion Paper No. 138, (January 1979).

[7] General Accounting Office, Legislative and Regulatory Actions Needed to Deal with a Changing Domestic Telecommunications Industry (Gaithersburg Md.: General Accounting Office, 1981); Idem., Status of Federal Communications Commission Efforts to Allocate Costs Between Telephone Companies Regulated and Unregulated Activities (Gaithersburg, Md.: General Accounting Office, 1983).

cost must be capable of being related to the costs that might be experienced by a potential entrant into the access services market. Even though the costs (by any measure) to an existing producer will inevitably be different from those of an entrant,[8] no pricing plan based purely on cost can guarantee the sustainability of a monopoly. The present interest in cost based access charges adds to the need for an industry standard cost accounting system so that prices for monopoly services do not diverge greatly from their economic optima.

In appendix A an attempt was made to provide a framework to consider the circumstances under which the four FCC goals are plausible individually and jointly. For this purpose game theory was used instead of more traditional methods of analysis. The division of cost burdens, which cannot be allocated easily on the basis of cost causation, produces situations of rivalry among groups to whom the costs are allocated. Game theory provides a basis for examining the circumstances under which a division of costs will result in stability. The core,[9] when it exists, describes one such stable situation.

The conditions needed for the existence of the core were described in the contexts of various situations in the second and third sections of the appendix. Since these conditions are related to demand characteristics and cost structures, it is reasonable to suggest that the existence of the core depends on local or regional conditions. Thus, while uniform national design of access charges may not result in economic efficiency and universal service, as defined by the core, other types of access charges applied on regional or local bases may produce

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[8]James McKie, "Time's Arrow and Marginal Cost Pricing," in Harry Trebing, ed., New Dimensions in Public Utility Pricing (East Lansing: Michigan State University Press, 1976), pp. 523-539.

[9]The core of a game is the set of "payoffs" or outcomes such that no group of individuals can improve the payoff to its members by withdrawing from the game--for example, by engaging in bypass.

the core in some areas of the country, in which case, nationwide universal service may be unachievable. This might suggest that a state-by-state approach to access charge design may be preferred to a national approach.

In addition to the empty core,[10] there is a variety of possible situations. The core may contain a single point, indicating that only one feasible set of access charges will lead to economic efficiency and universal service simultaneously. Or the core may contain many points: in such case, regulatory authorities have the option of choosing from a variety of access designs and of introducing other objectives into the access charge design. The extent to which particular access charges achieve all the FCC goals depends on the conditions present in the service area. Again, the stability of a given customer base depends on whether the core exists, and if it does, on the number of points that it contains. This determination can be made on the basis of cost and demand information specific to each geographic area: perhaps a state, or a LATA, or even a central office.

There are a number of reasons for extending the fundamentals of the design of telephone access prices into other telephone prices under the state jurisdictions. First, competition may spread soon into other telephone services. In such cases, stability will be achieved by sustainable prices only. Second, delay of the introduction of rational pricing may increase, rather than reduce, the long-run adjustment costs of moving away from the current status quo. Third, there seem to exist economically efficient ways of reducing the burden of high telephone rates on the poor. Indeed, the manipulation of prices to accomplish equity objectives may be the costliest method of all.

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[10]There may not be any set of access charges such that some coalition cannot better itself by engaging in bypass and, therefore, universal service is not achievable.

In order to extend rational pricing, state PUCs should consider the introduction of usage sensitive pricing in the local market. Such prices, when based on marginal cost, may be sustainable, subject to qualifications such as those discussed by McKie.[11] Furthermore, usage sensitive pricing may provide the only self-supporting mechanism for reducing the cost of minimal access to the network and thus, would serve the objective of universal service. Secondly, usage sensitive pricing would promote competition in areas of overcapitalized networks, helping reduce any remaining overcapitalization. Both the exploration and the implementation of these strategies requires detailed knowledge of the demand and cost structures of telephone services--knowledge that is deficient at present.

This literature makes the point that, in addition to the aforementioned reasons for usage sensitive prices, to achieve a payoff in the core user prices must be equal to marginal cost which, of course, may be zero. That is, all points in the core are the result of an access charge and usage pricing policy. The usage portion of this policy must be equal to marginal cost, according to most analysts, in order for the policy to be in the core. The reason is simple. In the absence of marginal cost pricing, there is always some rearrangement of prices which is closer to marginal cost, in some sense, and which creates some social surplus that can be distributed to the participants of the game. Since this rearrangement must be an improvement for at least some of the players, while no one is made worse off, the original policy could not have been economically efficient and therefore was not in the core. Hence, all core points are associated with marginal cost pricing. The core itself is the set of all feasible rearrangements of access charges among the customers such that no individual or group of individuals has any incentive to leave the game, that is, to bypass or disconnect from

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[11]The problem with usage sensitive pricing has been that the costs of implementing it were greater, in some cases, than any possible benefits.

the network. These matters are discussed more thoroughly in appendix A.[12]

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[12]Most of the game-theoretic analysis of this chapter and the appendix is based on G.R. Faulhaber, "Cross-Subsidization: Pricing in Public Enterprises," American Economic Review (1975), 65, 966-77; S.C. Littlechild, "Common Costs, Fixed Charges, Clubs and Games," Review of Economic Studies (1975), 42, 117-24; W.W. Sharkey, "Suggestions for a Game-Theoretic Approach to Public Utility Pricing and Cost Allocation," Bell Journal of Economics (1982), 13, 57-68; W.W. Sharkey, The Theory of Natural Monopoly (Cambridge; Cambridge University Press, 1982); and V.S. Fumas and A.B. Whinston, "Subsidy-Free Welfare Games," Southern Economic Journal (1982), 49, 389-405. The literature on optimal prices and subsidy free prices is summarized and critiqued in Chester C. Fenton, A Study to Assist in The Evaluation of The Socioeconomic Impact of the Telephone Rate Structure, Contract FCC-0250, (Cambridge, Mass.: Technology + Economics, Inc., November 6, 1978).

CHAPTER 6

POLICY DISCUSSION AND TRANSFERABILITY OF STUDY RESULTS

We now draw from the empirical findings in chapter 4, the theoretical results and conclusions in chapter 5, the general literature, and the history of events related in chapter 2 in order to discuss the complex policy issues surrounding access charges, as well as the transferability of the results of this study to divested BOCs, independent telephone companies, and other states. The discussions are organized into three sections. The first contains a discussion of federal policy on access charges. The second contains a discussion of state rate-making policy in response to federal policy, and the third contains the discussion on transferability of the study results.

Discussion of the Federal Policy on Access Charges

At the outset of this study there was no intention of being either critical or supportive of the FCC's action in FCC CC Docket No. 78-72. However, the results of the study indicate that substantial problems may exist with a uniform national policy. Furthermore, the recovery of the entire cost of the loop from the end user is a questionable policy partly based on a misspecification of the cost structure of telephone service. Instead, recovery of a portion of the loop cost through toll rates may be appropriate.

A substantial error may have been made when the FCC opted to retain control over the determination of access charges. The adopted policy imposes a uniformity across states in the end-user access charge for interstate service. This uniform policy, while relatively simple to administer, creates severe nonuniformity of impact on the subscribers to local service in the various states. This is evidenced by the fact that the most important elements in our five-state experiments are the demand, cost, and instititional characteristics of the particular state in which the BOC operates. In addition, the Universal Service Fund, intended to help matters, appears instead to exacerbate the disparity among states. Without drawing this discussion into a states' rights issue, our simulations and theoretical work do suggest that a reevaluation of the state/federal jurisdictional dividing lines is appropriate.

One regulatory option that would allow policy to be better tailored to the highly variant conditions in the states is to redefine the FCC jurisdiction over local exchange costs. Under this approach, the FCC would retain jurisdiction over the costs of interstate carriers from point-of-presence to point-of-presence. This jurisdictional structure would place in the state jurisdiction the costs of the local distribution of all calls, including interstate and state toll calls as well as local exchange calls. In seeking rates from the FCC, the interexchange carriers would claim, as part of their operating expenses, the access fees they would have been required to pay in each state. Those access fees, in this case, would be set by the individual state commissions.

This redefinition of the jurisdictional structure has certain advantages. First, it places that part of the total system cost with the most uniform cost structure under the purview of the FCC which can then formulate a national uniform policy. Second, and complementary to the first advantage, state commissions can institute policies that cope best with the cost conditions encountered in their state. Third, separations as it exists at present would no longer be necessary. Instead, each state would be required to implement procedures to allocate the total cost of toll and exchange service among access, toll usage, and exchange. This approach would eliminate political compromises worked out on a national level and integrated in the existing separations procedures, and allow state regulators to come to grips with apparent trade-offs between efficiency and universal service at the state level.

Chief among the disadvantages of this approach is that it might require Congressional action to accomplish. The FCC could find itself not exercising any jurisdiction over telephony if the trend toward encouraging competition among interstate carriers continues and the FCC abstains from exercising jurisdiction over competitive services. It seems highly unlikely the FCC would be supportive of a policy which eliminates its regulatory purview over telephony. Another disadvantage is that regulators in some states may have an incentive to impose inordinately high access charges on interstate toll carriers, believing that in this way customers in other states can be made to subsidize part of the local loop cost. State commissions that engage in such actions invite retaliation from other state regulators. The result might be similar to tariff wars in international trade, the outcome of which is that all jurisdictions raise tariff prices, or in the present case, access charges. Consequently, participants are worse off than they would be had they cooperated and kept the price of access low. The potential for individual commissions to engage in this kind of "beggar thy neighbor" policy is limited, however, since access charges cannot be set so high as to invite bypass.

Also, at the outset of this study, there was no intention to criticize or support the separations procedures or the proposed revision in the handling of non-traffic sensitive costs. However, the results reported in chapter 4 indicate the current separations process does not reflect cost-causative relationships and that the proposed revisions in the allocation of NTS costs have significant and varying impacts on the various states. Our concern, stated simply, is that the separations procedures misspecify the cost structure. As a result, costs are allocated in such a way that prices for access, toll usage, and local exchange may give incorrect price signals and misallocate telecommunications resources. Thus, the FCC's vision of efficiency is not attained, and universal service is threatened because the costs of access are misspecified.

Recall from chapter 4 that increases in toll traffic that result in additional investment in traffic sensitive plant tend to drive up local exchange rates. It was hypothesized that the source of this problem was attributable to the separations of traffic sensitive costs. Specifically, these allocations do not reflect a cost-causative relationship and, as a result, the separations procedures misspecify the cost structure. If the FCC is to continue regulating a portion of local exchange cost, it needs to examine carefully the allocation of plant designated as traffic sensitive.

One source of the misspecification of the cost structure for telephone service is the conceptual classification of costs into traffic and non-traffic sensitive costs. A narrow focus on this classification scheme is also the basis of the apparent conflict between efficient pricing and universal service. The contention that the loop is non-traffic sensitive, and therefore the cost should be recovered from end-use subscribers, is erroneous and imposes severe and harmful constraints on rate-making policy.

Consider an example which focuses on the cost of the loop. Suppose subscriber A places an interstate call to subscriber D through an interstate carrier C, and suppose B is the local company serving D. To complete the call, C will incur costs of doing business, consisting of the costs of its internal operation and access charges such as those it pays to B in order to complete the delivery of A's call to D. Subscriber A, who initiated the call, will pay all of C's costs attributable to A's call through a rate structure either set by regulatory authorities or determined by market forces. The central question in this example is who should pay for the final connection between a switch owned by the local company B and the home of the subscriber receiving the call, D.

The argument supporting the FCC's decision defines subscriber D's act of subscription as the major cost-causative factor. This final connection, it is argued, is made on a loop dedicated to D. Further, the FCC contends the cost of this loop is not sensitive to traffic and therefore has a marginal cost of zero with respect to traffic. It was the act of subscription by D that caused B to incur the cost of D's loop. Consequently, D should pay the full rental cost of his loop.

Placing undue emphasis on the act of subscription obscures some important considerations. First, subscription may cause B to install a loop, but the act of subscription alone did not cause the loop to cost what it does.[1] Instead, it is suggested that a long history of emphasis on developing the lucrative long distance markets has led to a network configuration with higher loop costs than would have been otherwise. Thus, the local company B incurs common costs associated with serving both toll and local exchange markets. This line of reasoning, however, does not necessarily resolve the problem of the allocation of loop costs between toll and exchange service. If the loop is truly non-traffic sensitive, marginal costs are zero. Thus, the cost of common plant cannot be fairly attributed to either service.

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[1]John W. Wilson, "Telephone Access Costs and Rates," Public Utilities Fortnightly, September 15, 1983, pp. 18-23.

However, by employing concepts from the theory of cooperative games, one can begin to resolve the rate-making problem associated with D's loop and incorporate multiple objectives. One line of reasoning turns on the fact that carrier C needs D's loop to complete A's call to D. If C cannot gain access to D's loop because D refuses to allow the carrier to use it free, then C would have to bear the cost of making the connection some other way or negotiate with D for the use of his loop. The game-theoretic approach would suggest that it would be consistent with efficient pricing[2] to charge C some part of C's cost of making the final connection by his least-cost alternative to using D's loop. Thus, efficiency and universal service may be incorporated into the rate-making problem through a coalition which recognizes the mutual need of subscribers and carriers for the loop. From this particular perspective the FCC so far may have failed to arbitrate the pricing problem in a manner fully consistent with the public interest.

Throughout the above example, it was assumed that the cost structure was properly specified and the cost of the loop was non-traffic sensitive. This classification of costs, however, is a short-run concept and essentially synonymous with excess capacity. The cost of the loop is related to the demand for telephone service at any point in time. As long as the frequency of a time coincidence of demand for a loop is low, it would appear from a usage perspective not to be related to traffic. However, as the frequency of coincident demands increases, queuing at the line termination on the subscriber's premises would occur and the blocking probabilities for ingoing and outgoing calls would become unacceptable. These congestion costs would at some point trigger the subscription for an additional loop to

[2]The qualification of "consistent with efficient pricing" is used for two reasons. First, all traffic sensitive costs must be priced at their marginal cost. Second, there is the assumption that the cost structure is properly specified.

relieve this congestion.[3] Thus, time coincidence of demand, rather than usage, is the proper conceptual underpinning for specifying the cost structure of the loop.

From this perspective, blocking probabilities, time of use, and an estimate of the degree of queuing at the customer's premises become relevant to the pricing of the loop. To impose the cost of the loop on the end-use subscriber regardless of his use, time of use, and blocking probabilities in his immediate exchange is to unfairly burden some users who may be off-peak or noncoincident demand users. Furthermore, the role of incoming calls in contributing to congestion implies some of the loop cost can be attributed to a toll carrier trying to complete a toll call during periods of high coincident demand.

In summary, it has been argued that the FCC access charge decision cannot necessarily be supported as being in the public interest. First, the imposition of the entire cost of the loop on the end user fails to recognize the mutual need both the subscriber and toll carrier have for the loop. By attributing the entire cost to the subscriber, toll carriers obtain the use of the loop free, even when their users impose positive marginal costs in the form of congestion costs. Second, the specification of the loop as a non-traffic sensitive cost obscures the essential cost-causative relationship and the fact that most often there is excess capacity on a given loop. Instead, more focus should be placed on the time coincident demand for the use of a loop. Finally, and most importantly, one can question the FCC's role in regulating a portion of the local exchange. This is particularly true when the FCC attempts to mandate broad national policies with a uniform price structure and politically compromised cost allocations. To promote such a policy as economically efficient and in the public interest may be questionable.

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[3]For example, a business subscriber ordering additional PBX trunk, or perhaps a parent of teenagers ordering an additional line in the home.

Discussion of Rate-Making Policy of State Commissions

Most states are now compelled to develop a system of access charges to replace the settlements process by another means of payment among telephone companies and OCCs for state toll calls. In addition, commissions must continue to set customer prices for state toll calls. Both of these are very complex problems and they come at a time when there is substantial pressure on local rates brought about by federal policy on access charges, depreciation, CPE deregulation, the divestiture, and possible competition in most telecommunication markets. An increase in local rates raises concern about universal service. Those who cannot afford a price increase in local service also cannot afford to take advantage of price decreases in other telecommunication markets to minimize their total telephone bill. The only option for such people may be to drop from the local network. One tool available to state commissions is their rate-making authority, and ideas for using it to prevent drop-off are often mentioned. Among those ideas are keeping local rates low through an appropriate design of state toll rates and access charges, moving towards mandatory local measured service rates, or employing lifeline rates. These ideas are discussed more fully in what follows.

Intrastate Toll Access Charges

The need for cost-based rates as a result of increasing competition significantly influenced the FCC access charge decision. The FCC concluded that cost-based rates for interstate access require that all of the interstate share of subscriber loop costs ultimately be paid by the end user. This should lead to a decrease in interstate toll rates. In addition, the FCC believes that this will limit or stop uneconomic bypass. This also means, however, that customers who make few toll calls will end up with higher total telephone bills.

The state commissions must now reach decisions on intrastate toll access charges and must also consider the impact of the end-user charges on universal service.

Local jurisdictions are also faced with the possibility of bypass and competition in the local loop. Consequently, the state commissions face the same concerns about cost-based rates as did the FCC. Uneconomic competition in the local loop or for intrastate toll services will encourage large customers to either leave the network or to reduce the amount of network services they buy. This in turn leaves a shrinking customer base to pay for the costs of providing and operating the network. Some degree of competition in the local loop will be unavoidable due to the changes in technology occurring today. However, uneconomic competition or competition that arises because of false price signals can be avoided by pricing services at their costs.

In addition to the need to determine cost-based rates for intrastate toll, state commissions are also concerned about setting rates that will retain universal service. The interstate end-user charge will add to the customers' total bills (unless they are heavy users of toll services) and the amount will rise over time to an estimated average $8.50 per line.[4] If an intrastate end-user charge is also implemented, the impact will be much higher. State regulators are seeking ways to ameliorate the impact of these charges on their customers. Discussions of the relevant issues are found in the subsections that follow.

Issues Concerning Price Averaging

One issue to be determined is whether there will be statewide averaging of intrastate rates and the pooling of access charges. The current emphasis on cost-based rates, along with the introduction of

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[4]FCC CC Docket No. 78-72, Phase I, "In The Matter of MTS and WATS Market Structure," Third Report and Order, p. 10.

competition to this market, would suggest that intrastate toll rates be de-averaged and that each local exchange carrier collect its own access charge based on its costs (a bill-and-keep process). However, four problems with a bill-and-keep process have been identified. One is, that with de-averaged rates, two intrastate calls of the same distance, duration, and time of day may be charged at different rates, and the public may perceive this as unfair. A more important problem is the possibility that a given company's costs for access, especially the non-traffic sensitive costs, may be so high as to deter toll competition for its rate payers. A third problem with the bill-and-keep process is that many of the telephone companies have little or no experience in constructing the type of tariffs needed for access charges, and an incorrect tariff could create financial problems. Also, the cost involved in making the necessary cost studies may be excessive for smaller companies. A fourth problem with bill-and-keep procedures is that a high cost factor would be difficult to implement, assuming that such a factor was found to be necessary.

Another major issue relative to intrastate access charges is whether or not they should replicate the structure of the interstate access charge. The major argument in favor of selecting a different access charge structure for intrastate toll is that it allows the state commission to tailor the charge to the specific needs of the state and raises the possibility of reducing rates for local exchange.

There are several arguments in favor of replicating the interstate access charge structure. Unless a local exchange company does the billing for all interexchange carriers, it is seldom possible to distinguish intrastate toll traffic from interstate toll traffic. Consequently, it becomes important to devise a system that creates incentives for accurate reporting of the two types of traffic. Traffic sensitive charges that are the same per unit for each type of traffic would do much to accomplish this goal. Also, replicating the interstate access charge system may reduce the administrative costs involved in constructing an intrastate access charge.

Determining Average Levels of Access Charges

In each of the five study states, the percentage price change in intrastate toll was a factor having a significant influence on average local revenue requirements. In three of the states, a price decrease exacerbated the impact of the federally-imposed user access fee, while an increase partially mitigated the FCC's user access fee. In the other two states, the price decrease caused a much smaller increase of local revenue requirements, while the increase had a substantially larger mitigating effect. The question is how to relate this information to the problem of designing access charges for intrastate toll.

In the SMAC model, average MTS revenues per subscriber line MOU were the proxy for price, but if intrastate access charges are implemented, the toll revenues will be derived from two sources--state MTS and state access charges. Thus, if a subscriber line MOU is carried by the BOC, toll revenues will be derived from message unit charges to subscribers, and if a subscriber line MOU is carried by an OCC, then toll revenues to the BOC will be derived from an access charge.

This bifurcation in the message toll markets makes it more difficult to institute a price increase or a price decrease in some intended way. It is also the case that few states have adequate cost-of-service analyses for intrastate services to implement cost-based pricing at this time. Furthermore, a precipitous move to a cost-based pricing policy may result in unanticipated price changes. Again, since the results given in chapter 4 indicate that the price of intrastate message toll services is an important variable in determining the impact on local rates of access charges, it is most important that the states know and control the rate effects of intrastate access charge policy on intrastate toll rates.

A conservative policy would be to ensure that these rates are unchanged, at least for the first year. A less conservative policy would be to increase these rates slightly.[5] The analysis of our SMAC experiments suggests a potentially disastrous policy would be to decrease the message toll rates, assuming a commission seeks to minimize local rate increases. More complete and reliable elasticity data would be needed to resolve this.

We now suggest a simple approach to determine the required revenue per subscriber line MOU that is passed to an OCC[6] and that is roughly equivalent to "no change in price" for intrastate toll. Using data from a test year period prior to the implementation of access charges, the following are needed:

R_s = net revenues from intrastate toll,

U_s = intrastate toll subscriber line MOU.

The proxy for price used in SMAC is R_s/U_s, or average revenue per state toll subscriber line MOU. As a first step, a study of traffic over specific routes during the test year needs to be done in order to separate U_s into two components:

U_s^{BOC} = subscriber line MOU that would remain entirely with the BOC,

U_s^{OCC} = subscriber line MOU that would be partially handled by an OCC.

Additionally, one needs an estimate of those revenues that would continue to be collected by the BOC from subscribers for state MTS. The usage on which these revenues are collected is U_s^{BOC}. Finally, some costs are needed. Specifically required are the toll-related costs avoided because some toll functions are given over to an OCC

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[5]The exact effect of this policy is dependent upon price elasticities and the actual amount of bypass that price increases might precipitate.

[6]OCC stands for other common carrier, which in this context will include the new AT&T interLATA function.

and because some toll-related costs are transferred to AT&T as part of divestiture. Let the symbols for these newly defined revenues and costs be:

R_s^{BOC} = revenues collected by the BOC for U_s^{BOC}

C = costs avoided or transferred by the BOC.

We now define the unknown variable R^{AC} (revenues from access charges). If we assume that the costs of providing long-haul services are the same for all carriers including the BOC which will give up long-haul costs in the amount C, and if access charges had been in effect during the test period, then the required revenues can be partitioned into three components. First is R_s^{BOC}. Second is R^{AC}, which is the BOC's revenues from intrastate access charges, while the third is C, which is the revenues the OCCs must obtain in order to cover their long-haul costs. Thus, the total revenues from all sellers of state MTS for the same amount of traffic as the BOC had in its test year is given by

$$R_s^{BOC} + R^{AC} + C$$

A close approximation to the "no change in price" policy leads to the following identity:

$$\frac{R_s^{BOC} + R^{AC} + C}{U_s^{BOC} + U_s^{OCC}} = \frac{R_s}{U_s}$$

This identity can be solved for R^{AC}, yielding

$$R^{AC} = R_s - R_s^{BOC} - C \qquad (6.1)$$

Any new costs incurred by the BOC resulting from the Modified Final Judgement (MFJ) requirement to provide equal access should be added to the right hand side of this equation.

The measurement of state toll traffic handled by an OCC on which access charges will be paid will be based on traffic transferred between an OCC and a BOC, which might differ from subscriber line MOU for technical reasons. Thus, if we define $\overline{U}_s^{OCC}$ to be a usage measure equivalent to the subscriber line measurement U_s^{OCC}, then the average access price per MOU charged to an OCC is given by

$$\frac{R^{AC}}{\bar{U}_s^{OCC}} = \frac{R_s - R_s^{BOC} - C}{U_s^{OCC}} \qquad (6.2)$$

A major problem remains: how to design rate elements and formulate appropriate charges to achieve the revenues required by (6.1) with the amount of traffic estimated to be transferred between an OCC and BOC.

We make no attempt to solve that problem here as many different solutions may be appropriate in the different states. However, we do set out some general propositions. First, the closer-to-the-average price that each OCC pays for each minute of access, the less incentive there will be to establish multiple points-of-presence within a LATA. Second, (as stated earlier), the greater the divergence of the intrastate access charge rate structure from the FCC's interstate access charge rate structure, the greater the administrative costs of setting prices and collecting revenues and the greater the incentive to misreport state and interstate message units.

The second proposition was clearly identified by the FCC in its FCC CC Docket No. 78-72. However, if the FCC-approved access charge elements are used as a starting point for intrastate access charges and then increased or decreased across the board so as to meet the required average intrastate revenue per minute, the administrative costs could be minimized while the incentive to misreport would still be present. The questions each state would then need to answer are whether misreporting would actually materialize and whether audit procedures could be established to prevent it.

Again, as mentioned earlier, the most prominently recommended alternative is to replicate interstate carrier access charges for the intrastate carrier access charges. This too would minimize administrative costs of identifying and accounting for traffic types that differ only by virtue of crossing state lines and would eliminate the incentive for misreporting such calls. This strategy, however, would probably result in revenues from access charges being different from the revenues needed according to equation (6.1).

If that difference is a surplus, the rates for all intrastate toll service can and should be raised to levels commensurate with interstate rates and the FCC access charges adopted for intrastate use. It is also possible that intrastate use of the interstate carrier access charges will cause a shortfall in revenues from those needed according to equation (6.1). If any of that shortfall is made up through end-user access fees, that action is tantamount to a price decrease in intrastate message service. The prices of message toll services offered by the BOCs and not involving OCCs would also have to be decreased in order to compete (unless effective legal barriers limit OCC activity within LATAs). The SMAC experiments indicate that these price decreases would exacerbate the pressure on local rates even beyond that directly created by an additional end-user access fee. An alternative to an end-user access charge designed to recover the shortfall would be a flat (non-usage sensitive) access charge levied on the OCCs. Such a charge could be spread among the OCCs on the basis, for example, of an engineering determination of their relative capacities to carry intrastate calls.

Sustainability of a "No Change in Price" Policy

Suppose a state commission decides to replicate the interstate carriers' carrier access fees as established by the FCC, and suppose intrastate message toll rates are kept at or above current levels by making up shortfalls from access charge usage sensitive fees with a flat charge levied on the interconnecting OCCs as suggested above. Are these sustainable prices? According to the game-theoretic framework set out in appendix A, if the FCC-established carriers' carrier access fees are based on marginal costs of the traffic, then those are core prices.[7] If the flat charge levied on the interconnecting OCCs is less than the cost of all possible coalitions of OCCs forming to accomplish the same function achieved by interconnection with a BOC without actually interconnecting, then these too would be core prices. Recall that core prices are sustainable. Legal constraints on competition could force up the cost of forming coalitions and thereby increase the size of the core.

Aside from coalitions of OCCs, there is the potential for coalitions of subscribers to form and bypass the local networks in order to gain direct access to OCCs (or their subsidiaries) that specialize in services that do not otherwise need to interconnect with a BOC. The above pricing scheme is probably not a core price with respect to these types of services where large amounts of traffic are highly concentrated among a limited number of subscribers. Indeed, most such coalitions may have already formed and are currently private line users. As technology develops and legal barriers fall, more and more services involving smaller concentrations of traffic will develop cores that do not contain the above prices. This is the specter of bypass. It is the threat of bypass that pervaded the FCC decision on access charges and it is the threat of bypass that causes local telephone companies to seek large intrastate toll rate decreases at the expense of local rates. How serious the threat really is and how far dealing with it can be pushed into the future are currently unknown.

Measured Rate Service

Local measured rate service (MRS) is a rate structure such that customers are charged on the basis of their use of the network. Some

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[7]As indicated elsewhere in this chapter there is substantial doubt that such prices will reflect the appropriate marginal costs.

type of measured rate service is in use in most states, though only a small percentage of subscribers use this rate. The typical measured rate tariff has a flat rate for access to the network, and this flat rate includes a limited call allowance. In addition to the flat rate, there is a rate for usage which exceeds the call allowance. The typical usage element is a frequency tariff, i.e., a charge per call. However, several areas have a four-element usage tariff whereby the charge per call includes charges based on distance, duration, and time of day.

The concept of measured rate service reflects sound pricing theory. That is, the price of a telephone call is based on the costs created by that call. Those who create greater cost pay a higher price. Cost-based pricing should lead to efficient use of the telephone network and is the type of pricing needed to enhance competitive markets and prevent uneconomic bypass.

To institute MRS which carries the appropriate rates, one needs to know the marginal cost of additional usage, relative to all elements in the tariff (frequency, duration, distance, and time of day). However, little is known about the relationship of marginal costs and these four elements. The current system of classifying costs as traffic sensitive and non-traffic sensitive does not capture these relevant economic relationships. Common costs are a significant part of the cost of providing telephone services, and the allocation of common costs is a subject fraught with controversy to which definitive answers may be a long time coming.

In addition to definitional problems in designing a proper measured rate tariff, other problems also exist. The additional metering costs for some exchanges (primarily those with older electro-mechanical central office equipment) may exceed any benefits described from measured rates and could, in fact, raise the total cost of telephone service in a given area. Also, the cost and demand structures that vary throughout a territory would make uniform measured rates suboptimal.

Another consideration is the possibility that the marginal costs per call are virtually zero. In such a case the cost of implementing cost-based MRS would outweigh the probable benefits. Measured rate service is a more attractive option if it is shown that the marginal costs of additional calling are relatively high.

The impact of measured rates on universal service is somewhat uncertain. Measured rates do give customers the ability to control and limit the usage portion of their bills. This feature should help some customers keep their telephone service. However, if the measured rates are cost-based rates, then the flat rate portion of the tariff may be relatively high in some areas. The end-user access tariff will exacerbate this problem. In chapter 4, a description was given of experiments that examined mandatory MRS from the standpoint that universal service was a more important objective than achieving marginal cost-based measured rates. These MRS experi ments were not the main purpose of this study, so the simulation model was not particulary well suited to them. However, they are at least indicative of what could be accomplished at a relatively low average measured rate price per subscriber line exchange MOU. The results were surprisingly consistent across the states and showed that for a flat residential rate of $5 plus the $2 FCC charge, an average revenue of approximately 1¢ per MOU would recover the company's revenue requirements, even under the worst-case situation. No additional metering or billing costs were included. While this rate structure still constitutes substantial increase in local rates, the flat portions of residential bills would decrease anywhere from 30 percent to 57 percent for the three states tested. This would most likely cause lines to be added, rather than dropped.

The possible pitfalls of prices such as these come from the likelihood that the prices are not cost based. It would be pure coincidence if they were, although a 1¢ average charge per MOU may be closer to the marginal cost than the widely used practice of no charge per MOU. If the 1¢ charge is higher than an appropriate marginal cost-based price, an incentive for large users to bypass the local network for local calls is created. There are experiments with cable companies, some office buildings are supplying their own communication networks, and local private networks are being developed by some businesses. In addition, cellular radio services will be available in the near future, although at rather high prices. Consequently, the same concerns voiced by the FCC regarding uneconomic bypass may someday apply to local services. Measured rates that depart significantly from the underlying cost structure will encourage uneconomic bypass.

The second pitfall is political in that subsidies would flow from high local service users to low local service users. In fact, it is that subsidy that would replace the toll subsidies presumed to flow to local service that the FCC is intent on removing. Thus, given the FCC presumption, the subsidy flowing from heavy long distance users to light long distance users could be replaced with a subsidy flowing from heavy local users to light local users through an above-marginal-cost MRS. To the extent that the group of heavy long distance users is the same group of subscribers as the group of heavy local service users, the FCC access charge impacts could be mitigated by keeping a subsidy flowing between the same groups as before. However, there is little evidence of any correlation between these two groups. Thus, if subsidies are the point of discussion, MRS with usage rates not reflecting marginal costs will shift the burden of providing the subsidy among local rate payers; certainly that would cause political problems.

The measured rate option may well be a feasible one. However, to institute it most effectively the commissions need sound cost analyses that will accurately relate the costs of usage to the various usage characteristics, i.e., frequency, distance, duration, and time of day. For areas without any significant threat of bypass or competition in the local loop, it may also be possible to design rates that depart from the cost structure in the short run. If this is done, there also needs to be ongoing monitoring for potential or actual bypass. This would signal when there is need for changes in rates to conform more accurately to the cost structure of exchange service.

Lifeline Rates

Lifeline rates are typically a form of measured rates in which the flat rate portion is set quite low to enable low income customers to buy telephone service. Lifeline rates could, of course, simply be very low flat rates, but it is more common for them to have both access and usage charges.

Lifeline rates will certainly help achieve the goal of universal service. There are, however, two types of problems with lifeline rates. One relates to who uses the lifeline rates and the other relates to cost-based pricing objectives.

The objective of establishing lifeline rates is to make telephone service affordable for low income customers. In order to meet this objective, the use of lifeline rates would, of course, have to be limited to the low income customers. Defining the criteria for eligibility is difficult to do in a manner which would guarantee that only needy customers will qualify. This is a problem common to most social welfare programs and has already proved very difficult in the case of electric and gas lifeline rates. In addition, once the criteria for eligibility are determined, screening and monitoring procedures are needed. If this is done by the telephone company, there is an added administrative cost to be paid by the other customers. Privacy questions may also come to the fore.

In addition to customer definition problems for lifeline rates, there is a potential legal problem. Laws vary among the states, and in some cases the state law may not allow a specific utility rate to be directed only to specified income groups. When this is the case, the lifeline rate must be an option available to all customers. Also, when a commission wishes to avoid definitional problems, the lifeline rate can be an option available to all customers. Thus, the lifeline rate can remain low only as long as a relatively small percentage of customers elect this option. Once a significant percentage of customers selects lifeline rates, the lifeline rate may have to rise substantially in order for the company to recover its cost. At some point, the rate could rise so much that it ceases to be a lifeline rate.

It may, however, be possible to design a lifeline rate that could be offered to all customers and result in only the truly needy customers adopting it. One such example might be to offer a relatively low flat rate with a limited call allowance, e.g., 30 calls per month, and then charge a very high rate for each call over the call allowance. This rate would be far in excess of a usage rate for measured rate service, and would serve as a deterrent to the selection of the lifeline option except in those cases where the customer's financial situation dictated this choice.

The second major problem with lifeline rates is the fact that they are typically not cost-based prices, and, therefore, a subsidy is flowing to some other customer group much like the mandatory MRS subsidies described above. Such a subsidy may be necessary to prevent large numbers of low income customers from dropping off the network.

The goal of universal service is a legitimate goal of regulation, and the fact of such a subsidy is not as big a problem as is the source of the subsidy. Unlike the mandatory MRS case, the burden of providing the subsidy would typically be spread over a much larger group of customers--all those not electing lifeline rates.

Transferability of Study Results

The empirical work in this study focused on five state operations of 1982 BOCs still owned by AT&T. An immediate question is raised as to the transferability of the empirical results to divested BOCs, independent telephone companies, and telephone company operations in other states. The fact is the SMAC model used in our experiments is suitable for experimenting with data derived from the Uniform System of Accounts and separations data of any of the companies mentioned above. A proxy for differences among all companies was the difference among the five study states.

Of the factors reported in chapter 4 that affected the impact of access charges, the state (demand, cost, and institutional characteristics) was by far the most important. There was very little interaction between the state factor and the other experimental factors. This suggests that general conclusions and interpretations should apply reasonably well to all states and all companies including divested BOCs.

Numerical conclusions are another matter. The way to think about numerical conclusions for companies (or states) not studied herein, is to ask the question, what numerical results would have been obtained if another company (or a different state operation of a company) had been run through the SMAC model? The answer is that the average effect (designated M in chapter 4) would have been different. Other company- (or state-) specific results were for the most part negligible. While in the state-specific analysis of chapter 4 numerical values were different from state to state, the composite analysis of all five states showed only a 6.5 percent decrease in the goodness of fit of a predictive model if the five-state average values for the factor effects (other than M) were used in place of the state-specific values. This suggests two approaches for a state (not in the study) to apply the numerical conclusions of chapter 4 to themselves.

First, if a company operating in a state is substantially similar to one of the study state companies, the state-specific results of that similar study state could be used with some confidence. In this case, similarity is defined in terms of company size; physical and financial structure; dispersion and make up of the state's population in the company's territory; relative subscriber line MOU for state toll, interstate toll, and local exchange service; and current rates, to name just a few of the many parameters that may differ from state to state. Second, if the company operation in a state appears unlike any of the five study states, the average values of factor effects should be used. In either approach, one should not assume that the average effect, M, for any given study state would apply to their state.

Given these general comments about transferability of study results, we now discuss more thoroughly the expected results from applying SMAC to divested BOCs and independent telephone companies. Also, discussed below are the implications for study results of the BOCs giving up CPE.

Divestiture

For reasons given in chapter 1, there was no attempt to model in a direct way the effects of divestiture on average local revenue requirements. However, it is possible to identify sources of those effects and the conditions under which the effects will increase or decrease local rates. We do not presently know the magnitude of the effects of divestiture because information was not available at the time the data for this study were being collected. Estimates of the effects uniquely attributable to divestiture may be available from the FCC, which is currently studying these effects, and from the BOCs, which have no doubt already developed a proforma, postdivestiture set of books.[8] Because of the results obtained in our experiments with SMAC, we believe it is possible to integrate forthcoming estimates of divestiture effects into the results of the SMAC experiments. The purpose of this subsection is to discuss ways in which this integration might be done.

Sources of Divestiture Impacts

When the BOCs are divested, the existing BOC sources of costs and revenues will be allocated among AT&T and the individual BOCs in accordance with the approved implementation plan. To the extent there is a mismatch between these costs and revenues there will be an immediate effect on local revenue requirements. Additionally, the plan of reorganization calls for new expenditures and investments by the BOCs that otherwise would not have been made. These include expenditures to reconfigure the network to avoid crossing LATA boundaries inappropriately and to comply with the equal access requirement of the MFJ.

From the point of view of the BOCs, the source of rate impact on local rates due to divestiture will be a function of the following:

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[8]At the time of this writing the FCC was developing a study on divestiture but had not released any results publicly. Also, in July 1983, Ohio Bell Telephone Company submitted to the Public Utilities Commission of Ohio Staff a postdivestiture, proforma set of books. These data would not have been detailed enough to use in our SMAC model had Ohio been one of our study states. Therefore, no attempt was made to secure similar data from the study states.

interstate costs and associated revenues transferred to AT&T, intrastate costs and associated revenues transferred to AT&T, CPE costs and associated revenues transferred to AT&T, and new costs and associated revenues caused by compliance with the provisions of the MFJ.

In the interstate case, the central question is whether plant used for interstate purposes that is tranferred to AT&T would have been allocated to the interstate jurisdiction had it not been transferred. If so, then divestiture would have no effect on local rates due to the transfer of assets used for interstate purposes. However, results of the experimentation with SMAC raised the possibility that there is not a cost-causative relationship between actual costs and costs allocated by the separations process. If this is the case, then again, the SMAC results suggest that local rates would benefit slightly from the transfer of interstate assets in four of the five study states and would have essentially no effect in Michigan.

In the intrastate toll case, there should be little or no transfer of assets in single LATA states. In multiple LATA states, the major metropolitan areas of these states tend to be in different LATAs. This means that intrastate long distance routes with the greatest concentration of traffic will be retained by AT&T. These routes typically have a higher revenue per cost ratio than intrastate routes with lesser concentrations of traffic. Given these general observations, it would not be surprising to see the divestiture bring pressure on local rates in all multiLATA states because of the loss to the BOCs of their most profitable intrastate routes.

In the CPE case, results will be mixed from state to state depending upon regulatory policy towards CPE in recent years. Those states where CPE rentals have been raised to fully distributed cost levels may find that costs avoided with the transfer of CPE assets are less than those fully distributed costs.[9] In such cases, lost revenues will exceed transferred costs, and pressure will come on local rates. If only nominal rental charges have been previously collected for CPE, local rates will, of course, benefit from the transfer of CPE assets. Overall policy regarding CPE is discussed more fully in the subsection following this one.

Finally, new expenditures required to comply with the MFJ will be made primarily for interexchange functions. These costs should be recovered from carrier access charges or toll users.

Secondary effects will come from the fact that the overall structure of the divested company will be different from its original structure. In this context, structure refers to the multiparameter description of a company given by its Uniform System of Accounts, its categories of equipment defined for separations, and its relative proportions of state toll, interstate toll, and local exchange traffic. Thus, the structural elements that distinguish a predivested company from the subsequent postdivested company are the same parameters that distinguish the BOC operations in the five study states from one another.

Recall that differences in the structural parameters among the states was the single most important independent factor in explaining the effects of access charges. Recall also that the interaction of the state parameters with the seven other analyses of variance factors[10] accounted for only 6.5 percent of the variability in the

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[9]Avoidable costs usually are less than fully distributed costs.

[10]These factors are percent change in state toll average price, own-price elasticity for state toll, interaction of the two previously listed factors, percent change in interstate taffic, own-price elasticity for being connected, usage profile of dropped customers, status of TS plant capacity.

data. Since divestiture will cause mostly incremental changes in the structure of a company, which are probably small compared with the structural differences among the five study states, the interactive effects of divestiture with the seven other parameters can almost certainly be ignored. This means that estimates of the primary and secondary effects of divestiture in terms of percent change in average local revenue requirements should be added to the average (or mean) effect of access charges to obtain a reasonable approximation of the total effects. The other numerical results we obtained in the SMAC experiments pertaining to the effect of price changes, elasticity changes, and usage changes should remain relatively unchanged after divestiture.

The Impact of CPE Deregulation

The transfer of embedded CPE assets to an AT&T subsidiary will have an additive effect on the results reported in chapter 4. The ultimate impact of the transfer of CPE assets on average exchange revenues per line depends primarily on two things. The first concerns the relationship between current CPE revenues and costs. If CPE is currently leased at its fully distributed cost, the ultimate impact of CPE deregulation is increased rates. During the transition period of five years, however, the results in chapter 4 understate the predicted change in average exchange revenues. On the other hand, if CPE revenues are not compensatory, the results presented in chapter 4 overstate the ultimate impact. Beyond this important issue the effect of the potential for unavoided cost related to CPE must be considered. Each of these potential impacts from CPE cost and revenues is discussed below.

The Mismatch of Revenues and Costs and Interstate Subsidies

The transfer of CPE assets to an AT&T subsidiary means that the BOC will lose the CPE-related costs and revenues. The BOC will no longer incur the depreciation, taxes, and return on CPE investment once the transfer is effective. Simultaneously with the transfer of assets, the BOC loses revenue flows from two sources. One revenue source is from CPE rental paid by local exchange rate payers. In addition, revenues are lost from the interstate jurisdiction. The transfer of CPE assets removes CPE-related costs from the separations process. Thus, an important revenue flow is lost. The FCC, in order to cushion the impact of the transfer, will continue to include CPE costs in the interstate revenue requirement after the transfer of CPE assets has occurred and will amortize these costs over a five-year period.[11] The loss of costs and revenues by the BOC can alter the magnitude of the estimates of change in average exchange revenue per line.

The potential impact of CPE deregulation on average exchange revenues per line is attributable to the CPE pricing policies adopted by the state commission. If CPE was priced below its associated costs, the magnitude of the change in average revenues per line reported in chapter 4 is altered. These changes are predictable and rather straightforward.

The Joint Board, as well as the FCC, have seemed to implicitly assume that CPE prices are fully compensatory, and therefore, the CPE-related revenues flowing from the interstate jurisdiction are a subsidy to the average exchange revenue per line. If this assumption is correct, the results reported in chapter 4 are indicative of the immediate impact. However, over a five-year period, the change in average revenues would be expected to increase as the CPE base amount in the interstate cost of service is amortized. Thus, the results reported in chapter 4 understate the ultimate impact.

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[11]It should be recognized that the interstate revenue flow for CPE is factored into the results in chapter 4 because CPE is subject to the separations procedures.

Not everyone, however, shares the FCC and Joint Board's assessment of CPE prices. The North American Telephone Association (NATA), an alliance of terminal equipment manufacturers, asserted the CPE prices were not compensatory.[12] Even though the FCC presently rejects this assertion, there exists the possibility that CPE revenues are less than costs that are transferred as a result of divestiture. As a result, the estimates of changes in average exchange revenue per line reported in chapter 4 would understate the ultimate impact five years from now. When the revenue flow from the interstate jurisdiction is factored into the analysis, the interim estimates of changes in the average exchange revenue per line are understated as well.

It is apparent from this discussion that the impact of CPE on the change in average exchange revenue per line is positive. The magnitude of the increase is directly related to the current match between CPE revenues and costs. In states where the interstate revenue flow subsidized CPE prices, the impact will be smaller than in states that have priced CPE at fully distributed costs.

Unavoidable Costs

After the transfer of embedded CPE to the AT&T subsidiary, certain expenses associated with providing and billing for CPE will be recovered from AT&T during a transitional period.[13] However, there exists the possibility that the BOC, during and after the transition period may

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[12]In fact, the FCC previously made a similar finding in 1976. FCC Docket No. 20003, "In the Matter of Economic Implications Arising From Policies and Practices Relating to Customer Interconnection, Jurisdictional Separations and Rate Structures," First Report, 61 FCC 2nd 766 (September 27, 1976), p. 857; and Second Report, 75 FCC 2nd 506 (January 29, 1980), paragraph 97.

[13]See Plan of Reorganization, pg. 78-109.

incur costs previously attributed to the provision of CPE that cannot be avoided. Such costs would be related to overhead, administrative, and data processing activities of the BOC. After the transition period, expenses related to order negotiation, order processing, and billing will be incurred for customer hookup, disconnection, and service alteration. To the extent that the expenses related to CPE are separable and avoidable, there will be no impact on the average revenue per line. It is, however, highly unlikely that such costs are totally separable, and therefore, are unavoidable at least in the short term.

Independent Telephone Companies

All the empirical work in this study has involved data from Bell Operating Companies only. Independent companies, although not directly affected by divestiture, will be affected by access charges. In this section we address some of the limited ways in which results and conclusions of this study apply to independent companies. There are three principal differences between the BOCs and most independent companies.

First, independent companies tend to have the fewer customers per square mile than do the BOCs. Further, their service areas typically do not encompass the larger metropolitan areas. Therefore, the physical structure of these companies as captured in their Uniform System of Accounts is different. The ratios of toll calls to local calls are likely also to exhibit much more variability among these companies than was exhibited among the five study companies. The analysis of SMAC results revealed that differences among the states had by far the most significant influence on the impact of access charges. Differences among states can be equated to differences among companies. Thus, if five independent telephone companies had been experimented with instead of five BOCs, we would expect to have seen a greater dispersion of the average effect. Because of the weak interaction of these average effects with the other experimental factors exhibited in the simulations, our further expectation is that the effects of the other factors would not differ substantially from those found with the BOCs, provided the assumptions required to develop the SMAC model also apply to the independents. This brings us to the second difference.

The assumption that interstate access charges can be set so as to obtain revenues equal to the interstate revenue requirement as determined by separations is dependent on the extent of pooling and the parameters of any universal service fund. It is possible that high cost companies with limited toll calling would not recover their interstate revenue requirement, especially in the absence of pooling. These companies are typically the smaller independents. In these cases, if the shortfall were somehow passed on to the local rate payers an additional main effect would occur, possibly a very large one. Again, the effects of the other factors would most likely change only slightly but their importance could pale in comparison to the mean effect.

Third, a larger portion of state toll revenues of the smaller independents will be converted from present methods of recovery to access charges than is likely to occur in the BOCs or large independents. This is because the BOCs and larger independents will originate and terminate some state toll traffic themselves. In the case of the BOCs, a decrease in intrastate toll rates has the effect of increasing local revenue requirements and that result from the SMAC experiments would surely apply as well to the independents. Thus, a new scheme of intrastate access charges would have to be such that no change occurs in the average revenue per state toll MOU if the adverse effect on local rates is to be avoided. Furthermore, the administrative cost of maintaining separate access charges for state and interstate MOU is more burdensome for the smaller independents than BOCs. Thus, a stronger reason exists for replicating the FCC's carrier carrier access charges in these companies. To replicate the FCC's carriers' carrier access charges and recover through a flat charge to OCCs the type of shortfall from those revenues needed (according to equation (6.1) of the previous section) will, in some instances, result in such a large flat charge to OCCs that no OCC will find it economically viable to serve the independent company's area. In these cases, a mandatory statewide pooling of these flat charges to OCCs may be the only means to preserve toll service to all parts of the state. To cause those flat charges to revert to the users would virtually eliminate any hope for universal service in some high cost rural areas.

Summary

In this chapter we have discussed the present FCC policy on access charges. We are skeptical about the appropriateness of basing prices on costs determined through the separations process and about the appropriateness of the current classification of plant as non-traffic sensitive to determine who should pay for it. We are concerned, having found substantial state-to-state differences in the impact of a uniform federal access charge policy, that the jurisdictional dividing lines of telephone company plant have not been redrawn to give states jurisdiction over all local distribution of calls.

We have also suggested that intrastate toll rates should not be decreased during at least the first year of access charges, if local rate increases are to be minimized, and we presented the rudiments of a means to accomplish a "no change in price" policy in state toll while at the same time instituting intrastate access charges.

Other rate design alternatives to protect universal service were discussed. They are mandatory measured rates and lifeline rates. It is not clear that either offers the answer to maintaining universal service. Unfortunately, too little is known about the structure of costs of local telephone service to evaluate the economic merits of measured rates. Also, lifeline rates may be difficult to administer properly and are almost certainly not cost based.

Finally, general conclusions and policy analyses in this report are believed to be valid in most states for most companies including independents and divested BOCs. Numerical conclusions, while less generally applicable, can still be used with some adjustment.

APPENDIX A

THE APPLICATION OF GAME THEORY TO NETWORK ACCESS PRICING

A Game-Theoretic Framework

Consider a hypothetical telephone exchange service area. In the following analysis of this service area, superscripts N = [1, 2, ., j, ., n] represent the set of all customers and subscripts K = [0, 1, 2, ., i, ., k] represent the set of services. This classification provides a basis for the analysis of the direction of subsidies among individuals and services. Potential subsets of customers in N are indicated by S.

Now, suppose that there is free entry into this telephone area so that any subset S of customers may set up for itself a competing firm that will supply the group with services. For this assumption to be tenable and competition to be viable, it is necessary to assume that all firms in the industry have available to them the same technology and that they can produce according to the same cost function C.[1]

In general, for any two services 1 and 2, C can be represented as

$$C(x_1, x_2) = C_o + C_1(x_1) + C_2\ (x_2); \qquad (A.1)$$

where x_1 is the quantity of service 1 produced and x_2 is the quantity of

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[1]This assumption is commonly made, but it makes demands that may be hard to meet in application. In a time of inflation and increasing productivity, costs as measured by accountants may differ among new and old firms. In the world of historically-determined revenue requirements such costs do matter. The existing technology used by a firm also affects the alternatives open to it; hence its marginal cost.

service 2 produced. C_1 and C_2 are variable costs that increase monotonically with the quantities of the respective services. C_o is a fixed cost, in the sense that it is insensitive to variations in output.

Fixed costs are not unique to regulated monopolies. They may arise from indivisibilities in the production process. In the case of equation (A.1) the fixed element is common to both services and thus is termed common cost. Common cost is a more general form of joint cost, in which the proportions of output are not fixed. While joint cost (fixed output proportions) is rare in telephony, common costs predominate.

Assume that the utility's fixed costs vary with the coalition S that it serves. For the null set of customers, $C_o^{\phi} = 0$ and for any two coalitions of customers, S and T, such that $S \cap T = \phi$

$$C_o^S + C_o^T \geq C_o^{S \quad T} \qquad \text{(A.2)}$$

This type of function is called subadditive.[2]

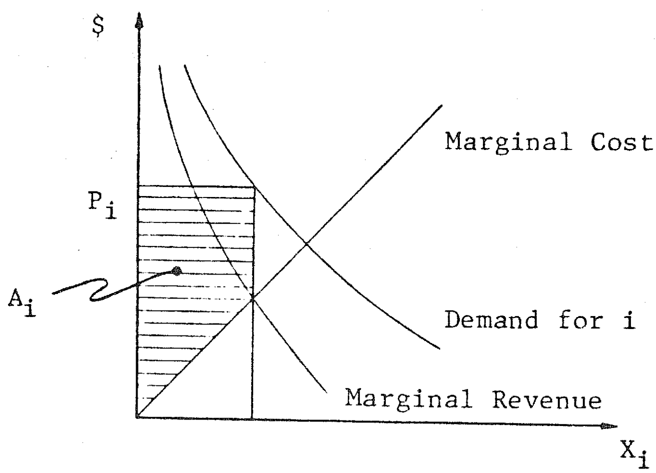

Fig. A-1 Marginal cost pricing of service i

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[2]In general, subadditivity of costs is a necessary cost condition for the existence of natural monopoly. See W.J. Baumol, "On the Proper Cost Tests for Natural Monopoly in a Multiproduct Industry," <u>American Economic Review</u> (1977), 67, 809-22.

Consider now the case of a multiproduct monopolist producing according to a production technology indicated by equation (A.1), whose intention it is to maximize profits by equating marginal revenue to marginal cost. To accomplish this purpose the price of each service needs to deviate from the marginal cost of that service according to the well known inverse elasticity rule:[3]

$$\frac{P_i - MC_i}{P_i} = -\frac{1}{\eta_i} ; \qquad (A.3)$$

where P_i is the price of service i, MC_i is the marginal cost of the same product, and η_i is the direct price elasticity of the service;

$$\eta_i = - \left(\frac{P_i}{X_i}\right) \left(\frac{dX_i}{dP_i}\right);$$

In figure A-1, the shaded area A_i indicates the extent to which revenues obtained from customers of service i exceed the variable costs of that service. In terms of equation (A.1) and in order for the monopoly to be viable, the shaded areas associated with both services need to be sufficiently large to exceed the common costs C_o^N, that is

$$A_1^N + A_2^N \geq C_o^N ; \qquad (A.4)$$

This is the break-even condition for the viability of production. What then should be the access charge in the case of the two services?

In the face of potential customer coalitions seeking alternative suppliers, there is a limit to what the multiproduct monopolist may

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[3]This pricing rule is sometimes called "Ramsey Pricing." Its applicability to telecommunications requires that many conditions be met. In particular, access services are highly complimentary to toll services, while toll services are substitutable in some degree, so equation (A.3) would have to be generalized. See Chester G. Fenton, A Study to Assist in The Evaluation of The Telephone Rate Structure, Contract FCC-0250, (Cambridge, Mass.: Technology & Economics, Inc., November 6, 1978), pp. 27-8.

charge for access. In order to maintain his market the monopolist needs to administer prices that will discourage individuals and groups from seeking alternative suppliers. Such prices are termed subsidy-free in the sense that for each service the customer does not pay more than is necessary to fully compensate the monopolist for supplying that service. Subsidy-free prices are stable or sustainable if the production function is subadditive (equation [A.2]), and costs are the same for all firms (see footnote 1 above). Sustainability implies that no coalition S will find it worthwhile to set up a competitor firm.

The potential for strategic interaction among alternative coalitions of customers on the basis of access prices suggests naturally an analysis using game theory. The general idea of such analysis stems from parlor games. Starting from a well-defined situation, each participant is allowed a sequence of personal moves--moves he determines himself. The players' personal moves are interspersed with chance or random moves. At the end of a game, each player is awarded a payoff, a prize, that depends on the game's progress. The essence of such games, and of game theory in general, is the existence of self-interested actions on the part of players and of rivalry among them.

There exist three main types of game-theoretic models. Each type is associated with a different research objective. Games in "extensive form" are used to provide a very detailed description of the rules and regulations governing a particular situation that involves rivalry. Games in the "normal form" are used to explore conflicts. In particular, particular, the game's payoff matrix, listing the joint payoffs to the game's players, provides a basis for the analysis of bargaining. Games in the "characteristic function form" are used to analyze cooperation among players in the context of a situation involving rivalry.

The game's characteristic function is a real-valued function defined on subsets of the population of players N and assigning to each subset $S \subset N$ the minimum payoff that the group will accept for itself, i.e., the maximum value of the associated two-person game between S and N - S.[4] In other words, payoffs listed by the characteristic function assign to each coalition of players the amount that the members of that coalition can obtain from the game, whatever the remaining players may do.

The analysis of cooperation is an exploration of the alternative strategies that are available to all individuals and groups of players, in the face of opposition from other individuals and groups. An optimal strategy from a player's perspective is a course of action that will give him the highest expected payoff against every strategy of the opposing players. A game's solution is a n-tuple of optimal strategies, associated with the game's N players. Obviously, changing the players' motivations and available strategies will change the game's solution.

In particular, in the case of cooperative games in characteristic function form, the FCC goals of efficiency, universal service, and non-discrimination find natural counterparts as particular solutions. Each type of solution satisfies a particular aspect of each FCC goal. The relationship between these goals and game-theoretic solutions is determined by the imposed restrictions on admissable payoff structures. Alternate rules governing players' interaction determine the distribution of payoffs, whose self-interest will be served best, and the extent to which the FCC goals are achieved.

To provide a basis for cooperative interaction there must exist a reasonable motivation for the formation of coalitions. For this

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[4]That is, between S and everyone else. For a concise discussion of these concepts see Martin Shubik, "Game Theory Models and Methods in Political Economy," in K.J. Arrow and M.D. Intrilligator, eds. Handbook of Mathematical Economics, volume I (New York: North-Holland Publishing Company, 1981), pp. 285-330.

purpose, cooperative game theory is applied to situations in which the characteristic function, ν, exhibits superadditivity,[5] which is expressed formally as:

$$\nu(A \cup B) \geq \nu(A) + \nu(B) \text{ for all disjoint subsets A, B of individuals.} \quad (A.5)$$

Thus, if coalitions A and B have no players in common, their merger into a single coalition will result in a payoff to the merged coalition at least as great as the sum of the payoffs to A and B.

A distinction needs to be made between two types of cooperative games. Games with side payments are based on the existence of binding agreements concerning strategy and the possibility of transferring payoffs between players. In such games only the total payoff to each possible coalition needs to be considered. In games without side payments no binding agreements are possible and there is a need to consider payoff vectors, V, that describe the distribution of each coalition's payoff among its members.

There exist three most common sets of distributions of a game's payoff among its players: imputations, Pareto optimal set, and the core. For any particular game there are likely to be more imputations than points in the Pareto optimal set and more in the latter than in the core.[6] Of course the core and the other solutions may be empty, may have one point, or an infinity of points.

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[5]The reverse of subadditivity, which was defined in equation (A.2). Subadditivity means "the whole is less than the sum of the parts" (sometimes called "economies of scope"); i.e., it is as cheap or cheaper for one firm to produce two products than for two firms to produce the products. Superadditivity means that the payoff to two groups that combine is as great or greater than if they remained separate.

[6]The core of a game, defined in Chapter 3, is a set of solutions such that no player would be better off if he withdrew from the game.

To define the above solutions, consider a vector in Euclidean n-space summarizing the payoffs to each of the players $\pi = (\pi^1, \pi^2, ..., \pi^n)$. The first restriction concerns group rationality, or self-interest. It ensures that the total of the payoffs to all players is equal to the payoff that accrues to the grand coalition of all the players:

$$\sum_{j=1}^{n} \pi^j = \nu(N) \tag{A.6}$$

The second restriction concerns the self-interest of each individual, or individual rationality. According to it, each player needs to receive at least as much by participating in a coalition as he would obtain by individual action:

$$\pi^j \geq \nu(\{j\}); \text{ all } j \in N \tag{A.7}$$

The set of payoff vectors satisfying the conditions of group and individual rationality, or expressions (A.6) and (A.7), is called a set of imputations. The Pareto optimal set of payoffs excludes payoffs for which these exists an alternative set such that at least one of the players is better off.

The third common restriction requires that every coalition of players display the same rationality as an individual player. Thus, according to the coalitional rationality:

$$\sum_{j \in S} \pi^j \geq \nu(S) \text{ for every } S \subset N; \tag{A.8}$$

The set of payoffs satisfying expressions (A.6), (A.7) and (A.8) represents the core. A coalition arrangement that yields a payoff vector that is in the core is stable, since the core is the set of all payoffs such that no individual or group of individuals can improve the payoffs to its members by withdrawing from the game. Thus, the core provides for economic efficiency. Alternatively, game-theoretic considerations suggest that the FCC objective of efficiency is achievable by the conditions that ensure the existence of the core. In other words, in a case in which the core is empty there is no access price that will ensure the viability of the network. In a case in which the core contains only one point there exists only one set of prices that will make the network viable. In a case in which the core contains many points it is possible to choose from many possible sets of prices without endangering the viability of the network. Indeed, in such cases other considerations can enter the design of economically efficient prices.

Universal service can be achieved if the game that includes all individuals in the service area has a core. By selecting a payoff vector in the core, no individual or subgroup of individuals has an incentive to leave the game, that is, to bypass the local network. Thus, the objectives of efficiency and universal service are virtually consistent if the game consisting of all players has a core. It is worth noting that universal service need not provide more than access to local exchange.

If the game that includes all players has a core, but despite this, a payoff vector outside the core is chosen, the result is likely to be that some group will have an incentive to break away from the game. What the FCC has termed uneconomic bypass would be an example of such an outcome. That is, the defecting group finds that its interests are served by avoiding the pricing and access charge policy of the local exchange and subscribing to an alternative service. This bypass is uneconomic because the core exists and consequently there is a price and access charge policy which would improve the welfare of the defecting group and be economically efficient. A second possible consequence of regulators choosing a noncore payoff, besides uneconomic bypass, is simply customers disconnecting from the network. Hence, uneconomic bypass or uneconomic disconnection may result from noncore pricing.

If the game consisting of all players has no core, the game is unstable. Such a game, in all likelihood, will ultimately break down.

A possible exception might be a situation in which bypass is forbidden by law, even if such bypass were economically efficient. In the absence of such legal coercion, however, it is likely that some customers would break away from a regulated pricing game that had no core. Exactly how the disintegration would occur and how far it would go depends upon the cost structure of the industry, as well as the customers' willingness to pay. It may be that the network would divide into two smaller regulation games, one of which having 90 percent, for example, of the original participants and the other having the remaining 10 percent. If these two smaller games each has a core and the regulated payoff vector is indeed in each respective core, then the disintegration would stop at this point since each subgame is separately stable. Another possibility is that the game is inherently unstable and subject to a phenomenon known as cycling. Games that cycle are ones that have incentives for new coalitions to form, and thus break up or reconfigure the game, regardless of the current status of the coalitions. An example of this is discussed in the last section of this appendix dealing with consumption externalities.

The FCC's objective of nondiscrimination could imply a need either to charge all individuals the same access price without regard to costs (the legal definition of discrimination) or a need to differentiate access prices according to the cost that is attributable to each individual (the economic definition). Another alternative that has been suggested is pricing according to the stand-alone cost of serving a customer class, since the stand-alone cost of a class is its opportunity cost, stand-alone cost is the maximum that can be charged that class.[7]

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[7]See David Chessler, "Accounting and Information Changes for Ratemaking and Separations After the 1982 Consent Decree", in Daniel Z. Czamanski, ed., Proceedings of the Third Biennial Regulatory Information Conference (Columbus, Ohio: The National Regulatory Research Institute, 1982) in which he discusses this concept using the term "current cost" for what we call "stand-alone cost."

In conclusion, in terms of game theory, the core of an appropriately specified game consists of efficient access prices. If the core exists, any payoff vector in it is also consistent with universal service. However, prices in the core may not result in the achievement of non-discrimination, when nondiscrimination is understood as uniform pricing. It is interesting to speculate about the advisability of a uniform set of access prices for all states if it should be the case that local conditions lead to a core in some states, but not all of them. In the following section an attempt is made to specify the conditions needed for the existence of the core in the context of specific hypothetical games.

Cost-Sharing Analysis and Welfare Games

In the previous section it was implied that there are prices, equivalent to payoffs in the core of an appropriately specified game, that discourage the formation of new coalitions by denying prospective members of such coalitions prizes in excess of what they already received. Such prices are subsidy free. The purpose of this section is to explore the variety of possible conditions that could yield subsidy free access prices and thus lead to economically efficient arrangement of customers among telephone companies. In fact, the resulting access charges can affect patterns of use of the existing network of facilities, as well as lead to alterations in the companies' plans for future expansions.

This section is limited to the most rudimentary analysis of those conditions that are required to yield subsidy-free prices. In the first part of the section all consumers are assumed to have the same "willingness to pay." The objective of the resulting game is to divide among the players some cost burden. This is a cost-sharing game. Further on in the section differences are introduced in the consumers' willingness to pay. The cost-sharing game is transformed into a welfare game.

To focus on the cost-sharing analysis, consider a local exchange service area with K = [1, 2, 3, 4]. Service 1 stands for local exchange emergency service only. Service 2 stands for local calls only, excluding emergency calls. Service 3 stands for intrastate toll calls. Service 4 stands for interstate toll calls only. Suppose that in order to serve the needs of this service area the exchange fixed cost is $700. Thus, in order to break even, in the sense of figure A-2, the utility needs to collect access charges revenues from each service type so that

$$r_1 + r_2 + r_3 + r_4 = 700. \qquad (A.9)$$

Equation (A.9), represents the basic break-even constraint. Each r_i stands for revenues collected for access rights to service i. So far, there is no indication of the preferred way of collecting these revenues. Certainly, there is no reason to set access charges in some relation to quantities of the services consumed.

Assume, however, that the costs of establishing the service of various groups are as follows:

- any one service	= $300	
- services 1 and 2	= $400	
- services 2 and 3	= $500	(A.10)
- services 2, 3, and 4	= $600	
- services 1, 2, 3, and 4	= $700	

Under these cost conditions, it is reasonable that any group of customers consuming a particular combination of services would insist that its contribution to the utility's revenues not exceed the cost of setting up a separate telephone company that will serve its needs only. This implies that the cost share of any group, or coalition of groups, should not exceed the stand-alone cost of that group or coalition.

Thus, the following must hold:

$$
\begin{aligned}
r_1 + r_2 + r_3 + r_4 &= 700 \\
r_1 + r_2 &\leq 400 \\
r_2 + r_3 &\leq 500 \qquad \text{(A.11)} \\
r_2 + r_3 + r_4 &\leq 600 \\
r_i \leq 300 \text{ for } i &= 1, 2, 3, 4
\end{aligned}
$$

It is possible to show[8] that this type of stand-alone test for cross subsidization simulates the workings of a competitive market in which entry is free. Under such circumstances the constraints implied by this test would be satisfied automatically because otherwise customers could get lower prices by contracting with another supplier. More generally, it is evident from this example that subsidy-free prices are defined in terms of constraints in addition to the break-even constraint in equation (A.9) above.

The above example pertains to subsidies among services. Access prices to services such that the revenues collected from each service are not greater than the stand-alone cost and are no less than the incremental cost, are called "commodity subsidy free." Much of the existing interest, however, is in subsidies between and among consumers. Are rural users subsidizing urban users? Are urban poor subsidizing commercial or industrial customers or both? Because people consume different bundles of telephone services, commodity subsidy-free prices are not equivalent to the absence of subsidies among individuals. The

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[8]See Sharkey, The Theory, p. 41.

absence of subsidies among individuals is termed "anonymous equity".[9]

The relationship between commodity subsidy free prices and anonymous equity is determined by the existing patterns of consumption of services across consumers. In the case in which consumers have identical patterns of consumption all prices are consumer subsidy free; i.e. there exists anonymous equity, even if those prices are not commodity subsidy free. However, anonymous equity may result when consumers specialize in the consumption of particular services only if the prices are commodity subsidy free.

In general, a cooperative game with side payments is represented by a set of players N and a real valued characteristic function ν, which is defined on all subsets $S \subseteq N$. The core of the game (N, ν) is the set of vectors P such that $\sum_{j \in N} P^j = \nu(N)$ and $\sum_{j \in S} P^j \geq \nu(S)$. In the case of access prices these crucial conditions are written as:

$$\sum_{j=1}^{n} P^j = C(N) \tag{A.12}$$

To prevent coalitions of buyers from seeking service from other suppliers,

$$\sum_{j \in S} P^j \leq C(S) \text{ for all } S \subseteq N. \tag{A.13}$$

But subadditivity of costs is not a sufficient condition to determine whether commodity subsidization exists and whether entry is attractive, nor for the core of the cost-sharing game to exist. It is possible that, because of the service's production technology, equation (A.12) and inequality (A.13) are not mutually consistent. Furthermore, in the cost

[9]See Robert D. Willig, "Customer Equity and Local Measured Service," in J.A. Bande et al., eds., Perspectives on Local Measured Service (Kansas City, 1979).

sharing game it was assumed that all the services were worth producing. In general, it is important to determine how customers value various bundles of services in relation to the cost of producing them. Thus, there is a need to compare the consumer's willingness to pay and the cost of production.

Suppose that each customer's willingness to pay for access to service i is indicated by a vector $y_i = (y_i^1, \ldots, y_i^n)$. The y_i^j can be interpreted either as reservation prices or as consumer's surpluses. Now, in addition to equation (A.12) and (A.13) the requirements for the existence of the core include:

$$P_i^j \leq y_i^j, \text{ for } i = 1, \ldots, k \text{ and } j = 1, \ldots, n \tag{A.14}$$

In other words, the access price cannot exceed the maximum price that a customer is willing to pay.

It is possible, however, that the FCC's objective of universal service is not compatible with the objective of subsidy-free prices. Before searching for a subsidy-free price vector, it is important to administer an incremental cost test that will determine the desirability of producing each bundle of services. The incremental cost of producing a bundle of services for a specific group of customers is

$$C(N) - C(\overline{S}) \tag{A.15}$$

where $\overline{S}$ represents potential customers not included in S. The production for S is desirable if

$$\sum_{j \in S} y^j \geq C(N) - C(\overline{S}); \tag{A.16}$$

If the inequality in equation (A.16) holds for all $S \subseteq N$, the universal bundle N, or universal service, is feasible.

Once a feasible bundle of services has been found, it is possible to determine whether there exists a vector of access prices P that satisfies equation (A.12), and inequalities (A.13) and (A.14). Obviously, a necessary condition for such a vector to exist is that the core of the associated cost-sharing game exists. That is, that equation (A.12) and inequality (A.13) are internally consistent. The existence of such a core is not a sufficient condition for the existence of P satisfying (A.12), (A.13), and (A.14).

Thus, in theory at least, it is possible to fashion a set of access prices to the variety of telephone services such that the FCC's goals of universal service, nondiscrimination, and network efficiency, are mutually consistent. However, no general statement can be made concerning the existence of such a set under the particular conditions that might exist in each company's service area. Indeed, the question of existence of such a set hinges upon the structure of costs and demand patterns in each service area. It is for this reason that no statement can be made about the general applicability of particular access prices prior to a state by state search for the core, based on empirical knowledge of cost and demand conditions in that state.

Consumption Externalities

In a game-theoretic framework, consumption externalities are incorporated directly as part of the willingness to pay vector, y. While in their absence it is possible to identify test conditions that are needed for the existence of the core, their presence obscures that search and makes it difficult to determine the circumstances under which sustainable subsidy-free prices may exist. Yet, the phenomenon of consumption externalities is very important in designing access charges. It is possible to argue that their presence is a sufficient condition to dictate access charges below marginal cost.

A number of individuals have analyzed consumption externalities in the context of the telephone system.[10] Assuming that the cost of providing telephone services varies in relation to the number of subscribers and that people's satisfaction increases as the number of subscribers increases, it is easy to demonstrate that the resulting willingness to pay can sustain continual growth, even in the case of a stationary population with stationary income. It is argued that as new subscribers join, the incremental utility of the telephone service increases and induces nonusers to join the network. This causes the incremental utility to grow further. Thus, as long as access charges do not violate equation (A.14) it would seem natural that the FCC's objective of universal service would be achieved automatically. At the same time, it is possible that in the case of small service areas, i.e, those with few subscribers, nonusers' willingness to pay may not exceed the access charges made necessary by the company's break-even constraints. This is the so-called "start-up problem."

Both phenomena, the dynamic tendency toward universal service and the start-up problem, suggest that it may be in the public interest to price access below what may be optimal in the absence of consumption externalities.[11] Indeed, it is possible to measure the extent by which the optimal access charge should deviate from the marginal cost of access. In other words, the optimal access charge may not be subsidy-free.

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[10]See for example, R. Artle and C. Averous, "The Telephone System As A Public Good: Static and Dynamic Aspects," The Bell Journal of Economics and Measurement Science (1973), 4, 89-100; L. Squire, "Some Aspects of Optimal Pricing for Telecommunications," The Bell Journal of Economics and Measurement Science (1973), 4, 515-525; and J. Rohlfs, "A Theory of Interdependent Demand for a Communications Service," The Bell Journal of Economics (1974), 5, 16-37.

[11]For an elaborate demonstration of this proposition see Willig, Customer Equity.

While in the absence of consumption externalities stability is achieved by access charges that satisfy the core conditions for the associated cost-sharing or welfare games, the possiblity of deviations of access charges from such sustainable prices introduces anew the problem of stability. The possibility that access charges for some group of customers may be below that of another group's charges introduces an opportunity for individuals and groups to bargain. The following example serves to illustrate the resulting instability.[12]

Suppose that three communities are located at the vertices of an equilateral triangle. (See Figure A-2) Each community of identical customers is interested in constructing an exchange for the use of its residents. The only available sites are at locations 1, 2, and 3 on the perimeter of the triangle. Suppose that the cost of using the exchange is related to the distance from the community. Then the potential for cost-sharing of distance-related usage charges may induce the communities to cooperate.

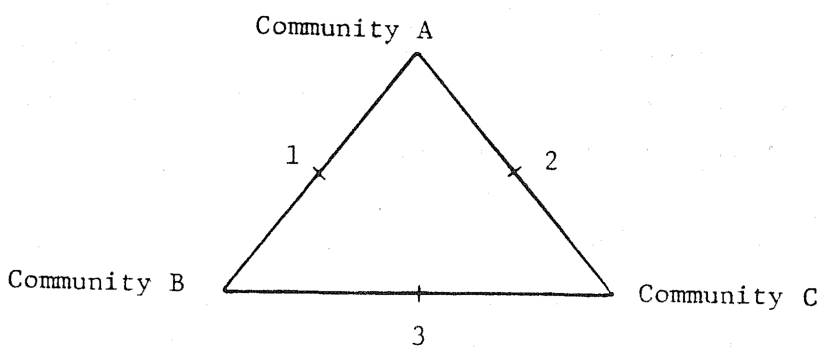

Fig. A-2 A hypothetical market with consumption externalities

Suppose that the cost of constructing an exchange at each location is $100. If two exchanges are built, the cost is $200 and if three

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[12]The example is based on Sharkey, The Theory.

[13]See equations (A.2) and (A.5) for a definition.

exchanges are built, the cost is \$300. Thus, there are no economies or diseconomies of scope.[13] The willingness to pay for access of these identical communities is a function of the location of the exchange.

$$U_A(S) = \begin{cases} 120 \text{ if } S \text{ contains locations 1 or 2} \\ 40 \text{ if } S = [3] \\ 0 \text{ if } S = [\phi] \end{cases}$$

$$U_B(S) = \begin{cases} 120 \text{ if } S \text{ contains locations 1 or 3} \\ 40 \text{ if } S = [2] \\ 0 \text{ if } S = [\phi] \end{cases}$$

$$U_c(S) = \begin{cases} 120 \text{ if } S \text{ contains locations 2 or 3} \\ 40 \text{ if } S = [1] \\ 0 \text{ if } S = [\phi] \end{cases}$$

Thus, each community is willing to pay \$120 for nearby locations and \$40 for more distant locations. This may be explained by the fact that while access charges do not reflect the distance of the exchange from the community, usage charges do.

Bargaining among the communities leads to the realization that each pair of communities can achieve a joint surplus of (2 x 120) -100 = 140 by selecting the site between them. Therefore, the following constraints hold:

$$U_A + U_B \geq 140$$

$$U_A + U_C \geq 140 \qquad \text{(A.17)}$$

$$U_B + U_C \geq 140$$

Together these inequalities imply that $U_A + U_B + U_C \geq 210$. But, the highest level of surplus that is obtainable by all three groups together is:

$$(120 + 120 + 40) - 100 = 180$$

Furthermore, if two exchanges were constructed the surplus would decline:

$$360 - 200 = 160$$

Thus, there is no basis for the coalition of three communities to form.

Suppose, however, that two of the three communities (e.g., A and B) form a coalition and share the construction costs. The surplus to A and B will be \$70 each. C, on the other hand, will obtain a surplus of \$20 if it builds by itself. But C has a strong incentive to disrupt the existing coalition of A and B. For example, C could propose to A that it will pay 75 percent of the cost at location 2. The surplus to C would be forced up from \$20 to \$45 and of A from \$70 to \$95. Obviously counteroffers would be forthcoming. The sufficient condition for stability in this type of situation depends on restrictions on demand as well as on costs. In the absence of any further restrictions the existing situation is unstable.

To conclude the discussion of this section, the existence of consumption externalities provides a justification for the deviation of access charges from marginal cost.[14] At the same time, such deviations may be the basis for instability in the arrangement of customers among telephone companies.

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[14]See the estimates of welfare implications contained in J.M. Griffin, "The Welfare Implications of Externalities and Price Elasticities For Telecommunications Pricing," Review of Economics and Statistics (1982), 64, 59-66.

APPENDIX B

THE COLE AND BEAUVAIS STUDY OF THE IMPACT OF ACCESS CHARGES AND LOCAL MEASURED RATES: A REINTERPRETATION OF THEIR RESULTS

The purpose of this appendix is to reinterpret the results of a previous study of the impact of access charges. This study, "The Economic Impact of Access Charges: Does Anyone's Ox Need to be Gored?"[1] was conducted by Lawrence P. Cole and Edward C. Beauvais of the GTE Service Corporation. The study is unique in that a data set on residential customers from a GTE exchange in Huron, Ohio was used to analyze the impact of the Pure 2 option for access charges coupled with measured usage rates for local service. The analytical model used by Cole and Beauvais was the Telecommunications Policy (TELPOL) model developed by the Microeconomic Analysis Group of AT&T. The focus of this review is the conclusions Cole and Beauvais drew with respect to gainers and losers using their Huron data set and under Pure 2 and local measured service. Their score sheet is misleading. It attributes an income transfer from consumer to producers as a gain for consumers. Proper interpretation of their results substantially alters their conclusions.

This appendix consists of three sections. In the first section, the TELPOL model is briefly discussed. In the second section, the theoretical considerations relevant to interpreting their results are presented. Finally, the third section contains a presentation of the Cole and Beauvais results and conclusions, and an alternative interpretation of their results which we claim is more accurate.

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[1]L. Cole and E. Beauvais, "The Economic Impact of Access Charges," presented to the 14th Annual Conference of the MSU Institute of Public Utilities, 1982.

The Telecommunications Policy Model

The TELPOL model was developed to analyze changes in policies governing the level of payments made by interstate carriers to the intrastate operations of the Bell System for the use of local exchange facilities.[2] Impacts on rate groups are quantified by estimating changes in economic welfare. Economic welfare is the sum of consumer's and producer's surplus. The model has five basic modules, one of which optimizes prices given the demand and cost constraints in the specified markets. Complete documentation of this model is available in two volumes: Telecommunications Policy Model: Evaluating Changes in Telecommunications Policies: Whose Ox Will Be Gored?[3] and Telecommunications Policy Model: User's Guide.[4] Rather than presenting the TELPOL model in detail here, we refer the reader to this documentation.

The TELPOL model was carefully examined as a possible blueprint for the analytical model needed for this current report. It was rejected on 2 grounds. First, the demand structure of the TELPOL model is needlessly complex. In order to implement the demand model, the researcher must know 36 elasticities for Bell services and 9 elasticities for OCC services. In addition 21 assumptions regarding the nature of competition between Bell and OCCs must be made. Even Bell in their example using TELPOL has only 2 direct estimates of the total 66 parameters of the demand model. The remaining 64 were derived by assumption, analogy, or constructed. Even though sensitivity analysis can be used to evaluate the robustness of the information with respect to each parameter, many runs would be necessary and computation costs possibly would exceed the value of information gained. It was concluded a more

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[2]E. P. Marfisi, K. J. Murphy, M. M. Murphy, J. H. Rolfs, and D. Silverstein, Telecommunications Policy Model-Evaluating Changes in Telecommunications Policies: Whose Ox Will Be Gored? (Microeconomic Analysis Group: AT&T, 1981).

[3]Cole and Beauvais, "Economic Impact."

[4]Marfisi et al., Telecommunications Policy Model.

elegant model would specify broader demand equations better tailored to the empirical evidence available.

The second reason the TELPOL model was rejected as a blueprint involved its focus on economic welfare. The analytical framework of TELPOL, with its optimizer and its marginal costs and demand structure, is essentially a long-run model. It was conjectured that the concern of commissions was somewhat more immediate and directly tied to the revenue requirement for exchange service.

Some Theoretical Considerations Relevant to the Cole-Beauvais Results

Economic welfare considers both the well-being of consumers and producers. Maximization of economic welfare and economic efficiency occurs when the prices of all goods and services are set equal to their respective marginal costs. Constraints on profits and capacity as well as regulatory distortions can lead to prices different from marginal cost, and, as a result, induce distortions in the allocation of resources. This situation exists for the Cole-Beauvais simulation of the Pure 2 option with local measured service.

The assumption of a zero profit constraint for the total company implies total producers surplus realized in all markets will equal the fixed costs of production, if any. Since TELPOL is a long-run model, producers' surplus should be zero. Furthermore, it is assumed through their construction of the initial measured rate for local service that the price was below the marginal costs. At the same time, past FCC ratemaking policies have set interstate toll prices above the marginal cost of toll usage. When prices for local and toll usage are allowed to adjust to their respective marginal costs, one would expect an overall improvement in resource allocation. If profit is constrained to be zero, this improvement in social welfare will be a gain in aggregate consumer surplus. The aggregation of the two markets, however, should not obscure the reality that consumers in one market are gaining while those in the other are losing. However, the aggregation of markets and continued focus on the zero profit constraint could lead one to ignore the fact that there must be gainers and losers in the shift to marginal cost prices.

Economic welfare consists of two parts. Consumers' surplus is a measure of the gains occurring to consumers in a market. Producers' surplus is the gain occurring to producers, and is more commonly recognized as profits in a long-run model. Pricing below marginal cost in a market benefits consumers, but at the expense of producers who earn negative profits (i.e., negative producer surplus). For a two market firm with a zero profit constraint, the market priced below marginal cost must be subsidized by the market in which prices are above marginal cost. Thus, when prices are set to marginal costs in both markets, consumers in the subsidized market must lose, while consumers in the subsidizing market gain when prices are lowered to marginal cost. Together there is an overall gain in consumer welfare in the two markets. The underlying shift in the pattern of subsidies between markets and the attendant gains and losses by consumers, however, cannot be discerned with such an aggregate perspective.

Reinterpretation of the Cole and Beauvais Results

Cole and Beauvais have two problems of interpretation of results that need correction. First, it appears that the zero profit constraint is violated in aggregate for the two markets examined, but this cannot be absolutely determined from the information presented. The result is that the total change in economic welfare does not necessarily accrue to consumers. The upshot is that profits accruing to the producer are attributed as a gain for consumers. These problems are corrected below.

Table B-1 presents the Cole and Beauvais results for the local service market in Huron, Ohio. Table B-2 presents their results for

TABLE B-1

CHANGES IN ECONOMIC WELFARE: LOCAL USAGE IN HURON

Economic Impact of LSM II on User Groups

Group	Q_0	Q_1	ΔCS	ΔPS	ΔW
Sample	1258	963	$-39.98	$45.29	$5.31
Poor	999	765	-31.75	35.96	4.21
Non-Poor	1335	1022	-42.43	48.06	5.63
Senior	734	562	-23.33	26.43	3.10
Non-Senior	1334	1021	-42.39	48.02	5.86
Senior Poor	652	499	-20.72	23.47	2.75

Source: Cole and Beauvais Study

TABLE B-2

CHANGES IN ECONOMIC WELFARE: INTERSTATE TOLL USAGE IN HURON

Economic Impact of LSM II on User Groups

Group	Q_0	Q_1	ΔCS	ΔPS	ΔW
Sample	270	356	$32.87	$-28.35	$4.52
Poor	241	318	29.35	-25.31	4.04
Non-Poor	277	366	33.76	-29.09	4.67
Senior	180	238	21.94	-18.90	3.04
Non-Senior	281	371	34.23	-29.51	4.72
Senior Poor	142	187	17.27	-14.91	2.36

Source: Cole and Beauvais Study

interstate toll market. Column 1 of each table contains the initial consumption data, while column 2 presents consumption after the price change. Column 3 contains the change in consumers' surplus and column 4 is the change in producers' surplus. Column 5 is the change in economic welfare, which is the sum of the changes in consumers' and producers' surplus.

Based on the information in these tables, Cole and Beauvais come to the following conclusions:

1. For the entire sample of Huron customers, the average gain in economic welfare from the local usage market segment is $5.31 per customer per year.

2. The most striking observation that can be made about these changes in economic welfare at the local level is that all groups, on average, gain from the price change.

3. The Non-Senior and Non-Poor are the biggest gainers, but even the most disadvantaged group evaluated, the Senior Poor, show a positive gain of $2.75 per customer per year.

4. In the interstate toll market, changes in economic welfare are positive for all groups analyzed. On average, the change in economic welfare is $4.52 per customer per year.

5. Based on our (Cole and Beauvais) sample of residential customers, the mean customer will gain an additional $9.83 in economic welfare annually.

All of the above conclusions are misleading. Each will be discussed in turn.

It is best to begin with the last conclusion first. Economic welfare, as pointed out above, considers both the welfare of producers and consumers. The additional $9.83 in economic welfare is a net gain for producers. In other words, there is an income transfer from consumers to producers of $9.83 per customer annually. This change implies the zero profit constraint is violated.

To see this, consider the overall change in consumers' surplus per customer for the entire sample for both markets. The change in consumers' surplus for the local market for the entire sample is -$39.98. Clearly, this is a loss and in opposition to the implication of conclusions 1 and 2 above. For the toll market, the change in consumers' surplus is $32.87 per customer per year. Taking both markets together, the net change in consumers' surplus is -$7.11. Obviously, for the entire sample of residential customers, they lose on average.

Producers, on the other hand, gain. They gain $45.29 per customer in additional profits from the local market, and lose -$28.35 per customer in profits from the toll market. The overall gain in profits for producers is $16.94 per customer per year.

We would rewrite Cole and Beauvais's conclusions as follows:

1. For the entire sample of Huron customers, the average gain in economic welfare from the local usage market segment is $5.31 per customer per year, but this gain in efficiency accrues to producers, since increases in producers' surplus outweighs decreases in consumers' surplus.

2. The most striking observation that can be made about these changes in economic welfare at the local level is that all consumer groups, on average, lose from the price change.

3. The Non-Senior and Non-Poor are the biggest losers, but even the most disadvantaged group evaluated, the Senior Poor, shows a loss of combined local and toll market of $2.45 per customer per year.

4. In the interstate toll market, changes in economic welfare are positive for all groups analyzed. On average, the change in economic welfare is $4.52 per customer per year, with increases in consumers' surplus outweighing decreases in producers' surplus.

5. Based on the sample of residential customers, the mean customer will lose $7.11 in economic welfare annually while society as a whole, producers and consumers, will gain $9.83 in increased economic efficiency.

APPENDIX C

AN EXAMPLE OF SMAC IN THE APPLICATION OF THE INTERACTIVE COST ALLOCATION SYSTEM (ICAS)

A decision support system, called the Interactive Cost Allocation System (ICAS), was developed by the National Regulatory Research Institute at The Ohio State University. ICAS is a computer software application tool used to assist regulators in developing cost allocation methodologies for rate design and analysis. Its application occurs when regulators attempt to design a rate structure that accurately reflects the costs of service for a multiproduct utility. Due to the difficulties involved in assigning costs among services, a decision support system was developed with the objective of incorporating procedures for allocating costs and an interactive computing system. ICAS has the capability to accept a complex network of cost allocations with the flexibility to expand or consolidate its data base. The following features are available on ICAS:

1. English language-based command structure
2. User-defined accounts and cost categories
3. User-defined allocation formulas and procedures
4. Report generator
5. Data request form generator
6. On-line data inquiry and retrieval
7. Self-testing features
8. Built-in mathematical interpreter for data analysis
9. English language-based allocation procedures
10. Iterative process to solve for allocation dependencies within accounts and formulas

Data Base

A cost allocation system is developed by specifying the types of information in the data base. With ICAS, the user has the ability to define and manipulate the data base to evaluate and test any number of cost allocation schemes. The data base consists of seven data items: ACCOUNT, CATEGORY, FORMULA, SUMMARY, DIAGNOSE, ERROR, and REQUEST. The data items are described below.

ACCOUNT - Accounts consist of related costs or values determined by a function of the company or law. Some examples of accounts are maintenance and installation, building, land, social security, depreciation expense, or number of centrex lines. Up to 1,000 accounts can be defined.

CATEGORY - Categories consist of services provided by the company. They are determined by the type and level of detail required for allocating costs. Up to 50 categories can be defined.

FORMULA - Formulas consist of equation definitions used to allocate costs from accounts to service categories. They can be a single value or a proportionality used over a range of categories. Up to 250 formulas can be defined.

SUMMARY - Summaries are used to present important results generated by ICAS such as revenue requirements, total plant investment, and rate of return. Up to 50 summaries can be defined.

DIAGNOSE - Diagnostics are used to check the results generated by ICAS. Its main purpose is to validate whether accounts have been fully allocated. Up to 20 diagnostics can be defined.

ERROR - Error messages are generated during the execution of the allocation procedures. It is saved by the system for the purpose of assisting the user in performing corrections to the data base.

REQUEST - A request defines the format of the data to be obtained from the company. This data consists of accounts and ancillary data. Up to 100 requests can be defined.

Developing Formulas

Formulas are calculated by the ICAS mathematical interpreter. It allows the user to construct complex arithmetic expressions to analyze and perform cost allocations. It incorporates predefined variables, basic mathematical operations, and mathematical functions.

To perform cost allocations, formulas must be defined. There are two types of formulas: standard and generic. The standard formula calculates a single value to be used in allocations. A generic formula calculates a value for all categories and is denoted by a numeric sign (#) at the end of the formula name (e.g., EXPENSE#, RATE BASE#). When a generic formula is used, its value is determined by the service category that is being allocated. To access a generic formula value for a particular category, a colon (:) will replace the number sign (#) in the formula name followed by the category name (e.g. EXPENSE:TOTAL, RATE BASE:CPE).

Predefined variables identify account and cost category relationships. The variable would represent the value that was allocated to an account for a particular cost category. A variable is formed by the category name and account number as shown below.

```
CPE 100.1
 |   |
 |   |________ Account Number
 |
 |____________ Category Name
```

The interpreter contains four built-in functions for simplifying the writing of a formula. These functions are

1. SUM - sum a group of accounts and categories
2. AVG - average a group of accounts and categories
3. MIN - find the minimum value in a group of accounts and categories
4. MAX - find the maximum value in a group of accounts and categories

Functions are used in a formula in the same manner as the variables, or constants. All of the functions have the following format:

SUM <starting category/account number, ending category/account number>

Some examples are

SUM<TOTAL100, TOTAL199.99>
AVG<TOTAL600, CPE600>
MIN<CPE500, BAS500>

The interpreter has five arithmetic operations: exponentiation (↑), multiplication (*), division (/), addition (+), and subtraction (-). It will allow up to nine sets of parentheses with any level of enclosures. The following are valid arithmetic expressions:

TOTAL100/TOTAL200
(BAS212-BAS211)*0.5
RETURN*(EXPENSE#-DEPREC#)
1000+RATEBASE#/REVENUE:TOTAL
((100+TAX#)*0.5+TOTAL500-FACTOR:CPE)+SPF
SUM<#600,#699>/SUM<TOTAL600,TOTAL699>

Allocation Procedures

Allocation procedures are defined by the user and can be used to allocate costs according to many different methodologies. These procedures allow costs to be allocated and reallocated using a step method. During the allocation process, many interdependencies are generated among the accounts and formulas. These interdependencies are solved by ICAS using an iterative technique in computing cost of service.

A cost allocation system is based on the service categories and the account data determined by the user. The system is allocated according to the structure of its service categories. Categories are defined by their group number and their input categories. During the allocation process, ICAS must know whether the procedure defines an allocation or a transfer of costs. This is determined by the category group number. If the categories being allocated have the same category group number, the costs are transferred. For example:

Assume
1. Category A has $1,000
2. Allocate 50% of the cost of category A to category B
3. Both categories belong to category group 2

The final results would be

Category A = $500
Category B = $500

If the categories being allocated have different category group numbers, the costs are allocated. Using the same example as above, the final results would be

Category A = $1,000
Category B = $ 500

Input categories must be defined for each category. In the above examples, category A is an input category to category B. This limits the amount in category B to the amount in category A. ICAS uses the input category information to assure that costs are not overallocated.

Allocation procedures are specified with each account. ICAS allows up to 10 steps of procedures and comments for every account. Comments are identified by an asterisk (*) in the first column of a step. All procedures are English language-based for easy comprehension and documentation as shown in table C-1. The following is an example of how to develop allocation procedures:

Example

Suppose a cost allocation system is defined as follows:

Service Categories	Group No.
TOTAL	0
↙ ↘	
STATE ISTATE	1

Category	Description	Group No.	Input Category
TOTAL	Total Amount	0	---
STATE	Intrastate Services	1	TOTAL
ISTATE	Interstate Services	1	TOTAL

Account No.	Description
100	Total Investment
200	Total Taxes

Formula	Equation
INVEST#	#100/TOTAL100
FACTOR	0.34871

CASE A. Total amount in Account 100 (Total Investment) is $1,000.
Allocate intrastate investment by formula FACTOR.
Total amount in Account 200 (Total Taxes) is $5,490.
Allocate taxes according to investment.

Procedures for Account 100.

1. SET TOTAL EQUAL TO 1000
2. ALLOCATE TOTAL TO STATE BY FACTOR
3. ALLOCATE TOTAL TO ISTATE

Procedures for Account 200.

1. SET TOTAL EQUAL TO 5490
2. SAME AS ACCOUNT 100

CASE B. Total amount in Account 100 (Total Investment) is $1,000.
Total intrastate investment is $450.
Remainder of Account 100 is interstate investment.
Total amount in Account 200 (Total Taxes) is $5,490.
Allocate taxes according to investment.
Allocate back 20% of interstate taxes to residence.

Procedures for Account 100

1. SET TOTAL EQUAL TO 1000
2. SET STATE EQUAL TO 450
3. ALLOC TOTAL TO ISTATE THE RESIDUAL

Procedures for Account 200

1. SET TOTAL EQUAL TO 5490
2. ALLOC TOTAL TO CATEGORIES BY INVES#
3. ALLOC ISTATE TO STATE BY 0.20

TABLE C-1
ALLOCATION PROCEDURES

SET [category]* EQUAL TO [formula]

The [formula] is calculated and its value represents the costs for the [category] in the account.

SAME AS ACCOUNT [account range]

The account is allocated according to the accounts specified in the account range. An example of an [account range] is 221-223,201,603.

USING ACCOUNT [account range]

This procedure sums and copies the account values specified by the [account range]. All accounts specified will be set to zero to eliminate any double counting.

ALLOCATE [category 1] TO [category 2] BY [formula]

This procedure allocates [category 1] to [category 2] according to the value calculated from the formula.

ALLOCATE TO [category] BY [formula]

This procedure allocates the category that was specified by a previous ALLOCATE or USING procedure to the [category] according to the value calculated from the [formula].

ALLOCATE [category] TO SUBGROUP EXCEPT [category list] BY [formula]

This procedure allocates the [category] to all categories using this category as an input category excluding those categories in the [category list]. Allocations are based on values calculated from the [formula].

---

*All user-defined variables are in brackets "[]".

TABLE C-1
ALLOCATION PROCEDURES (continued)

ALLOCATE [category 1] TO [category 2]

> This procedure allocates the residual of [category 1] to [category 2].

ALLOCATE [category 1] TO [category 2] THE RESIDUAL

> This procedure allocates the residual of [category 1] to [category 2].

ALLOCATE [category] TO CATEGORIES EXCEPT [category list] BY [formula]

> This procedure allocates the [category] to all categories excluding those categories in the [category list]. Allocations are based on values calculated from the [formula].

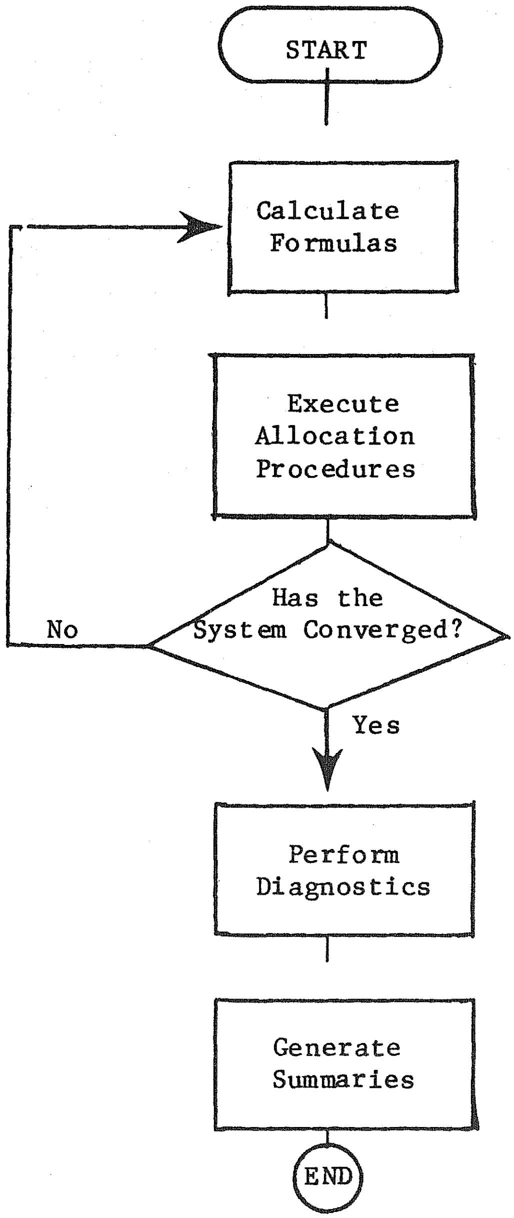
AGGREGATE [category]

> This procedure sums the subcategories of [category] to calculate its new value.

Source: Authors' Design

Executing Allocation Procedures

Account allocation procedures are executed by ICAS through an iterative process. The control parameters for this process are user defined such as the convergence level and the maximum number of iterations. The process begins by calculating all formulas and executing all account procedures. Then, ICAS checks for convergence or if the maximum number of iterations has been reached. ICAS will repeat this process until control parameters are satisfied. After the iterations, ICAS will perform diagnostics to test the validity of the results and generate summaries. The following flowchart describes this process.



Generating a Report

ICAS provides a facility to generate a standard report. The report is divided into six sections: 1) run statistics, 2) service categories, 3) formulas and results, 4) account data, 5) account allocations, and 6) summaries. Section 1 reports the run statistics generated from ICAS's iteration process. Section 2 reports the cost of service categories used in allocating costs for each account. Section 3 reports the formulas used for calculating cost parameters and its results. Section 4 reports account data with the procedures used to defined allocations. Section 5 reports the allocation values in allocating accounts to the service categories. Section 6 reports summaries of the results defined by the user. Table C-2 presents the general format of the report. A report generated from a sample SMAC run is shown in the following pages.

TABLE C-2

DESCRIPTION OF REPORT SECTIONS

Section of Report	Heading	Description
1	Company Name	The name of the company which is represented by the cost data.
	Number of Accounts	The number of accounts defined by the user.
	Number of Categories	The number of categories defined by the user.
	Number of Formulas	The number of formulas defined by the user.
	Number of Iterations	The number of iterations executed to produce the reported cost data.
	Convergence Criteria	The convergence level reached on the last iteration.
2	Category Name	Name of cost-of-service category.
	Description	Description of the type of services provided.
	Group Number	A number grouping categories for allocating or transferring costs.
	Input Category	Categories that allocate their costs into this service category.
3	Formula Name	Name of formula used in calculating cost and allocation parameters.
	Description	Description of the purpose and use of formula.
	Category	Name of category represented by a corresponding result.
	Result	Values generated by the formula.

TABLE C-2 (continued)

DESCRIPTION OF REPORT SECTIONS

Section of Report	Heading	Description
4	Account Number	A number that represents an account line item or ancillary data.
	Description and Procedures	Description of the function of the account and the procedures used to allocate costs to the service categories.
5	Account Number	A number that represents an account line item or ancillary data.
	Allocations to Service Categories	Values allocated to each service category.
6	Description	Description of summary.
	Category	Name of category represented by a corresponding result.
	Result	Values generated by the summary.

Source: Authors' Design

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*                              I C A S                                    *
*                                                                         *
*               INTERACTIVE  COST  ALLOCATION  SYSTEM                     *
*                                                                         *
*                           VERSION 3.0                                   *
*                                                                         *
*                                                                         *
*                                                                         *
*                           DEVELOPED  BY                                 *
*                                                                         *
*                                                                         *
*       THE  NATIONAL  REGULATORY  RESEARCH  INSTITUTE                    *
*                      OF  COLUMBUS, OHIO                                 *
*                                                                         *
*                                                                         *
*               AUTHORS: MICHAEL D. WONG                                  *
*                        CLARK MOUNT-CAMPBELL                             *
*                                                                         *
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COMPANY - SOUTHWESTERN BELL(MISSOURI)

NUMBER OF ACCOUNTS.......... 304

NUMBER OF CATEGORIES........ 4

NUMBER OF FORMULAS.......... 136

NUMBER OF ITERATIONS........ 10

CONVERGENCE CRITERIA........ 0.00010000

S E R V I C E   C A T E G O R I E S

NO	CATEGORY	DESCRIPTION OF CATEGORY	GROUP	INPUT CATEGORIES
1	TOTAL	TOTAL AMOUNTS FOR ACCOUNTS OR SUBACCOUNTS	0	
2	STATE	STATE SERVICES INCLUDING STATE PRIVATE LINE AND LIKE SERVICES	1	TOTAL
3	ISTATE	INTERSTATE SERVICES	1	TOTAL
4	ISTATEPL	INTERSTATE PRIVATE LINE AND LIKE SERVICES	1	TOTAL

F O R M U L A S   A N D   R E S U L T S

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
1	BB	RATIO OF BUSINESS REVENUES TO RESIDENTIAL REVENUES LESS CPE PER LINE 3.62905085	TOTAL	3.629051
2	CROSS#	LOCAL DIAL SWITCHING EQUIPMENT RATIO FOR CROSSBAR NTS.CROSS*SPF#+(1-NTS.CROSS)*DMU#	TOTAL STATE ISTATE ISTATEPL	1.000000 0.862928 0.137073 0.000000
3	DIFF.221	FRACTIONAL CHANGES IN CENTRAL OFFICE EQUIPMENT SUM<TOTAL221,TOTAL221.99>/975,052,544	TOTAL	0.999551
4	DIFF.240	FRACTIONAL CHANGES IN OUTSIDE PLANT SUM<TOTAL240,TOTAL240.99>/832,701,440	TOTAL	1.000000
5	DMU#	DIAL MINUTES OF USE RATIO #3222/TOTAL3222	TOTAL STATE ISTATE ISTATEPL	1.000000 0.909361 0.090640 0.000000
6	EED	FRACTION OF THE AVG EXCHANGE MOU/LINE = AVG EXCHANGE MOU CURTAIL LINE 0	TOTAL	0.000000
7	ELEC#	LOCAL DIAL SWITCHING EQUIPMENT RATIO FOR ESS NTS.ELEC*SPF#+(1-NTS.ELEC)*DMU#	TOTAL STATE ISTATE ISTATEPL	1.000000 0.863695 0.136306 0.000000
8	EXCH.INIT	INITIAL EXCHANGE USAGE FACTOR 30,047,523,340	TOTAL	30,047,522,800
9	EXCH.USE	EXCHANGE USAGE FACTOR CALCULATION EXCH.INIT*(1+EED*FF.DROP)	TOTAL	30,047,522,800
10	EXP#	TOTAL EXPENSES SUM<#602.1,#677>	TOTAL STATE ISTATE ISTATEPL	846,076,160 599,848,704 228,597,536 17,629,680
11	F.S	USAGE FACTOR UPDATE FOR STATE (ISTATE.USE*STATE.INIT)/(ISTATE.INIT*STATE.USE)	TOTAL	1.000000
12	F.SE	USAGE FACTOR UPDATE FOR STATE AND EXCHANGE (ISTATE.USE*(STATE.INIT+EXCH.INIT))/(ISTATE.INIT*(STATE.USE+EXCH.USE))	TOTAL	1.000000
13	FED.TAX#	FEDERAL TAXES FEDTX*RATEBASE#*(RETURN-ICOST)	TOTAL STATE ISTATE ISTATEPL	18,731,376 13,108,047 4,823,012 800,312

FORMULAS AND RESULTS

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
14	FEDTX	FEDERAL TAX RATE 0.11410595	TOTAL	0.114106
15	FF.BUS	FRACTIONAL CHANGE FOR BUSINESS RATE PER LINE (VF.BUS+BB*SUB.FF)/(BB*SUB.FF.INIT)-1	TOTAL	0.148242
16	FF.DROP	FRACTION OF DROPPED OFF (LNRES+LNBUS)/(LNRES.INIT+LNBUS.INIT)-1	TOTAL	0.000000
17	FF.RES	FRACTIONAL CHANGE FOR RESIDENTIAL RATE PER LINE (VF.RES+SUB.FF)/SUB.FF.INIT-1	TOTAL	0.176693
18	FS.21201	STATE USAGE UPDATE FACTOR FOR ACCOUNT 212.01 0.654605491 5*STATE.221	TOTAL	0.654606
19	FS.21202	STATE ALLOCATION FACTOR FOR ACCOUNT 212.02 1/(1+0.55049898*F.SE)	TOTAL	0.644954
20	FS.22104	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.04 1/(1+1.127527983*F.SE)	TOTAL	0.470030
21	FS.22105	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.05 1/(1+.56888109*F.SE)	TOTAL	0.637397
22	FS.22109	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.09 1/(1+.5054098*F.S)	TOTAL	0.664272
23	FS.22115	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.15 1/(1+0.203592942*F.SE)	TOTAL	0.830847
24	FS.22117	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.17 1/(1+0.85430905*F.S)	TOTAL	0.539285
25	FS.22120	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.20 1/(1+5.31139584*F.S)	TOTAL	0.158444
26	FS.22121	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.21 1/(1+0.4778670742*F.S)	TOTAL	0.676652
27	FS.22122	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.22 1/(1+1.435593882*F.S)	TOTAL	0.410578
28	FS.22132	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 221.32 1/(1+0.597140868*F.SE)	TOTAL	0.626120
29	FS.3221	STATE ALLOCATION UPDATE FOR RELATIVE DIAL MINUTES FOR IS 1/(1+0.099674794*F.S)	TOTAL	0.909361

FORMULAS AND RESULTS

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
30	FS.3222	STATE ALLOCATION UPDATE FOR RELATIVE DIAL MINUTES FOR ISE 1/(1+0.099674794*F.SE)	TOTAL	0.909361
31	FS.3244.2	STATE ALLOCATION UPDATE FOR MOU, TRUNK OSP FOR IS 1/(1+0.652304493*F.S)	TOTAL	0.605216
32	FS.3244.3	STATE ALLOCATION UPDATE FOR MOU, TRUNK OSP FOR ISE 1/(1+0.652304493*F.SE)	TOTAL	0.605216
33	FS.3299.3	STATE ALLOCATION FOR CONVERSATION-MINUTE-MILES FOR IS 1/(1+0.966788547*F.S)	TOTAL	0.508444
34	FS.3299.4	STATE ALLOCATION FOR CONVERSATION-MINUTE-MILE FOR ISE 1/(1+0.966788547*F.SE)	TOTAL	0.508444
35	FS.3699.7	STATE ALLOCATION FOR AUTOMATICALLY RECORDED MESSAGES FOR IS 1/(1+0.601329621*F.S)	TOTAL	0.624482
36	FS.3699.8	STATE ALLOCATION FOR AUTOMATICALLY RECORDED MESSAGES FOR ISE 1/(1+0.601329621*F.SE)	TOTAL	0.624482
37	FS.622	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 622 1/(1+0.54477195*F.SE)	TOTAL	0.647346
38	FS.624	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 624 1/(1+0.5219237844*F.SE)	TOTAL	0.657064
39	FS.626	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 626 1/(1+0.529350304*F.SE)	TOTAL	0.653873
40	FS.627	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 627 1/(1+0.6263508126*F.SE)	TOTAL	0.614874
41	FS.629	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 629 1/(1+0.523144806*F.SE)	TOTAL	0.656537
42	FS.630	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 630 1/(1+0.5243375392*F.SE)	TOTAL	0.656023
43	FS.631	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 631 1/(1+0.52310668*F.SE)	TOTAL	0.656553
44	FS.6331	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 633.1 1/(1+0.5205298*F.SE)	TOTAL	0.657666
45	FS.644	STATE ALLOCATION UPDATE FACTOR FOR ACCOUNT 644 1/(1+0.70290309*F.S)	TOTAL	0.587233

F O R M U L A S   A N D   R E S U L T S

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
46	FS.6621	STATE USAGE UPDATE FACTOR FOR ACCOUNT 662.1 1/(1+0.421136812*F.SE)	TOTAL	0.703663
47	ICOST	EMBEDDED COST RATE FOR BONDS 0.04157732	TOTAL	0.041578
48	II	FRACTIONAL CHANGE IN INTERSTATE TOLL RATES 0	TOTAL	0.000000
49	IID	FRACTION OF THE AVG INTERSTATE TOLL MOU/LINE = AVG INTERSTATE MOU CURTAIL LINE 0	TOTAL	0.000000
50	INVESTMENT#	NET INVESTMENT SUM<#201,#264.99>-SUM<#171,#176.99>	TOTAL	2,061,051,390
			STATE	1,442,305,540
			ISTATE	530,685,440
			ISTATEPL	88,059,952
51	ISPL.LOOP	INTERSTATE PRIVATE LINE LOOP RATIO TOTAL2002/SUM<TOTAL2001,TOTAL2005>	TOTAL	0.027002
52	ISTATE.INIT	INITIAL INTERSTATE USAGE FACTOR 2,784,218,708	TOTAL	2,784,218,620
53	ISTATE.USE	INTERSTATE USAGE FACTOR CALCULATION ISTATE.INIT*(1+II) NI*(1+IID*FF.DROP)	TOTAL	2,784,218,620
54	LNBUS	NUMBER OF BUSINESS LINES LNBUS.INIT*(1+FF.BUS) NB.ELAS	TOTAL	296,276
55	LNBUS.INIT	INITIAL NUMBER OF BUSINESS LINES EXCLUDING WATS LINES 296,276	TOTAL	296,276
56	LNRES	NUMBER OF RESIDENTIAL LINES LNRES.INIT*(1+FF.RES) NR.ELAS	TOTAL	1,292,402
57	LNRES.INIT	INITIAL NUMBER OF RESIDENTIAL LINES 1,292,403	TOTAL	1,292,402
58	LOOP.COST#	(686,166,784-(TOTAL2002+TOTAL2003)*TOTAL2006)*SPF#	TOTAL	636,524,288
			STATE	464,075,008
			ISTATE	172,449,040
			ISTATEPL	0
59	MTS.LOOP	MESSAGE TELEPHONE SERVICE LOOP RATIO TOTAL2004/SUM<TOTAL2001,TOTAL2005>	TOTAL	0.927651
60	NB.ELAS	CONNECT ELASTICITY FOR BUSINESS 0	TOTAL	0.000000

F O R M U L A S   A N D   R E S U L T S

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
61	NI	OWN PROCE ELASTICITY FOR SUBSCRIBER LINE MOU OF INTERSTATE SERVICE 0	TOTAL	0.000000
62	NR.ELAS	CONNECT ELASTICITY FOR RESIDENCE 0	TOTAL	0.000000
63	NS	OWN PRICE ELASTICITY FOR SUBSCRIBER LINE MOU OF STATE SERVICE 0	TOTAL	0.000000
64	NSW.I	COST PARAMETER - SWITCHING EQUIPMENT, INTERSTATE 0	TOTAL	0.000000
65	NSW.IS	COST PARAMETER - SWITCHING, INTERSTATE AND STATE 0	TOTAL	0.000000
66	NSW.ISE	COST PARAMETER - SWITCHING EQUIPMENT, INTERSTATE, STATE, AND EXCHANGE 0	TOTAL	0.000000
67	NSW.S	COST PARAMETER - SWITCHING EQUIPMENT STATE 0	TOTAL	0.000000
68	NTF.ISE	COST PARAMETER - TRAFFIC, INTERSTATE, STATE, AND EXCHANGE 0	TOTAL	0.000000
69	NTK.I	COST PARAMETER - TRUNKING EQUIPMENT, INTERSTATE 0	TOTAL	0.000000
70	NTK.IS	COST PARAMETER - TRUNKING EQUIPMENT, INTERSTATE AND STATE 0	TOTAL	0.000000
71	NTK.ISE	COST PARAMETER - TRUNKING EQUIPMENT, INTERSTATE, STATE, AND EXCHANGE 0	TOTAL	0.000000
72	NTK.S	COST PARAMETER - TRUNKING EQUIPMENT, STATE 0	TOTAL	0.000000
73	NTS.CROSS	NON-TRAFFIC SENSITIVE FACTOR, CROSS BAR(47C) 0.257553	TOTAL	0.257553
74	NTS.ELEC	NON-TRAFFIC SENSITIVE FACTOR, ELECTRONIC(77C) 0.253298	TOTAL	0.253298
75	NTS.SXS	NON-TRAFFIC SENSITIVE FACTOR, STEP-BY-STEP(37C) 0.332663	TOTAL	0.332663
76	PL.LOOP	PRIVATE LINE LOOP RATIO SUM<TOTAL2002,TOTAL2003.9>/SUM<TOTAL2001,TOTAL2005>	TOTAL	0.072350

F O R M U L A S   A N D   R E S U L T S

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
77	PLANT#	PLANT RATIO SUM<#201,#277.99>/SUM<TOTAL201,TOTAL277.99>	TOTAL	1.000000
			STATE	0.700057
			ISTATE	0.258204
			ISTATEPL	0.041741
78	PLT211.264#	INVESTMENT RATIO FOR ACCOUNTS 211 THRU 264 SUM<#211,#264.99>/SUM<TOTAL211,TOTAL264.99>	TOTAL	1.000000
			STATE	0.700057
			ISTATE	0.258204
			ISTATEPL	0.041741
79	PLT212#	BUILDING RATIO SUM<#212,#212.99>/SUM<TOTAL212,TOTAL212.99>	TOTAL	1.000000
			STATE	0.665738
			ISTATE	0.329556
			ISTATEPL	0.004707
80	PLT221#	CENTRAL OFFICE EQUIPMENT RATIO SUM<#221,#221.99>/SUM<TOTAL221,TOTAL221.99>	TOTAL	1.000000
			STATE	0.762980
			ISTATE	0.228693
			ISTATEPL	0.068329
81	PLT231#	STATION APPARATUS RATIO SUM<#231,#231.99>/SUM<TOTAL231,TOTAL231.99>	TOTAL	1.000000
			STATE	0.715769
			ISTATE	0.263356
			ISTATEPL	0.020877
82	PLT232#	STATION CONNECTION RATIO SUM<#232,#232.99>/SUM<TOTAL232,TOTAL232.99>	TOTAL	1.000000
			STATE	0.720380
			ISTATE	0.266425
			ISTATEPL	0.013197
83	PLT234#	LARGE PRIVATE BRANCH EXCHANGE RATIO SUM<#234,#234.99>/SUM<TOTAL234,TOTAL234.99>	TOTAL	1.000000
			STATE	0.716499
			ISTATE	0.263236
			ISTATEPL	0.020267
84	PLT240#	OUTSIDE PLANT RATIO SUM<#240,#240.99>/SUM<TOTAL240,TOTAL240.99>	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747
85	PLT241#	POLE LINE RATIO PLT240#	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747
86	PLT242.1#	AERIAL CABLE RATIO PLT240#	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747

F O R M U L A S   A N D   R E S U L T S

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
87	PLT242.2#	UNDERGROUND CABLE RATIO PLT240#	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747
88	PLT242.3#	BURIED CABLE RATIO PLT240#	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747
89	PLT242.4#	SUBMARINE CABLE RATIO PLT240#	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747
90	PLT243#	AERIAL WIRE RATIO PLT240#	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747
91	PLT244#	UNDERGROUND CONDUIT RATIO PLT240#	TOTAL	1.000000
			STATE	0.695677
			ISTATE	0.259578
			ISTATEPL	0.044747
92	PLT261#	FURNITURE AND OFFICE EQUIPMENT RATIO SUM<#261,#261.99>/SUM<TOTAL261,TOTAL261.99>	TOTAL	1.000000
			STATE	0.698657
			ISTATE	0.301344
			ISTATEPL	0.000000
93	PLT264#	VEHICLES AND OTHER WORK EQUIPMENT RATIO SUM<#264,#264.99>/SUM<TOTAL264,TOTAL264.99>	TOTAL	1.000000
			STATE	0.704746
			ISTATE	0.261640
			ISTATEPL	0.033614
94	PRVT.LINE#	PRIVATE LINE RATIO SUM<#2002,#2003.9>/SUM<TOTAL2002,TOTAL2003.9>	TOTAL	1.000000
			STATE	0.626795
			ISTATE	0.000000
			ISTATEPL	0.373206
95	RATEBASE#	RATE BASE SUM<#201,#277.99>-SUM<#171,#171.99>-SUM<#176,#176.99>	TOTAL	2,061,050,620
			STATE	1,442,303,740
			ISTATE	530,685,440
			ISTATEPL	88,059,840
96	RETURN	RATE OF RETURN .121225	TOTAL	0.121225

FORMULAS AND RESULTS

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
97	REV.ACTUAL#	TOTAL REVENUES SUM<#500,#530>	TOTAL STATE ISTATE ISTATEPL	1,243,585,020 879,876,352 312,422,912 51,285,536
98	REVENUE#	REVENUE REQUIREMENT RATEBASE#*RETURN+SUM<#300,#307.99>+SUM<#600,#699.99>	TOTAL STATE ISTATE ISTATEPL	1,234,483,970 884,227,584 318,640,640 31,614,976
99	RR.CORRECTEX	REVENUE CORRECTION FOR EXCHANGE REVENUES TOTAL500-R0.EXCH+TOTAL506+TOTAL503-R0.CPE	TOTAL	10,135,248
100	RR.EXCH	REVENUE REQUIREMENT FOR EXCHANGE REVENUE:STATE-RR.SUB-RR.STOLL-R0.CPE-RR.CORRECTEX	TOTAL	350,540,544
101	RR.STOLL	UPDATE STATE TOLL REVENUE R0.STOLL*(STATE.USE/STATE.INIT)*(1+SS)	TOTAL	175,324,032
102	RR.SUB	REVENUE SUBCALCULATION TOTAL501+STATE524+STATE526+TOTAL523+TOTAL521+STATE504+STATE512	TOTAL	123,575,568
103	R0.CPE	CPE REVENUES 145,765,741+78,885,970	TOTAL	224,651,696
104	R0.EXCH	EXCHANGE REVENUES 346,191,293	TOTAL	346,191,104
105	R0.REV	TOTAL REVENUE 1,238,805,753	TOTAL	1,238,805,500
106	R0.STATE	STATE REVENUES 869,742,589	TOTAL	869,742,336
107	R0.STOLL	STATE TOLL REVENUES 175,324,046	TOTAL	175,324,032
108	SLU#	SUBSCRIBER LINE USAGE FACTOR #3299.2/TOTAL3299.2	TOTAL STATE ISTATE ISTATEPL	1.000000 0.919231 0.080770 0.000000
109	SPF#	SUBSCRIBER PLANT FACTOR #3299.1/TOTAL3299.1	TOTAL STATE ISTATE ISTATEPL	1.000000 0.729078 0.270923 0.000000

FORMULAS AND RESULTS

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
110	SPL.LOOP	INTRASTATE PRIVATE LINE LOOP RATIO TOTAL2602.4/SUM<TOTAL2602.1,TOTAL2602.4>	TOTAL	0.048163
111	SS	FRACTIONAL CHANGE IN STATE TOLL RATES 0	TOTAL	0.000000
112	SSD	FRACTION OF THE AVG STATE TOLL MOU/LINE = AVG STATE MOU CURTAIL LINE 0	TOTAL	0.000000
113	STATE.INIT	INITIAL STATE USAGE FACTOR 1,639,365,521	TOTAL	1,639,365,380
114	STATE.TAX#	STATE TAXES STETX*RATEBASE#*(RETURN-ICOST)	TOTAL	7,013,985
			STATE	4,908,320
			ISTATE	1,805,982
			ISTATEPL	299,678
115	STATE.USE	STATE USAGE FACTOR CALCULATION STATE.INIT*(1+SS) NS*(1+SSD*FF.DROP)	TOTAL	1,639,365,380
116	STATE.221	STATE ALLOCATION FOR CENTRAL OFFICE EQUIPMENT CHANGES (SUM<STATE221,STATE221.99>/SUM<TOTAL221,TOTAL221.99>)/0.70298	TOTAL	1.000000
117	STATE.600	STATE ALLOCATION UPDATE FOR MAINTENANCE, TRAFFIC, AND COMMERCIAL EXPENSES ((SUB.600+STATE662)/(TOT.600+TOTAL662))/0.7129588	TOTAL	1.000274
118	STCON.OTHER#	STATION CONNECTIONS - OTHER EQUIPMENT XSTATION#/XSTATION:TOTAL	TOTAL	1.000000
			STATE	0.720242
			ISTATE	0.266333
			ISTATEPL	0.013426
119	STETX	STATE TAX RATE 0.042727083	TOTAL	0.042728
120	SUB.FF	SUBCALCULATION FOR FRACTIONAL CHANGE IN LINES RR.EXCH/(LNRES+BB*LNBUS)	TOTAL	148
121	SUB.FF.INIT	INITIAL SUBCALCULATION FOR FRACTIONAL CHANGE IN LINES R0.EXCH/(LNRES.INIT+BB*LNBUS.INIT)	TOTAL	146
122	SUB.600	SUBCALCULATION FOR STATE ALLOCATION OF MAINTENANCE, TRAFFIC, 8 COMMERCIAL EXP. SUM<STATE602,STATE606.99>+SUM<STATE610,STATE612.99>+SUM<STATE621,STATE650.99>	TOTAL	350,283,008
123	SUBLINE#	SUBSCRIBER LINE RATIO MTS.LOOP*SPF#+TWX.LOOP*TWX.MOU#+PL.LOOP*PRVT.LINE#	TOTAL	1.000000
			STATE	0.721678
			ISTATE	0.251322
			ISTATEPL	0.027002

FORMULAS AND RESULTS

NO	NAME	DESCRIPTION AND FORMULA	CATEGORY	RESULT
124	SXS#	LOCAL DIAL SWITCHING EQUIPMENT RATIO FOR SXS NTS.SXS*SPF#+(1-NTS.SXS)*DMU#	TOTAL STATE ISTATE ISTATEPL	1.000000 0.849387 0.150614 0.000000
125	TAX#	TOTAL TAXES SUM(#307.002,#307.006)	TOTAL STATE ISTATE ISTATEPL	106,216,784 86,944,016 17,512,304 1,760,401
126	TOT.600	SUBCALCULATION FOR STATE ALLOCATION OF MAINTENANCE, TRAFFIC, & COMMERCIAL EXP. SUM(TOTAL602,TOTAL606.99)+SUM(TOTAL610,TOTAL612.99)+SUM(TOTAL621,TOTAL650.99)	TOTAL	490,490,368
127	TWX.LOOP	TWX LOOP RATIO TOTAL2602.2/SUM(TOTAL2602.1,TOTAL2602.4)	TOTAL	0.000000
128	TWX.MOU#	TWX MINUTES OF USE #3299.6/TOTAL3299.6	TOTAL STATE ISTATE ISTATEPL	0.000000 0.000000 0.000000 0.000000
129	USE.E	EXCHANGE USAGE FACTOR EXCH.USE/EXCH.INIT	TOTAL	1.000000
130	USE.I	INTERSTATE USAGE RATIO ISTATE.USE/ISTATE.INIT	TOTAL	1.000000
131	USE.IS	STATE AND INTERSTATE USAGE RATIO (STATE.USE+ISTATE.USE)/(STATE.INIT+STATE.INIT)	TOTAL	1.349175
132	USE.ISE	INTERSTATE, STATE, AND EXCHANGE USAGE RATIO (STATE.USE+EXCH.INIT+ISTATE.USE)/(STATE.INIT+EXCH.INIT+ISTATE.INIT)	TOTAL	1.000000
133	USE.S	STATE USAGE RATIO STATE.USE/STATE.INIT	TOTAL	1.000000
134	VF.BUS	INTERSTATE USER ACCESS FOR BUSINESS CUSTOMERS PER LINE 72	TOTAL	72.000000
135	VF.RES	INTERSTATE USER ACCESS FOR RESIDENTIAL CUSTOMERS PER LINE 24	TOTAL	24.000000
136	XSTATION#	SUM OF OTHER STATION EQUIPMENT #232.0111+#232.0141+#232.0171+#232.0201+#232.0231	TOTAL STATE ISTATE ISTATEPL	159,946,464 115,200,096 42,598,976 2,147,388

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
100.1000	TELEPHONE PLANT IN SERVICE	1. SET TOTAL TO 2,805,489,080 2. * APPORTIONED BASED ON ACCOUNTS 201 THRU 277 3. ALLOC TOTAL TO CATEGORIES BY PLANT#
100.2200	PLANT UNDER CONSTRUCTION, EXCLUDING PLANT BEING REQUESTED FOR ANOTHER CO.	1. * DIRECTLY REQUESTED OR APPORTIONED AS ACCOUNT 100.1 2. SET TOTAL TO 43,065,712 3. ALLOC TOTAL TO CATEGORIES BY PLANT#
100.3000	PROPERTY HELD FOR FUTURE USE	1. SET TOTAL TO 1,369,443 2. * DIRECTLY REQUESTED OR APPORTIONED AS ACCOUNT 100.1 3. ALLOC TOTAL TO CATEGORIES BY PLANT#
122.0000	MATERIALS AND SUPPLIES LESS ANY WORKING CAPITAL	1. SET TOTAL TO 16,483,457 2. * DIRECTLY REQUESTED OR APPORTIONED AS OUTSIDE PLANT IN SERVICE 3. ALLOC TOTAL TO CATEGORIES BY PLT240#
171.2120	DEPRECIATION RESERVE - BUILDINGS	1. SET TOTAL TO 57,909,712 2. * ALLOCATED BASED ON PLANT ACCOUNT 212 3. ALLOC TOTAL TO CATEGORIES BY PLT212#
171.2210	DEPRECIATION RESERVE - CENTRAL OFFICE EQUIPMENT	1. SET TOTAL TO 77,101,402 2. * ALLOCATED BASED ON PLANT ACCOUNT 221 3. ALLOC TOTAL TO CATEGORIES BY PLT221#
171.2310	DEPRECIATION RESERVE - STATION APPARATUS	1. SET TOTAL TO 50,375,208 2. * ALLOCATED BASED ON PLANT ACCOUNT 231 3. ALLOC TOTAL TO CATEGORIES BY PLT231#
171.2320	DEPRECIATION RESERVE - STATION CONNECTIONS	1. SET TOTAL TO 34,790,606 2. * ALLOCATED BASED ON PLANT ACCOUNT 232 3. ALLOC TOTAL TO CATEGORIES BY PLT232#
171.2340	DEPRECIATION RESERVE - LARGE PRIVATE BRANCH EXCHANGE	1. SET TOTAL TO -7,140,426 2. * ALLOCATED BASED ON PLANT ACCOUNT 234 3. ALLOC TOTAL TO CATEGORIES BY PLT234#

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
171.2410	DEPRECIATION RESERVE - POLE LINES	1. SET TOTAL TO 19,193,871 2. * ALLOCATED BASED ON PLANT ACCOUNT 241 3. ALLOC TOTAL TO CATEGORIES BY PLT241*
171.2421	DEPRECIATION RESERVE - AERIAL CABLE	1. SET TOTAL TO 42,509,952 2. * ALLOCATED BASED ON PLANT ACCOUNT 242.1 3. ALLOC TOTAL TO CATEGORIES BY PLT242.1*
171.2422	DEPRECIATION RESERVE - UNDERGROUND CABLE	1. SET TOTAL TO 28,508,412 2. * ALLOCATED BASED ON PLANT ACCOUNT 242.2 3. ALLOC TOTAL TO CATEGORIES BY PLT242.2*
171.2423	DEPRECIATION RESERVE - BURIED CABLE	1. SET TOTAL TO 61,270,146 2. * ALLOCATED BASED ON PLANT ACCOUNT 242.3 3. ALLOC TOTAL TO CATEGORIES BY PLT242.3*
171.2424	DEPRECIATION RESERVE - SUBMARINE CABLE	1. SET TOTAL TO 155,644 2. * ALLOCATED BASED ON PLANT ACCOUNT 242.4 3. ALLOC TOTAL TO CATEGORIES BY PLT242.4*
171.2430	DEPRECIATION RESERVE - AERIAL WIRE	1. SET TOTAL TO -1,616,560 2. * ALLOCATED BASED ON PLANT ACCOUNT 243 3. ALLOC TOTAL TO CATEGORIES BY PLT243*
171.2440	DEPRECIATION RESERVE - UNDERGROUND CONDUIT	1. SET TOTAL TO 18,762,012 2. * ALLOCATED BASED ON PLANT ACCOUNT 244 3. ALLOC TOTAL TO CATEGORIES BY PLT244*
171.2610	DEPRECIATION RESERVE - FURNITURE AND OFFICE EQUIPMENT	1. SET TOTAL TO 19,405,617 2. * ALLOCATED BASED ON PLANT ACCOUNT 261 3. ALLOC TOTAL TO CATEGORIES BY PLT261*
171.2640	DEPRECIATION RESERVE - VEHICLES AND OTHER WORK EQUIPMENT	1. SET TOTAL TO 11,407,732 2. * ALLOCATED BASED ON PLANT ACCOUNT 264 3. ALLOC TOTAL TO CATEGORIES BY PLT264*

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
172.2030	AMORTIZATION RESERVE - PATENT RIGHTS	1. * ALLOCATED BASED ON ACCOUNT 203 2. * SAME AS ACCOUNT 203
172.2110	AMORTIZATION RESERVE - LAND	1. * ALLOCATED BASED ON PLANT ACCOUNT 211 2. * ALLOC TOTAL TO CATEGORIES BY PLT211*
176.2120	ACCUM. DEFERRED INCOME TAXES - BUILDINGS	1. SET TOTAL TO 11,415,176 2. * ALLOCATED BASED ON PLANT ACCOUNT 212 3. ALLOC TOTAL TO CATEGORIES BY PLT212*
176.2210	ACCUM. DEFERRED INCOME TAXES - CENTRAL OFFICE EQUIPMENT	1. SET TOTAL TO 140,153,484 2. * ALLOCATED BASED ON PLANT ACCOUNT 221 3. ALLOC TOTAL TO CATEGORIES BY PLT221*
176.2310	ACCUM. DEFERRED INCOME TAXES - STATION APPARATUS	1. SET TOTAL TO 47,468,499 2. * ALLOCATED BASED ON PLANT ACCOUNT 231 3. ALLOC TOTAL TO CATEGORIES BY PLT231*
176.2320	ACCUM. DEFERRED INCOME TAXES - STATION CONNECTIONS	1. SET TOTAL TO 35,581,608 2. * ALLOCATED BASED ON PLANT ACCOUNT 232 3. ALLOC TOTAL TO CATEGORIES BY PLT232*
176.2340	ACCUM. DEFERRED INCOME TAXES - LARGE PRIVATE BRANCH EXCHANGES	1. SET TOTAL TO 22,808,409 2. * ALLOCATED BASED ON PLANT ACCOUNT 234 3. ALLOC TOTAL TO CATEGORIES BY PLT234*
176.2410	ACCUM. DEFERRED INCOME TAXES - POLE LINES	1. SET TOTAL TO 2,437,676 2. * ALLOCATED BASED ON PLANT ACCOUNT 241 3. ALLOC TOTAL TO CATEGORIES BY PLT241*
176.2421	ACCUM. DEFERRED INCOME TAXES - AERIAL CABLE	1. SET TOTAL TO 7,502,696 2. * ALLOCATED BASED ON PLANT ACCOUNT 242.1 3. ALLOC TOTAL TO CATEGORIES BY PLT242.1*

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
176.2422	ACCUM. DEFERRED INCOME TAXES - UNDERGROUND CABLE	1. SET TOTAL TO 10,337,890 2. * ALLOCATED BASED ON PLANT ACCOUNT 242.2 3. ALLOC TOTAL TO CATEGORIES BY PLT242.2#
176.2423	ACCUM. DEFERRED INCOME TAXES - BURIED CABLE	1. SET TOTAL TO 25,163,469 2. * ALLOCATED BASED ON PLANT ACCOUNT 242.3 3. ALLOC TOTAL TO CATEGORIES BY PLT242.3#
176.2424	ACCUM. DEFERRED INCOME TAXES - SUBMARINE CABLE	1. SET TOTAL TO 13,693 2. * ALLOCATED BASED ON ACCOUNT 242.4 3. ALLOC TOTAL TO CATEGORIES BY PLT242.4#
176.2430	ACCUM. DEFERRED INCOME TAXES - AERIAL WIRE	1. SET TOTAL TO 14,984 2. * ALLOCATED BASED ON ACCOUNT 243 3. ALLOC TOTAL TO CATEGORIES BY PLT243#
176.2440	ACCUM. DEFERRED INCOME TAXES - UNDERGROUND CONDUIT	1. SET TOTAL TO 8,038,823 2. * ALLOCATED BASED ON ACCOUNT 244 3. ALLOC TOTAL TO CATEGORIES BY PLT244#
176.2610	ACCUM DEFERRED INCOME TAXES - FURNITURE AND OFFICE EQUIPMENT	1. SET TOTAL TO 13,491,332 2. ALLOC TOTAL TO CATEGORIES BY PLT261#
176.2640	ACCUM. DEFERRED INCOME TAXES - VEHICLES AND OTHER WORK EQUIPMENT	1. SET TOTAL TO 6,793,137 2. * ALLOCATED BASED ON ACCOUNT 264 3. ALLOC TOTAL TO CATEGORIES BY PLT264#
201.0000	ORGANIZATION	1. * ALLOC TOTAL TO CATEGORIES BY PLT211.264#
202.0000	FRANCHISES	1. SET TOTAL TO 675 2. ALLOC TOTAL TO CATEGORIES BY PLT211.264#

A C C O U N T D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
212.0100	BUILDINGS - OPERATING ROOM AND COE SPACE	1. SET TOTAL TO 174,395,034 2. * DIRECTLY REQUESTED OR BY WEIGHTED CENTRAL OFFICE EQUIPMENT 3. ALLOC TOTAL TO STATE BY FS.21201 4. ALLOC TOTAL TO ISTATE
212.0200	BUILDINGS - OPERATOR'S QUARTERS	1. SET TOTAL TO 1,485,761 2. * RELATIVE NUMBER OF TRAFFIC UNITS FOR ALL SWITCHBOARDS 3. ALLOC TOTAL TO STATE BY FS.21202 4. ALLOC TOTAL TO ISTATE
212.0300	BUILDINGS - GENERAL TRAFFIC SUPERVISION SPACE	1. SET TOTAL TO 10,120,374 2. * GENERAL TRAFFIC SUPERVISION EXPENSE 3. SAME AS ACCOUNT 621-621.99
212.0400	BUILDINGS - COMMERCIAL OFFICE SPACE	1. SET TOTAL TO 23,449,785 2. * GENERAL COMMERCIAL, SALES, CONNECTING RELATIONS & LOCAL COMMERCIAL EXPENSE 3. SAME AS ACCOUNT 640-640.99,643-645.99
212.0500	BUILDINGS - SPACE USED BY ANOTHER COMPANY FOR INTERSTATE OPERATIONS	1. SET TOTAL TO 1,613,632 2. ALLOC TOTAL TO ISTATE
212.0600	BUILDINGS - REVENUE ACCOUNTING SPACE	1. * APPORTIONED ACCORDING TO REVENUE ACCOUNTING EXPENSE 2. SET TOTAL TO 3,851,244 3. SAME AS ACCOUNT 662-662.99
212.0700	BUILDINGS - GARAGES, STOREROOMS, WAREHOUSES, AND POLE YARDS	1. SET TOTAL TO 25,748,628 2. * APPORTIONED BY STATION EQUIPMENT, OSP IN SERVICE, MATERIAL & SUPPLIES 3. SAME AS ACCOUNT 231-234.99,240-240.99,122-122.99
212.0800	BUILDINGS - SPACE RENTAL TO OTHERS	1. SET TOTAL TO 89,710 2. * DIRECTLY ASSIGNED ACCORDING TO RENTAL REVENUES 3. ALLOC TOTAL TO STATE
212.0900	BUILDINGS - GENERAL OFFICE SPACE	1. SET TOTAL TO 43,755,181 2. * APPORTIONED ACCORDING TO GENERAL EXPENSES 3. SAME AS ACCOUNT 661-665.99

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
212.1000	BUILDINGS - ANTENNA SUPPORTING STRUCTURES	1. * APPORTIONED ACCORDING TO THE COST OF ANTENNAS SUPPORTED 2. SET TOTAL TO 282,798 3. ALLOC TOTAL TO ISTATE
221.0400	MANUAL TELEPHONE SWITCHING EQUIP. - SWITCHBOARDS BOTH TOLL 8 DSA	1. SET TOTAL TO 1,689,704*USE.IS NSW.IS 2. * RELATIVE NUMBER OF TRAFFIC UNITS HANDLED AT THESE BOARDS 3. ALLOC TOTAL TO STATE BY FS.22104 4. ALLOC TOTAL TO ISTATE
221.0500	COE - MANUAL SWITCHING EQUIPMENT TRAFFIC SERVICE POSITIONS	1. SET TOTAL TO 25,676,915*USE.IS NSW.IS 2. * RELATIVE NUMBER OF TRAFFIC UNITS HANDLED AT THESE BOARDS 3. ALLOC TOTAL TO STATE BY FS.22105 4. ALLOC TOTAL TO ISTATE
221.0900	COE - MANUAL TELEPHONE SWITCHING EQUIPMENT - AUXILIARY SERVICE BOARDS	1. SET TOTAL TO 4,097,176*USE.IS NSW.IS 2. * RELATIVE NUMBER OF TRAFFIC UNITS 3. ALLOC TOTAL TO STATE BY FS.22109 4. ALLOC TOTAL TO ISTATE
221.1100	MANUAL TELEPHONE SWITCHING EQUIPMENT - AUX. SERVICE BOARDS, INTERCEPT BDS	1. SET TOTAL TO 2,269,595*USE.IS NSW.IS 2. * RELATIVE NUMBER OF SUBSCRIBER LINE MOU 3. ALLOC TOTAL TO CATEGORIES BY SLU*
221.1200	MANUAL TELEPHONE SWITCHING EQUIP. - AUX SERVICE BDS - RATE/ROUTE BDS NOT TOLL	1. * COST OF TOLL SERVICE BOARDS
221.1300	MANUAL TELEPHONE SWITCHING EQUIP. - SEPARATE TOLL SERVICE OBSERVING BDS	1. * RELATIVE NO. OF TOLL MIN. OF USE FROM ORIGINATING OFFICES
221.1500	DIAL TANDEM SWITCHING EQUIP. - PRIMARIY HANDLING EXCHANGE/SHORT HAUL TOLL	1. SET TOTAL TO 3,560,589*USE.IS NSW.IS 2. * RELATIVE NUMBER OF CONNECTIONS AT THE TANDEM OFFICE 3. ALLOC TOTAL TO STATE BY FS.22115 4. ALLOC TOTAL TO ISTATE
221.1600	DIAL TANDEM SWITCHING EQUIP. - LONG-HUAL TOLL TRAFFIC	1. * RELATIVE MINUTES OF USE AT EACH LOCATION(UNWEIGHTED)

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
221.1700	COE - INTERTOLL DIAL SWITCHING EQUIP., EXCLUDING PL OR TWX TRUNKS	1. SET TOTAL TO 50,409,182*USE.IS NSW.IS 2. * RELATIVE NUMBER OF MINUTES OF USE OF THE INTERTOLL DIAL SWITCHING EQUIP. 3. ALLOC TOTAL TO STATE BY FS.22117 4. ALLOC TOTAL TO ISTATE
221.1800	INTERTOLL DIAL SWITCHING - INTERCONNECT OF SWITCHED PRIVATE LINE TRUNKS	1. SET TOTAL TO 1,694,303 2. * RELATIVE NUMBER OF STATE & INTERSTATE PRIVATE LINES SERVED 3. ALLOC TOTAL TO ISTATE
221.2000	AUTOMATIC MESSAGE RECORDING EQUIPMENT - ENTIRE DURATION OF THE CALL	1. * NUMBER OF MIN OF USE INCURRED ON CUSTOMER DIALED CHARGE OR SWITCHED PL 2. SET TOTAL TO 32,510*USE.IS NSW.IS 3. ALLOC TOTAL TO STATE BY FS.22120 4. ALLOC TOTAL TO ISTATE
221.2100	COE - AUTOMATIC MEASSAGE RECORDING EQUIPMENT USED MOMENTARILY	1. SET TOTAL TO 11,348,225*USE.IS NSW.IS 2. * RELATIVE NO OF AUTO. TICKETED MESSAGES FOR CUSTOMER DIALED CHARGE OR SWITCH PL 3. ALLOC TOTAL TO STATE BY FS.22121 4. ALLOC TOTAL TO ISTATE
221.2200	COE - TOLL DIALING SWITCHING, OTHER	1. SET TOTAL TO 143,191*USE.IS NSW.IS 2. * RELATIVE MIN OF USE OF EQUIPMENT AT EACH LOCATION 3. ALLOC TOTAL TO STATE BY FS.22122 4. ALLOC TOTAL TO ISTATE
221.3100	AUX. SERVICE FOR MANUAL TELEPHONE SW BDS - AUX. SERVICE JOINTLY USED	
221.3200	MANUAL TELEPHONE SWITCHING EQUIPMENT - JOINT EXCHANGE AND TOLL	1. SET TOTAL TO 321,201*USE.ISE NSW.ISE 2. * RELATIVE NO OF TOLL MIN OF USE ASSOCIATED W/TOLL MESSAGE(ORGINATING) 3. ALLOC TOTAL TO STATE BY FS.22132 4. ALLOC TOTAL TO ISTATE
221.3300	LOCAL DIAL SWITCHING EQUIP - STEP-BY-STEP (37C)	1. SET TOTAL 39,621,179*USE.ISE NSW.ISE 2. ALLOC TOTAL TO CATEGORIES BY SXS#
221.3400	LOCAL DIAL SWITCHING EQUIP - CROSSBAR (47C)	1. SET TOTAL TO 41,368,407*USE.ISE NSW.ISE 2. ALLOC TOTAL TO CATEGORIES BY CROSS#

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
221.3500	LOCAL DIAL SWITCHING EQUIP - ELECTRONIC (77C)	1. SET TOTAL TO 341,231,036*USE.ISE NSW.ISE 2. ALLOC TOTAL TO CATEGORIES BY ELEC*
221.5100	SPECIAL SERVICES DIAL SWITCHING SYSTEMS	1. SET TOTAL TO 4,132,548 2. * DIRECT ASSIGNMENT 3. ALLOC TOTAL TO ISTATEPL
221.5500	WIDEBAND EXCHANGE TRUNK AND LOOP CIRCUIT EQUIPMENT FOR INTERSTATE PL	1. * ALLOCATE TO INTERSTATE PRIVATE LINE 2. SET TOTAL TO 438,979 3. ALLOC TOTAL TO ISTATEPL
221.5600	WIDEBAND EXCHANGE TRUNK AND LOOP CIRCUIT EQUIPMENT FOR STATE PL	1. * ALLOCATE TO INTRASTATE PRIVATE LINE
221.5800	EXCHANGE TRUNK BASIC CIRCUIT EQUIPMENT EXCLUDING WIDEBAND FOR MESSAGE SERVICES	1. SET TOTAL TO 89,940,193*USE.IS NSW.IS 2. * CORRESPONDING OUTSIDE PLANT CATEGORY 3. SAME AS ACCOUNT 240.04
221.5900	EXCHANGE TRUNK BASIC CIRCUIT EQUIP., EXCLUDING WIDEBAND FOR TOLL OR JOINT	1. SET TOTAL TO 48,401,757*USE.ISE NSW.ISE 2. * CORRESPONDING OUTSIDE PLANT CATEGORY 3. SAME AS ACCOUNT 240.05
221.6100	EXCHANGE TRUNK BASIC CIRCUIT EQUIP., EXCLUDING WIDEBAND FOR INTERSTATE PL	1. SET TOTAL TO 21,110,862 2. * ALLOCATE TO INTERSTATE PRIVATE LINE 3. ALLOC TOTAL TO ISTATEPL
221.6200	EXCHANGE TRUNK BASIC CIRCUIT EQUIP., EXCLUDING WIDEBAND FOR INTRASTATE PL	1. SET TOTAL TO 31,389,752 2. * ALLOCATE TO INTRASTATE PRIVATE LINE 3. ALLOC TOTAL TO STATE
221.6800	SUBSCRIBER LINE BASIC CIRCUIT EQUIPMENT EXCLUDING WIDEBAND	1. SET TOTAL TO 37,500,903 2. ALLOC TOTAL TO CATEGORIES BY SUBLINE*

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
221.7100	INTEREXCHANGE CIRCUIT EQUIP. FOR ANOTHER CO. FOR INTERSTATE USE	1. SET TOTAL TO 1,248,981*USE.I NSW.I 2. * DIRECT ASSIGNMENT TO INTERSTATE TOLL 3. ALLOC TOTAL TO ISTATE
221.7200	INTEREXCHANGE CIRCUIT EQUIP. FOR WIDEBAND SEVICE FOR INTERSTATE PL	1. SET TOTAL TO 3,029,575 2. * DIRECT ASSIGNMENT TO INTERSTATE PL 3. ALLOC TOTAL TO ISTATEPL
221.7300	INTEREXCHANGE CIRCUIT EQUIP. USED FOR WIDEBAND FOR STATE PL	1. SET TOTAL TO 1,401,241 2. * DIRECT ASSIGNMENT TO INTRASTATE PRIVATE LINE 3. ALLOC TOTAL TO STATE
221.7500	INTEREXCH. BASIC CIRCUIT EQUIP., EXCL WIDEBAND FOR INTERSTATE CO. INTERSTATE MS	1. SET TOTAL TO 45,511,593*USE.I NSW.I 2. * DIRECT ASSIGNMENT TO INTERSTATE TOLL 3. ALLOC TOTAL TO ISTATE
221.7600	INTEREXCH. BASIC CIRCUIT EQUIP., EXCL. WIDEBAND FOR INTERSTATE CO. STATE	1. SET TOTAL TO 8,738,865*USE.S NSW.S 2. * DIRECT ASSIGNMENT TO INTRASTATE TOLL 3. ALLOC TOTAL TO STATE
221.7700	INTEREXCH BASIC CIRCUIT EQUIP., EXCL WIDEBAND FOR INTERSTATE CO. JOINT MS	1. SET TOTAL TO 98,171,949*USE.IS NSW.IS 2. * ALLOCATE ACCORDING TO THE NO OF CONVERSATION-MIN-MILE 3. SAME AS ACCOUNT 3299.3
221.8100	INTEREXCH BASIC CIRCUIT EQUIP., EXCL WIDEBAND FOR INTERSTATE CO. INTERSTATE PL	1. SET TOTAL TO 27,292,123 2. * DIRECT ASSIGNMENT TO INTERSTATE PL 3. ALLOC TOTAL TO ISTATEPL
221.8200	INTEREXCH. BASIC CIRCUIT EQUIP., EXCL. WIDEBAND FOR INTERSTATE CO. STATE PL	1. SET TOTAL TO 16,454,913 2. * DIRECT ASSIGNMENT TO STATE PL 3. ALLOC TOTAL TO STATE
221.9000	INTEREXCH. SPECIAL CIRCUIT EQUIP., EXCL. WIDEBAND FOR ANOTHER CO., INTERSTATE PL	1. SET TOTAL TO 9,576,854 2. * DIRECT ASSIGNMENT TO INTERSTATE PL 3. ALLOC TOTAL TO ISTATEPL

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
221.9100	INTEREXCH. SPECIAL CIRCUIT EQIP., EXCL. WIDEBAND FOR ANOTHER CO., STATE PL	1. SET TOTAL TO 6,812,029 2. * DIRECT ASSIGNMENT TO STATE PL 3. ALLOC TOTAL TO STATE
231.0100	CPE BASE TO STATION EQUIPMENT FOR TELETYPEWRITER EXCHANGE SERVICE	1. SET TOTAL TO 7,312,813 2. * ALLOCATE BASED ON ACCORDING TO TWX MOU 3. ALLOC TOTAL TO CATEGORIES BY SPF#
231.0101	OTHER STATION EQUIPMENT FOR TELETYPEWRITER EXCHANGE SERVICE	1. SET TOTAL TO 306,955 2. * ALLOCATE ACCORDING TO RELATIVE TWX MOU 3. ALLOC TOTAL TO CATEGORIES BY SPF#
231.0130	CPE BASE AMOUNTS TO STATION EQUIPMENT INTERSTATE PL SERVICES	1. * ALLOCATE BY DIRECT ASSIGNMENT TO ISTATE PL
231.0131	OTHER STATION EQUIPMENT TO INTERSTATE PRIVATE LINE	1. SET TOTAL TO 5,445,601 2. * DIRECTLY ASSIGNED TO INTERSTATE PL 3. ALLOC TOTAL TO ISTATEPL
231.0160	CPE BASE AMOUNT TO STATION EQUIPMENT FOR STATE PL	1. * DIRECTLY ASSIGNED TO STATE
231.0161	OTHER STATION EQUIPMENT FOR STATE PRIVATE LINE	1. SET TOTAL TO 1,840,738 2. * DIRECTLY ASSIGNED TO STATE 3. ALLOC TOTAL TO STATE
231.0190	CPE BASE AMOUNTS TO STATION EQUIPMENT FOR STATION IDENTIFICATION EQUIP	1. * RELATIVE NUMBER OF MESSAGES AUTOMATICALLY RECORDED
231.0191	OTHER STATION EQUIPMENT FOR STATION IDENTIFICATION EQUIPMENT	1. * ALLOCATE RELATIVE # OF MESSAGES AUTOMATICALLY RECORDED

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
231.0220	CPE BASE AMOUNTS OF OTHER STATION EQUIPMENT	1. SET TOTAL TO 185,035,300 2. * ALLOCATED BY SPF 3. ALLOC TOTAL TO CATEGORIES BY SPF*
231.0221	OTHER - OTHER STATION EQUIPMENT	1. SET TOTAL TO 60,903,880 2. * ALLOCATE BY SPF 3. ALLOC TOTAL TO CATEGORIES BY SPF*
232.0110	INSIDE WIRING PORTION TO STATION EQUIPMENT FOR TELETYPEWRITER EXCHANGE SERVICE	1. SET TOTAL TO 395,512 2. * ALLOCATE BY RELATIVE TWX MINUTES OF USE 3. ALLOC TOTAL TO CATEGORIES BY SPF*
232.0111	OTHER STATION EQUIPMENT FOR TELETYPEWRITER EXCHANGE SERVICE	1. SET TOTAL TO 6,172 2. * ALLOCATE BY RELATIVE TWX MINUTES OF USE 3. ALLOC TOTAL TO CATEGORIES BY SPF*
232.0140	INSIDE WIRING PORTION TO STATION EQUIPMENT FOR INTERSTATE PL SERVICES	1. SET TOTAL TO 2,147,389 2. * DIRECTLY ASSIGNED TO INTERSTATE PL 3. ALLOC TOTAL TO ISTATEPL
232.0141	OTHER STATION EQUIPMENT FOR INTERSTATE PL SERVICES	1. SET TOTAL TO 1,071,839 2. * DIRECTLY ASSIGNED TO INTERSTATE PL 3. ALLOC TOTAL TO ISTATEPL
232.0170	INSIDE WIRING PORTION TO STATION EQUIPMENT FOR STATE PL SERVICES	1. SET TOTAL TO 562,555 2. * DIRECTLY ASSIGNED TO STATE PL 3. ALLOC TOTAL TO STATE
232.0171	OTHER STATION EQUIPMENT TO STATE PRIVATE LINE SERVICES	1. SET TOTAL TO 268,822 2. * DIRECTLY ASSIGNED TO STATE PL 3. ALLOC TOTAL TO STATE
232.0200	INSIDE WIRING PORTION TO STATION EQUIPMENT FOR STATION IDENTIFICATION EQUIP	1. * ALLOCATE BY RELATIVE NUMBER OF MESSAGES AUTOMATICALLY RECORDED?

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
232.0201	OTHER STATION EQUIPMENT FOR STATION IDENTIFICATION EQUIPMENT	1. * ALLOCATE BY RELATIVE # OF MESSAGES AUTOMATICALLY RECORDED
232.0230	INSIDE WIRING PORTION TO STATE EQUIPMENT FOR OTHER STATE EQUIPMENT	1. SET TOTAL TO 156,841,039 2. * ALLOCATED BY SPF 3. ALLOC TOTAL TO CATEGORIES BY SPF#
232.0231	OTHER-OTHER STATION EQUIPMENT	1. SET TOTAL TO 82,660,784 2. * ALLOCATED BY SPF 3. ALLOC TOTAL TO CATEGORIES BY SPF#
234.0130	CPE BASE AMOUNTS TO STATION EQUIPMENT INTERSTATE PL SERVICES	1. * ALLOCATE BY DIRECT ASSIGNMENT TO ISTATE PL
234.0131	OTHER STATION EQUIPMENT TO INTERSTATE PRIVATE LINE	1. SET TOTAL TO 1,747,720 2. * DIRECTLY ASSIGNED TO INTERSTATE PL 3. ALLOC TOTAL TO ISTATEPL
234.0160	CPE BASE AMOUNT TO STATION EQUIPMENT FOR STATE PL	1. * DIRECTLY ASSIGNED TO STATE
234.0161	OTHER STATION EQUIPMENT FOR STATE PRIVATE LINE	1. SET TOTAL TO 720,168 2. * DIRECTLY ASSIGNED TO STATE 3. ALLOC TOTAL TO STATE
234.0190	CPE BASE AMOUNTS TO STATION EQUIPMENT FOR STATION IDENTIFICATION EQUIP	1. SET TOTAL TO 52,365 2. * RELATIVE NUMBER OF MESSAGES AUTOMATICALLY RECORDED 3. SAME AS ACCOUNT 3699.7
234.0191	OTHER STATION EQUIPMENT FOR STATION IDENTIFICATION EQUIPMENT	1. SET TOTAL TO 1,808 2. * ALLOCATE RELATIVE # OF MESSAGES AUTOMATICALLY RECORDED 3. SAME AS ACCOUNT 3699.7

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
234.0220	CPE BASE AMOUNTS OF OTHER STATION EQUIPMENT	1. SET TOTAL TO 75,275,800 2. * ALLOCATED BY SPF 3. ALLOC TOTAL TO CATEGORIES BY SPF*
234.0221	OTHER - OTHER STATION EQUIPMENT	1. SET TOTAL TO 8,441,125 2. * ALLOCATE BY SPF 3. ALLOC TOTAL TO CATEGORIES BY SPF*
240.0100	WIDEBAND EXCH TRUNK & LOOP OUTSIDE PLANT FOR INTERSTATE PL	1. SET TOTAL TO 1,819,331 2. * DIRECT ASSIGNMENT TO INTERSTATE PRIVATE LINE 3. ALLOC TOTAL TO ISTATEPL
240.0200	WIDEBAND EXCH TRUNK & LOOP OUTSIDE PLANT FOR INTRASTATE PL	1. SET TOTAL TO 118,656 2. * DIRECT ASSIGNMENT TO STATE PL 3. ALLOC TOTAL TO STATE
240.0300	WIDEBAND EXCH TRUNK & LOOP OUTSIDE PLANT FOR WIDEBAND MESSAGE SERVICE	1. SET TOTAL TO 180,317*USE.ISE NTK.ISE 2. ALLOC TOTAL TO ISTATE
240.0400	EXCHANGE TRUNK OUTSIDE PLANT, EXCL WIDEBAND USED FOR EXCHANGE MS	1. SET TOTAL TO 38,063,890 2. * DIRECT ASSIGNMENT TO EXCHANGE 3. ALLOC TOTAL TO STATE
240.0500	EXCHANGE TRUNK OUTSIDE PLANT, EXCL WIDEBAND USED FOR TOLL MS/JOINT	1. SET TOTAL TO 11,370,155*USE.ISE NTK.ISE 2. * RELATIVE MIN OF USE OF PLANT 3. SAME AS ACCOUNT 3244.2
240.0700	EXCHANGE TRUNK OUTSIDE PLANT, EXCL WIDEBAND USED FOR INTERSTATE PL	1. SET TOTAL TO 6,480,171 2. * DIRECT ASSIGNMENT TO INTERSTATE PRIVATE LINE 3. ALLOC TOTAL TO ISTATEPL
240.0800	EXCHANGE TRUNK OUTSIDE PLANT EXCL WIDE USED FOR INTRASTATE PL	1. SET TOTAL TO 11,502,598 2. * DIRECT ASSIGNMENT TO INTRASTATE PL 3. ALLOC TOTAL TO STATE

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
240.0900	SUBSCRIBER LINE OUTSIDE PLANT, EXCL WIDEBAND	1. SET TOTAL TO 686,166,915 2. SAME AS ACCOUNT 5000
240.1000	INTEREXCH OUTSIDE PLANT FOR INTERSTATE CO.	1. SET TOTAL TO 552,751*USE.I NTK.I 2. * DIRECT ASSIGNMENT TO INTERSTATE TOLL 3. ALLOC TOTAL TO ISTATE
240.1100	WIDEBAND INTEREXCH OSP, EXCL INTEREXCH OSP FOR ISTATE CO. FOR INTERSTATE PL	1. SET TOTAL TO 424,843 2. * DIRECT ASSIGNMENT TO PRIVATE LINE 3. ALLOC TOTAL TO ISTATEPL
240.1200	WIDEBAND INTEREXCH OSP, EXCL INTEREXCH OSP FOR ISTATE CO. FOR STATE PL	1. SET TOTAL TO 192,661 2. * DIRECT ASSIGNMENT TO STATE PRIVATE LINE 3. ALLOC TOTAL TO STATE
240.1300	WIDEBAND INTEREXCHANGE OSP, EXCL. OSP FURNISHED TO ANOTHER CO, USED FOR ISTATE	1. SET TOTAL TO 4,315*USE.ISE NTK.ISE 2. ALLOC TOTAL TO ISTATE
240.1400	INTEREXCH OSP, EXCL WIDEBAND & INTEREXCH OSP FOR ISTATE CO. FOR INTERSTATE MS	1. SET TOTAL TO 16,542,318*USE.I NTK.I 2. * DIRECT ASSIGNMENT TO INTERSTATE TOLL 3. ALLOC TOTAL TO ISTATE
240.1500	INTEREXCH OSP, EXCL WIDEBAND AND INTEREXCH OSP FOR ISTATE CO. FOR STATE MS	1. SET TOTAL TO 3,181,296*USE.S NTK.S 2. * DIRECT ASSIGNMENT TO STATE TOLL 3. ALLOC TOTAL TO STATE
240.1600	INTEREXCH OSP, EXCL WIDEBAND & INTEREXCH OSP FOR ISTATE CO. FOR JOINT MS	1. SET TOTAL TO 35,738,512*USE.IS NTK.IS 2. * RELATIVE NO OF CONVERSATION-MIN-MILE 3. SAME AS ACCOUNT 3299.3
240.2000	INTEREXCH OSP, EXCL WIDEBAND FOR INTERSTATE PL	1. SET TOTAL TO 10,009,447 2. * DIRECT ASSIGNMENT TO INTERSTATE PRIVATE LINE 3. ALLOC TOTAL TO ISTATEPL

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
240.2100	INTEREXCH OSP, EXCL WIDEBAND FOR STATE PL	1. SET TOTAL TO 5,989,821 2. * DIRECT ASSIGNMENT TO STATE PRIVATE LINE 3. ALLOC TOTAL TO STATE
240.2400	IEOSP MISSLE COMPLEX SPECIAL CONTRACT	1. SET TOTAL TO 211,279 2. ALLOC TOTAL TO ISTATE
240.2500	ENFIA KTC-7 ETOSP USED FOR OCC	1. SET TOTAL TO 4,154,007 2. ALLOC TOTAL TO ISTATE
261.1000	FURNITURE AND OFFICE EQUIPMENT - DATA PROCESSING EQUIPMENT	1. SET TOTAL TO 44,399,996 2. SET ISTATE TO 13,562,444 3. ALLOC TOTAL TO STATE
261.2000	FURNITURE AND OFFICE EQUIPMENT - OTHER THAN DATA PROCESSING EQUIPMENT	1. SET TOTAL TO 33,593,753 2. ALLOC TOTAL TO STATE BY 0.7039069437*STATE.600 3. ALLOC TOTAL TO ISTATE
264.0000	VEHICLES AND OTHER WORK EQUIPMENT	1. SET TOTAL TO 43,767,371 2. SAME AS ACCOUNT 212.07
276.0000	TELEPHONE PLANT ACQUIRED	1. * APPORTIONED AS PLT211.264*
304.1000	INVESTMENT CREDITS; NET, STATION CONNECTIONS	1. SET TOTAL TO -499,033 2. ALLOC TOTAL TO CATEGORIES BY PLT232*
304.2000	INVESTMENTS CREDITS; NET, ALL OTHER PLANT ACCOUNTS	1. SET TOTAL TO 10,257,806 2. SAME AS ACCOUNT 201-231.99,233-277.99

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
306.0000	FEDERAL INCOME TAXES - OPERATING	1. SET TOTAL TO FED.TAX:TOTAL 2. * ALLOCATE AS FEDERAL TAXABLE INCOME 3. SET STATE TO FED.TAX:STATE 4. SET ISTATE TO FED.TAX:ISTATE 5. SET ISTATEPL TO FED.TAX:ISTATEPL
307.0010	STATE AND LOCAL INCOME TAXES	1. SET TOTAL TO STATE.TAX:TOTAL 2. * ALLOCATE AS STATE TAXABLE INCOME 3. SET STATE TO STATE.TAX:STATE 4. SET ISTATE TO STATE.TAX:ISTATE 5. SET ISTATEPL TO STATE.TAX:ISTATEPL
307.0020	PROPERTY TAXES	1. SET TOTAL TO 40,850,959 2. SAME AS ACCOUNT 100.1
307.0030	GROSS RECIEPTS TAXES	1. SET TOTAL TO 40,746,054 2. * DIRECTLY REQUESTED 3. ALLOC TOTAL TO STATE
307.0040	CAPITAL STOCK TAXES	1. SET TOTAL TO 1,323,986 2. SAME AS ACCOUNT 100.1
307.0050	SOCIAL SECURITY TAXES	1. SET TOTAL TO 23,295,809 2. * DIRECTLY REQUESTED 3. ALLOC TOTAL TO STATE BY 0.715524668*STATE.600 4. ALLOC TOTAL TO ISTATE
307.0060	OTHER TAXES	1. SET TOTAL TO 9,319 2. SAME AS ACCOUNT 100.1
307.0070	TAXES ON FIXED CHARGES ON NON-OPERATING INVESTMENTS	
308.2120	FIT DEFERRED TAX DEPREC. - BUILDINGS	1. SET TOTAL TO 2,794,428 2. ALLOC TOTAL TO CATEGORIES BY PLT212*

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
308.2210	FIT DEFERRED DEPREC. - CENTRAL OFFICE EQUIPMENT	1. SET TOTAL TO 33,661,880 2. ALLOC TOTAL TO CATEGORIES BY PLT221*
308.2310	FIT DEFERRED DEPREC. - STATION APPARATUS	1. SET TOTAL TO 9,155,728 2. ALLOC TOTAL TO CATEGORIES BY PLT231*
308.2320	FIT DEFERRED DEPREC. - STATION CONNECTIONS	1. SET TOTAL TO 8,383,285 2. ALLOC TOTAL TO CATEGORIES BY PLT232*
308.2340	FIT DEFERRED DEPREC. - LARGE PBX	1. SET TOTAL TO 3,332,110 2. ALLOC TOTAL TO CATEGORIES BY PLT234*
308.2410	FIT DEFERRED DEPREC. - POLE LINES	1. SET TOTAL TO 651,276 2. ALLOC TOTAL TO CATEGORIES BY PLT241*
308.2421	FIT DEFERRED DEPREC. - AERIAL CABLE	1. SET TOTAL TO 1,703,420 2. ALLOC TOTAL TO CATEGORIES BY PLT242.1*
308.2422	FIT DEFERRED DEPREC. - UNDERGROUND CABLE	1. SET TOTAL TO 2,271,893 2. ALLOC TOTAL TO CATEGORIES BY PLT242.2*
308.2423	FIT DEFERRED DEPREC. - BURIED CABLE	1. SET TOTAL TO 6,331,008 2. ALLOC TOTAL TO CATEGORIES BY PLT242.3*
308.2424	FIT DEFERRED DEPREC. - SUBMARINE CABLE	1. SET TOTAL TO 0 2. ALLOC TOTAL TO CATEGORIES BY PLT242.4*

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
308.2430	FIT DEFERRED DEPREC. - AERIAL WIRE	1. SET TOTAL TO 60,584 2. ALLOC TOTAL TO CATEGORIES BY PLT243*
308.2440	FIT DEFERRED DEPREC. - UNDERGROUND CONDUIT	1. SET TOTAL TO 1,711,493 2. ALLOC TOTAL TO CATEGORIES BY PLT244*
308.2610	FIT DEFERRED DEPREC. - FURNITURE AND OFFICE EQUIPMENT	1. SET TOTAL TO 3,263,953 2. ALLOC TOTAL TO CATEGORIES BY PLT261*
308.2640	FIT DEFERRED DEPREC. - VEHICLES AND OTHER WORK EQUIPMENT	1. SET TOTAL TO 2,408,206 2. ALLOC TOTAL TO CATEGORIES BY PLT264*
309.2120	INCOME CREDITS FROM PRIOR DEFERRALS OF FIT - BUILDINGS	1. SET TOTAL TO -22,895 2. ALLOC TOTAL TO CATEGORIES BY PLT212*
309.2210	INCOME CREDITS FROM PRIOR DEFERRALS OF FIT - CENTRAL OFFICE EQUIPMENT	1. SET TOTAL TO -865,847 2. ALLOC TOTAL TO CATEGORIES BY PLT221*
309.2310	INCOME CREDITS FROM PRIOR DEFERRALS OF FIT - STATION APPARATUS	1. SET TOTAL TO -7,445,038 2. ALLOC TOTAL TO CATEGORIES BY PLT231*
309.2320	INCOME CREDITS FROM PRIOR DEFERRALS OF FIT - STATION CONNECTIONS	1. SET TOTAL TO -2,468,497 2. ALLOC TOTAL TO CATEGORIES BY PLT232*
309.2340	INCOME CREDITS FROM PRIOR DEFERRALS OF FIT - LARGE PBX	1. SET TOTAL TO -7,174,461 2. ALLOC TOTAL TO CATEGORIES BY PLT234*

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ACCOUNT NO.	DESCRIPTION	PROCEDURES
309.2410	INCOME CREDIT FROM PRIOR DEFERRALS OF FIT - POLE LINES	1. SET TOTAL TO -6,244 2. ALLOC TOTAL TO CATEGORIES BY PLT241*
309.2430	INCOME CREDIT FROM PRIOR DEFERALS OF FIT - AERIAL WIRE	1. SET TOTAL TO 172,753 2. ALLOC TOTAL TO CATEGORIES BY PLT243*
309.2610	INCOME CREDIT FROM PRIOR DEFERALS OF FIT - FURNITURE 8 OFFICE EQUIPMENT	1. SET TOTAL TO -813,813 2. ALLOC TOTAL TO CATEGORIES BY PLT261*
309.2640	INCOME CREDIT FROM PRIOR DEFERALS OF FIT - VEHICLES 8 OTHER WORK EQUIPMENT	1. SET TOTAL TO -2,189,595 2. ALLOC TOTAL TO CATEGORIES BY PLT264*
313.0000	INTEREST INCOME	1. SET TOTAL TO 2,500,418 2. SAME AS ACCOUNT 100.2-100.29
316.0000	MISCELLANEOUS INCOME	1. SET TOTAL TO 408,452 2. ALLOC TOTAL TO STATE
323.0000	MISCELLANEOUS INCOME CHARGES	
323.1000	CONTRIBUTIONS TO CHARITABLE, SOCIAL OR COMMUNITY WELFARE PURPOSES	1. SET TOTAL TO 1,319,977 2. SAME AS ACCOUNT 661-677
323.2000	OTHER THAN PAID OUT AS CONTRIBUTIONS	1. SET TOTAL TO 293,626 2. * DIRECTLY ASSIGNED 3. SET ISTATE TO 5,616 4. ALLOC TOTAL TO STATE

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ACCOUNT NO.	DESCRIPTION	PROCEDURES
360.0000	EXTRAORDINARY INCOME CREDITS	1. SET TOTAL TO -29,719 2. * DIRECTLY ASSIGNED 3. ALLOC TOTAL TO STATE
370.0000	EXTRAORDINARY INCOME CHARGES	1. SET TOTAL TO 20,274 2. * DIRECTLY ASSIGNED 3. ALLOC TOTAL TO STATE
380.0000	INCOME TAX EFFECT OF EXTRAORDINARY AND DELAYED ITEMS-NET	1. SET TOTAL TO -7,297 2. ALLOC TOTAL TO STATE
500.0000	SUBSCRIBERS' STATION REVENUES	1. SET TOTAL TO 576,786,793 2. ALLOC TOTAL TO STATE
501.0000	PUBLIC TELEPHONE REVENUES	1. SET TOTAL TO 13,260,465 2. ALLOC TOTAL TO STATE
503.0000	SERVICE STATIONS	1. SET TOTAL TO 23,909 2. ALLOC TOTAL TO STATE
504.0000	LOCAL PRIVATE LINE SERVICES	1. SET TOTAL TO 17,853,187 2. SET ISTATEPL TO 558,997 3. ALLOC TOTAL TO STATE
506.0000	OTHER LOCAL SERVICE REVENUES	1. SET TOTAL TO 4,167,471 2. ALLOC TOTAL TO STATE
510.0000	MESSAGE TOLLS	1. SET TOTAL TO 377,589,996 2. SET STATE TO 150,926,462 3. SET ISTATE TO 226,663,534

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
511.0000	WIDE AREA TOLL SERVICES	1. SET TOTAL TO 98,760,706 2. SET STATE TO 24,075,903 3. SET ISTATE TO 74,684,803
512.0000	TOLL PRIVATE LINE SERVICES	1. SET TOTAL TO 63,564,775 2. SET ISTATEPL TO 50,670,309 3. ALLOC TOTAL TO STATE
516.0000	OTHER TOLL SERVICE REVENUES	1. SET TOTAL TO 10,266,337 2. SET STATE TO 321,681 3. SET ISTATE TO 9,944,656
521.0000	TELEGRAPH COMMISSIONS	1. SET TOTAL TO 9,648 2. ALLOC TOTAL TO STATE
523.0000	DIRECTORY ADVERTISING AND SALES	1. SET TOTAL TO 77,816,692 2. ALLOC TOTAL TO STATE
524.0000	RENT REVENUES	1. SET TOTAL TO 2,125,030 2. * DIRECTLY REQUESTED 3. SET ISTATE TO 955,228 4. SET STATE TO 1,113,547 5. SET ISTATEPL TO 56,255
525.0000	REVENUES FROM GENERAL SERVICES AND LICENSES	1. * DIRECTLY REQUESTED
526.0000	OTHER OPERATING REVENUES	1. SET TOTAL TO 1,361,802 2. * DIRECTLY REQUESTED 3. SET ISTATE TO 175,190 4. SET STATE TO 1,186,612
530.0000	UNCOLLECTIBLE OPERATING REVENUES-DR	1. SET TOTAL TO 14,848,322 2. SET ISTATE TO 6,723,322 3. SET STATE TO 8,125,000

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ACCOUNT NO.	DESCRIPTION	PROCEDURES
551.0000	TELEPHONE AND MISC. SERVICE REVENUE THAT ARE GROSS CHARGES FOR MESSAGES	
602.1000	REPAIRS OF POLE LINES	1. SET TOTAL TO 1,673,287*DIFF.240 2. ALLOC TOTAL TO CATEGORIES BY PLT241#
602.2000	REPAIRS OF AERIAL CABLE	1. SET TOTAL TO 19,218,073*DIFF.240 2. ALLOC TOTAL TO CATEGORIES BY PLT242.1#
602.3000	REPAIRS OF UNDERGROUND CABLE	1. SET TOTAL TO 7,765,850*DIFF.240 2. ALLOC TOTAL TO CATEGORIES BY PLT242.2#
602.4000	REPAIRS OF BURIED CABLE	1. SET TOTAL TO 24,467,447*DIFF.240 2. ALLOC TOTAL TO CATEGORIES BY PLT242.3#
602.5000	REPAIRS OF SUBMARINE CABLE	1. SET TOTAL TO 3,178*DIFF.240 2. ALLOC TOTAL TO CATEGORIES BY PLT242.4#
602.6000	REPAIRS OF AERIAL WIRE	1. SET TOTAL TO 458,004*DIFF.240 2. ALLOC TOTAL TO CATEGORIES BY PLT243#
602.7000	REPAIRS OF UNDERGROUND CABLE	1. SET TOTAL TO 2,357,346 2. ALLOC TOTAL TO CATEGORIES BY PLT244#
602.8000	SHOP REPAIRS AND SALVAGE ADJUSTMENTS	1. SET TOTAL TO -17,613*DIFF.240 2. ALLOC TOTAL TO CATEGORIES BY PLT242.1#

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ACCOUNT NO.	DESCRIPTION	PROCEDURES
603.0000	TRUNK TESTING	1. SET TOTAL TO 12,151,258 2. ALLOC TOTAL TO CATEGORIES BY PLT240#
603.1000	SUBSCRIBER LINE AND SERVICES ORDER TESTING	1. SET TOTAL TO 27,053,613 2. ALLOC TOTAL TO CATEGORIES BY SUBLINE#
604.0000	REPAIRS OF CENTRAL OFFICE EQUIPMENT	1. SET TOTAL TO 70,022,407 2. ALLOC TOTAL TO CATEGORIES BY PLT221#
605.0000	REPAIRS OF STATION EQUIPMENT	1. SET TOTAL TO 98,449,992 2. SET STATE TO 71,898,287 3. SET ISTATE TO 25,036,558 4. SET ISTATEPL TO 1,515,147
606.0000	REPAIRS OF BUILDINGS AND GROUNDS	1. SET TOTAL TO 10,903,758 2. ALLOC TOTAL TO CATEGORIES BY PLT212#
608.2120	DEPRECIATION - BUILDINGS	1. SET TOTAL TO 5,817,078 2. ALLOC TOTAL TO CATEGORIES BY PLT212#
608.2210	DEPRECIATION - CENTRAL OFFICE EQUIPMENT	1. SET TOTAL TO 49,216,120 2. ALLOC TOTAL TO CATEGORIES BY PLT221#
608.2310	DEPRECIATION - STATION APPARATUS	1. SET TOTAL TO 33,320,903 2. ALLOC TOTAL TO CATEGORIES BY PLT231#
608.2320	DEPRECIATION - STATION CONNECTIONS	1. SET TOTAL TO 21,831,280 2. ALLOC TOTAL TO CATEGORIES BY PLT232#

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
608.2340	DEPRECIATION - LARGE PBX	1. SET TOTAL TO 21,047,604 2. ALLOC TOTAL TO CATEGORIES BY PLT234#
608.2410	DEPRECIATION - POLE LINES	1. SET TOTAL TO 2,422,305 2. ALLOC TOTAL TO CATEGORIES BY PLT241#
608.2421	DEPRECIATION - AERIAL CABLE	1. SET TOTAL TO 5,389,308 2. ALLOC TOTAL TO CATEGORIES BY PLT242.1#
608.2422	DEPRECIATION - UNDERGROUND CABLE	1. SET TOTAL TO 3,342,168 2. ALLOC TOTAL TO CATEGORIES BY PLT242.2#
608.2423	DEPRECIATION - BURIED CABLE	1. SET TOTAL TO 11,873,075 2. ALLOC TOTAL TO CATEGORIES BY PLT242.3#
608.2424	DEPRECIATION - SUBMARINE CABLE	1. SET TOTAL TO 10,787 2. ALLOC TOTAL TO CATEGORIES BY PLT242.4#
608.2430	DEPRECIATION - AERIAL CABLE	1. SET TOTAL TO 569,097 2. ALLOC TOTAL TO CATEGORIES BY PLT243#
608.2440	DEPRECIATION - UNDERGROUND CONDUIT	1. SET TOTAL TO 1,664,815 2. ALLOC TOTAL TO CATEGORIES BY PLT244#
608.2610	DEPRECIATION - FURNITURE AND OFFICE EQUIPMENT	1. SET TOTAL TO 6,592,230 2. * DOES NOT INCLUDE AMOUNTS IN ACCOUNTS 702 AND 704 3. ALLOC TOTAL TO CATEGORIES BY PLT261#

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
608.2640	DEPRECIATION - VEHICLES AND OTHER WORK EQUIPMENT	1. SET TOTAL TO 239,516 2. * DOES NOT INCLUDE AMOUNTS IN ACCOUNTS 702 AND 704 3. ALLOC TOTAL TO CATEGORIES BY PLT264*
609.0000	EXTRAORDINARY RETIREMENTS	1. * DIRECTLY REQUESTED
610.0000	MAINTAINING TRANSMISSION POWER	1. SET TOTAL TO 5,316,249*DIFF.221 2. ALLOC TOTAL TO CATEGORIES BY PLT221*
611.0000	EMPLOYMENT STABILIZATION	1. * SAME AS ACCOUNT 602.1-610
612.0000	OTHER MAINTENANCE EXPENSES	1. SET TOTAL TO 3,995,727 2. SAME AS ACCOUNT 602.1-610
613.1000	AMORTIZATION OF INTANGIBLE PROPERTY - LEASEHOLDS	1. * SAME AS 211
613.2000	AMORTIZATION OF INTANGIBLE PROPERTY - OTHER THAN LEASEHOLDS	1. * SAME AS ACCOUNT 201,202,203
614.0000	AMORTIZATION OF TELEPHONE PLANT ACQUISITION ADJUSTMENT	1. * SAME AS ACCOUNT 100.4
621.1000	GENERAL TRAFFIC SUPERVISION - OTHER	1. SET TOTAL TO 10,377,028 2. SAME AS 626

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
622.0000	SERVICE INSPECTION AND CUSTOMER INSTRUCTION	1. SET TOTAL TO 2,494,955 2. ALLOC TOTAL TO STATE BY FS.622 3. ALLOC TOTAL TO ISTATE
624.0000	OPERATOR' WAGES	1. SET TOTAL TO 45,760,833 2. ALLOC TOTAL TO STATE BY FS.624 3. ALLOC TOTAL TO ISTATE
626.0000	REST AND LUNCH ROOMS	1. SET TOTAL TO 16,101 2. ALLOC TOTAL TO STATE BY FS.626 3. ALLOC TOTAL TO ISTATE
627.0000	OPERATOR' EMPLOYMENT AND TRAINING	1. SET TOTAL TO 842,936 2. ALLOC TOTAL TO STATE BY FS.627 3. ALLOC TOTAL TO ISTATE
629.0000	CENTRAL OFFICE STATIONARY AND PRINTING	1. SET TOTAL TO 318,616 2. ALLOC TOTAL TO STATE BY FS.629 3. ALLOC TOTAL TO ISTATE
630.0000	CENTRAL OFFICE HOUSE SERVICES	1. SET TOTAL TO 483,215 2. ALLOC TOTAL TO STATE BY FS.630 3. ALLOC TOTAL TO ISTATE
631.0000	MISCELLANEOUS CENTRAL OFFICE EXPENSES	1. SET TOTAL TO 3,457,804 2. ALLOC TOTAL TO STATE BY FS.631 3. ALLOC TOTAL TO ISTATE
632.0000	PUBLIC TELEPHONE EXPENSE	1. SET TOTAL TO 37,484 2. SAME AS ACCOUNT 3299.2
633.1000	OTHER TRAFFIC EXPENSES	1. SET TOTAL TO 13,776 2. ALLOC TOTAL TO STATE BY FS.6331 3. ALLOC TOTAL TO ISTATE

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ACCOUNT NO.	DESCRIPTION	PROCEDURES
633.2000	OTHER TRAFFIC EXPENSES - OTHER	1. * SAME AS ACCOUNT 3699.4-3699.6
634.0000	JOINT TRAFFIC EXPENSES-DR	1. SET TOTAL TO 19,995 2. * APPORTION RELATIVE # OF TRAFFIC UNITS 3. SAME AS 626
635.0000	JOINT TRAFFIC EXPENSES - CR	1. SET TOTAL TO -582,127 2. SAME AS 626
640.0000	GENERAL COMMERCIAL ADMINSTRATION	1. SET TOTAL TO 23,403,516 2. SAME AS ACCOUNT 643-643.99,644-644.99,645-645.99
642.0000	ADVERTISING	1. SET TOTAL TO 7,402,637 2. SET ISTATE TO 2,592,007 3. ALLOC TOTAL TO STATE
643.0000	SALES EXPENSE	1. SET TOTAL TO 33,131,970 2. SET ISTATE TO 11,593,708 3. ALLOC TOTAL TO STATE
644.0000	CONNECTING COMPANY RELATIONS	1. SET TOTAL TO 893,893 2. ALLOC TOTAL TO STATE BY FS.644 3. ALLOC TOTAL TO ISTATE
645.0000	LOCAL COMMERCIAL OPERATIONS	1. SET TOTAL TO 47,887,819 2. SET ISTATE TO 12,516,342 3. SET STATE TO 35,329,545 4. SET ISTATEPL TO 41,932
648.0000	PUBLIC TELEPHONE COMMISSIONS	1. SET TOTAL TO 3,459,754 2. SET ISTATE TO 1,706,992 3. ALLOC TO STATE

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
649.0000	DIRECTORY EXPENSE	1. SET TOTAL TO 27,251,916 2. SET ISTATE TO 629,768 3. ALLOC TO STATE
650.0000	OTHER COMMERCIAL EXPENSES	1. SET TOTAL TO 2,732 2. SAME AS 640-649.99
661.0000	EXECUTIVE DEPARTMENT	1. SET TOTAL TO 1,025,262 2. ALLOC TOTAL TO STATE BY 0.7033733817*STATE.600 3. ALLOC TO ISTATE
662.0000	ACCOUNTING DEPARTMENT - REVENUE ACCOUNTING EXPENSES	1. SET TOTAL TO 15,651,025 2. * DIRECTLY REQUESTED 3. ALLOC TOTAL TO STATE BY 0.6818058242*STATE.600 4. ALLOC TOTAL TO ISTATE
662.1000	ACCOUNTING DEPARTMENT - EXCLUDING REVENUE ACCOUNTING EXPENSES	1. SET TOTAL TO 14,403,854 2. ALLOC TOTAL TO STATE BY FS.6621 3. ALLOC TOTAL TO ISTATE
663.0000	TREASURY DEPARTMENT	1. SET TOTAL TO 1,064,233 2. ALLOC TOTAL TO STATE BY 0.7036616982*STATE.600 3. ALLOC TOTAL TO ISTATE
664.0000	LAW DEPARTMENT	1. SET TOTAL TO 1,889,983 2. ALLOC TOTAL TO STATE BY 0.7036618848*STATE.600 3. ALLOC TOTAL TO ISTATE
665.1000	OTHER GENERAL OFFICE SALARIES AND EXPENSES EXCLUDING ENGINEERING	1. SET TOTAL TO 15,840,670 2. ALLOC TOTAL TO STATE BY 0.7036620295*STATE.600 3. ALLOC TOTAL TO ISTATE
665.2000	OTHER GEN. OFFICE EXPENSE - ENGINEERING	1. SET TOTAL TO 16,933,121 2. ALLOC TOTAL TO CATEGORIES BY PLT211.264*

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
668.0000	INSURANCE	1. SET TOTAL TO 83,508 2. SAME AS ACCOUNT 665.2
669.0000	ACCIDENTS AND DAMAGES	1. SET TOTAL TO 372,564 2. SAME AS ACCOUNT 665.2
671.0000	OPERATING RENTS	1. SET TOTAL TO 8,338,772 2. SET ISTATE TO 2,210,913 3. ALLOC TOTAL TO STATE
672.0000	RELIEF AND PENSIONS	1. SET TOTAL TO 91,867,317 2. ALLOC TOTAL TO STATE BY 0.7050382782*STATE.600 3. ALLOC TOTAL TO ISTATE
673.0000	TELEPHONE FRANCHISE REQUIREMENTS	1. SET TOTAL TO 675,126 2. ALLOC TOTAL TO CATEGORIES BY PLANT*
674.0000	GENERAL SERVICES AND LICENSES	1. SET TOTAL TO 18,944,906 2. SET ISTATE TO 6,787,104 3. ALLOC TOTAL TO STATE
675.0000	OTHER EXPENSES	1. SET TOTAL TO 5,836,592 2. SAME AS ACCOUNT 665.2
676.0000	TELEPHONE FRANCHISE REQUIREMENT-CR	1. SET TOTAL TO -671,723 2. SET ISTATE TO -195,342 3. ALLOC TOTAL TO STATE
677.0000	EXPENSES CHARGED CONSTRUCTION - CREDIT	1. SET TOTAL TO -3,172,999 2. SET ISTATE TO -940,246 3. ALLOC TOTAL TO STATE

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
2001.0000	NUMBER OF WORKING TWX SUBSCRIBER LOOPS EXCLUDING WIDEBAND	
2002.0000	WORKING LOOPS EXCLUDING WIDEBAND FOR INTERSTATE PL	1. SET TOTAL TO 49,677 2. ALLOC TOTAL TO ISTATEPL
2003.0000	WORKING LOOPS EXCLUDING WIDEBAND FOR INTRASTATE PL	1. SET TOTAL TO 83,432 2. ALLOC TOTAL TO STATE
2004.0000	NO. OF SUBSCRIBER LINES AND WATS ACCESS LINES	1. SET TOTAL TO 1,706,696
2005.0000	NUMBER OF WORKING MESSAGE TELEPHONE SUBSCRIBER LINES USED FOR WIDEBAND	
2006.0000	AVERAGE COST OF WORKING LOOPS	1. SET TOTAL TO 372.944717
2602.1000	MESSAGE TELEPHONE SERVICE	1. SET TOTAL TO 1,707,026 2. ALLOC TOTAL TO STATE
2602.2000	TWX SERVICE	
2602.3000	INTERSTATE PRIVATE LINE SERVICES	1. SET TOTAL TO 23,402 2. ALLOC TOTAL TO ISTATEPL

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
2602.4000	INTRASTATE PRIVATE LINE SERVICES	1. SET TOTAL TO 83,341 2. ALLOC TOTAL TO STATE
2602.5000	WIDEBAND SERVICE	
2602.6000	WIDEBAND - WORKING LOOPS IN USE, EXCHANGE	
2602.7000	WIDEBAND - WORKING LOOPS IN USE, STATE	
2602.8000	WIDEBAND - WORKING LOOPS IN USE, INTERSTATE TOLL	
2699.0100	EXCHANGE PLANT USED FOR EXCHANGE MESSAGE SERVICE	1. SET TOTAL TO 586,903.9 2. ALLOC TOTAL TO STATE
2699.0200	EXCHANGE TRUNK PLANT, TOLL OR JOINT EXCHANGE/TOLL	1. SET TOTAL TO 530,181.6 2. ALLOC TOTAL TO STATE
2699.0300	EXCHANGE TRUNK PLANT FOR TWX	
2699.0400	EXCHANGE TRUNK PLANT, INTERSTATE PL	1. SET TOTAL TO 143,320.5 2. ALLOC TOTAL TO ISTATEPL

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
2699.0500	EXCHANGE TRUNK PLANT, INTRASTATE PL	1. SET TOTAL TO 172,638.9 2. ALLOC TOTAL TO STATE
2699.0600	INTEREXCHANGE PLANT, INTERSTATE MESSAGE TRAFFIC	1. SET TOTAL TO 1,156,154 2. ALLOC TOTAL TO ISTATE
2699.0700	INTEREXCHANGE PLANT, INTRASTATE MESSAGE TRAFFIC	1. SET TOTAL TO 217,578.9 2. ALLOC TOTAL TO STATE
2699.0800	INTEREXCHANGE PLANT, JOINTLY FOR STATE & INTERSTATE	1. SET TOTAL TO 2,566,741.1 2. ALLOC TOTAL TO STATE
2699.0900	INTEREXCHANGE TRUNK PLANT USED EXCLUSIVELY FOR TWX SERVICES	
2699.1000	INTEREXCHANGE PLANT, INTERSTATE PL	1. SET TOTAL TO 742,701.7 2. ALLOC TOTAL TO ISTATEPL
2699.1100	INTEREXCHANGE PLANT, INTRASTATE PL	1. SET TOTAL TO 437,863.2 2. ALLOC TOTAL TO STATE
3221.0000	RELATIVE DIAL MINUTES (UPDATE BY IS)	1. SET TOTAL TO 35,174,728,000 2. ALLOC TOTAL TO STATE BY FS.3221 3. ALLOC TOTAL TO ISTATE
3222.0000	RELATIVE DIAL MINUTES (UPDATE BY ISE)	1. SET TOTAL TO 35,174,728,000 2. ALLOC TOTAL TO STATE BY FS.3222 3. ALLOC TOTAL TO ISTATE

A C C O U N T   D A T A

ACCOUNT NO.	DESCRIPTION	PROCEDURES
3244.1000	TRUNK AND LOOP PLANT FOR WIDEBAND	
3244.2000	MINUTES OF USE, TRUNK OSP, EXCL WIDEBAND (UPDATE BY IS)	1. SET TOTAL TO 4,430,405,421 2. ALLOC TOTAL TO STATE BY FS.3244.2 3. ALLOC TOTAL TO ISTATE
3244.3000	MINUTES OF USE, TRUNK OSP, EXCL WIDEBAND (UPDATE BY ISE)	1. SET TOTAL TO 4,430,405,421 2. ALLOC TOTAL TO STATE BY FS.3244.3 3. ALLOC TOTAL TO ISTATE
3244.4000	SUBSCRIBER LINE OUTSIDE PLANT, EXCLUDING WIDEBAND USED FOR TWX SERVICE	
3299.1000	SUBSCRIBER PLANT FACTOR	1. SET TOTAL TO 1 2. SET ISTATE TO .270923 3. ALLOC TOTAL TO STATE
3299.2000	SUBSCRIBER LINE USE	1. SET TOTAL TO EXCH.USE+STATE.USE+ISTATE.USE 2. SET STATE TO EXCH.USE+STATE.USE 3. SET ISTATE TO 1*ISTATE.USE
3299.3000	NUMBER OF CONVERSATION-MINUTE-MILES (UPDATE BY IS)	1. SET TOTAL TO 286,787,573,542 2. ALLOC TOTAL TO STATE BY FS.3299.3 3. ALLOC TOTAL TO ISTATE
3299.4000	NUMBER OF CONVERSATION-MINUTE-MILES (UPDATE BY ISE)	1. SET TOTAL TO 286,787,573,542 2. ALLOC TOTAL TO STATE BY FS.3299.4 3. ALLOC TOTAL TO ISTATE
3299.6000	RELATIVE NUMBER OF TWX MIN-OF-USE	

ACCOUNT DATA

ACCOUNT NO.	DESCRIPTION	PROCEDURES
3699.1000	RELATIVE NO OF CONVERSATION-MIN-MILE FOR INTEREXCHANGE TRUNK PLANT FOR JOINT USE	1. SET TOTAL TO 286,776,690,798 2. ALLOC TOTAL TO STATE
3699.2000	RELATIVE NO OF CONNECTION-MIN-MILE, INTEREXCHANGE TRUNK FOR INTERTOLL FOR TWX	
3699.3000	REL. NO. OF CONNECTION-MIN-MILES, INTEREXCHANGE TRUNK FOR REMOTE ISTATE TWX	1. * DIRECT ASSIGNMENT TO INTERSTATE TOLL
3699.6000	REL. NO. OF TELEPHONE 8 TWX TRAFFIC UNITS FOR INTERSTATE OPERATIONS	
3699.7000	NO. OF AUTOMATICALLY RECORDED MESSAGES (UPDATE BY IS)	1. SET TOTAL TO 38,649,775 2. ALLOC TOTAL TO STATE BY FS.3699.7 3. ALLOC TOTAL TO ISTATE
3699.8000	NO. OF AUTOMATICALLY RECORDED MESSAGES (UPDATE BY ISE)	1. SET TOTAL TO 38,649,775 2. ALLOC TOTAL TO STATE BY FS.3699.8 3. ALLOC TOTAL TO ISTATE
5000.0000	SUBSCRIBER LINE OUTSIDE PLANT ALLOCATION	1. SET TOTAL TO 686,166,784 2. SET STATE TO TOTAL2006*TOTAL2003+LOOP.COST:STATE 3. SET ISTATEPL TO TOTAL2006*TOTAL2002 4. SET ISTATE TO LOOP.COST:ISTATE

ACCOUNT ALLOCATIONS TO SERVICE CATEGORIES

ACCOUNT NO.	TOTAL	STATE	ISTATE	ISTATEPL
100.1000	2,805,488,900	1,963,999,490	724,386,560	117,102,528
100.2200	43,065,696	30,148,400	11,119,706	1,797,583
100.3000	1,369,442	958,686	353,594	57,161
122.0000	16,483,456	11,467,148	4,278,726	737,578
171.2120	57,909,696	38,552,672	19,084,464	272,559
171.2210	77,101,392	54,200,720	17,632,512	5,268,160
171.2310	50,375,200	36,056,944	13,266,564	1,051,670
171.2320	34,790,592	25,062,416	9,269,063	459,098
171.2340	-7,140,424	-5,116,099	-1,879,611	-144,707
171.2410	19,193,856	13,352,708	4,982,284	858,859
171.2421	42,509,936	29,573,136	11,034,603	1,902,172
171.2422	28,508,400	19,832,608	7,400,125	1,275,652
171.2423	61,270,144	42,624,176	15,904,322	2,741,627
171.2424	155,644	108,278	40,402	6,965
171.2430	-1,616,558	-1,124,600	-419,621	-72,334
171.2440	18,762,000	13,052,277	4,870,184	839,535
171.2610	19,405,616	13,557,852	5,847,757	0
171.2640	11,407,731	8,039,550	2,984,714	383,451
172.2030	0	0	0	0
172.2110	0	0	0	0
176.2120	11,415,175	7,599,515	3,761,936	53,724
176.2210	140,153,472	98,525,056	32,052,064	9,576,352
176.2310	47,468,496	33,976,432	12,501,069	990,988
176.2320	35,581,600	25,632,240	9,479,807	469,536
176.2340	22,808,400	16,342,173	6,003,979	462,235
176.2410	2,437,675	1,695,832	632,764	109,078
176.2421	7,502,695	5,219,446	1,947,527	335,720
176.2422	10,337,889	7,191,823	2,683,478	462,585
176.2423	25,163,456	17,505,616	6,531,855	1,125,977
176.2424	13,693	9,526	3,554	613
176.2430	14,984	10,424	3,890	670
176.2440	8,038,822	5,592,417	2,086,693	359,710
176.2610	13,491,331	9,425,801	4,065,525	0
176.2640	6,793,136	4,787,433	1,777,353	228,340
201.0000	0	0	0	0
202.0000	675	473	174	28
212.0100	174,395,024	114,159,888	60,235,136	0
212.0200	1,485,760	958,246	527,514	0
212.0300	10,120,373	6,617,429	3,502,938	0
212.0400	23,449,776	16,430,052	7,007,707	12,004
212.0500	1,613,631	0	1,613,631	0
212.0600	3,851,243	2,666,511	1,184,731	0
212.0700	25,748,624	18,146,240	6,736,864	865,496
212.0800	89,710	89,710	0	0
212.0900	43,755,168	30,528,976	12,763,274	462,908
212.1000	282,798	0	282,798	0
221.0400	1,689,703	794,210	895,493	0
221.0500	25,676,912	16,366,384	9,310,528	0
221.0900	4,097,175	2,721,635	1,375,540	0
221.1100	2,269,594	2,086,279	183,314	0

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ACCOUNT ALLOCATIONS TO SERVICE CATEGORIES

ACCOUNT NO.	TOTAL	STATE	ISTATE	ISTATEPL
221.1200	0	0	0	0
221.1300	0	0	0	0
221.1500	3,560,588	2,958,300	602,288	0
221.1600	0	0	0	0
221.1700	50,409,168	27,184,880	23,224,288	0
221.1800	1,694,302	0	1,694,302	0
221.2000	32,510	5,151	27,359	0
221.2100	11,348,224	7,678,789	3,669,435	0
221.2200	143,191	58,791	84,400	0
221.3100	0	0	0	0
221.3200	321,201	201,110	120,091	0
221.3300	39,621,168	33,653,680	5,967,475	0
221.3400	41,368,400	35,697,920	5,670,460	0
221.3500	341,230,848	294,719,232	46,511,488	0
221.5100	4,132,547	0	0	4,132,547
221.5500	438,979	0	0	438,979
221.5600	0	0	0	0
221.5800	89,940,192	89,940,176	0	0
221.5900	48,401,744	29,293,456	19,108,240	0
221.6100	21,110,848	0	0	21,110,848
221.6200	31,389,744	31,389,744	0	0
221.6800	37,500,896	27,063,536	9,424,796	1,012,571
221.7100	1,248,980	0	1,248,980	0
221.7200	3,029,574	0	0	3,029,574
221.7300	1,401,240	1,401,240	0	0
221.7500	45,511,584	0	45,511,584	0
221.7600	8,738,864	8,738,864	0	0
221.7700	98,171,936	49,914,816	48,257,104	0
221.8100	27,292,112	0	0	27,292,112
221.8200	16,454,912	16,454,912	0	0
221.9000	9,576,853	0	0	9,576,853
221.9100	6,812,028	6,812,028	0	0
231.0100	7,312,812	5,331,603	1,981,208	0
231.0101	306,955	223,794	83,161	0
231.0130	0	0	0	0
231.0131	5,445,600	0	0	5,445,600
231.0160	0	0	0	0
231.0161	1,840,737	1,840,737	0	0
231.0190	0	6	0	0
231.0191	0	0	0	0
231.0220	185,035,296	134,904,976	50,130,304	0
231.0221	60,903,872	44,403,600	16,500,257	0
232.0110	395,512	288,359	107,153	0
232.0111	6,172	4,500	1,672	0
232.0140	2,147,388	0	0	2,147,388
232.0141	1,071,838	0	0	1,071,838
232.0170	562,555	562,555	0	0
232.0171	268,822	268,822	0	0
232.0200	0	0	0	0
232.0201	0	0	0	0

A C C O U N T   A L L O C A T I O N S   T O   S E R V I C E   C A T E G O R I E S

ACCOUNT NO.	TOTAL	STATE	ISTATE	ISTATEPL
232.0230	156,841,024	114,349,184	42,491,824	0
232.0231	82,660,768	60,266,064	22,394,688	0
234.0130	0	0	0	0
234.0131	1,747,719	0	0	1,747,719
234.0160	0	0	0	0
234.0161	720,168	720,168	0	0
234.0190	52,365	32,701	19,664	0
234.0191	1,808	1,129	679	0
234.0220	75,275,792	54,881,840	20,393,936	0
234.0221	8,441,124	6,154,229	2,286,894	0
240.0100	1,819,330	0	0	1,819,330
240.0200	118,656	118,656	0	0
240.0300	180,317	0	180,317	0
240.0400	38,063,888	38,063,888	0	0
240.0500	11,370,154	6,881,394	4,488,758	0
240.0700	6,480,170	0	0	6,480,170
240.0800	11,502,597	11,502,597	0	0
240.0900	686,166,784	495,190,272	172,449,024	18,526,752
240.1000	552,751	0	552,751	0
240.1100	424,843	0	0	424,843
240.1200	192,661	192,661	0	0
240.1300	4,315	0	4,315	0
240.1400	16,542,317	0	16,542,317	0
240.1500	3,181,295	3,181,295	0	0
240.1600	35,738,496	18,170,976	17,567,504	0
240.2000	10,009,446	0	0	10,009,446
240.2100	5,989,820	5,989,820	0	0
240.2400	211,279	0	211,279	0
240.2500	4,154,006	0	4,154,006	0
261.1000	44,399,984	30,837,536	13,562,443	0
261.2000	33,593,744	23,653,328	9,940,416	0
264.0000	43,767,360	30,844,864	11,451,276	1,471,165
276.0000	0	0	0	0
304.1000	-499,032	-359,492	-132,954	-6,584
304.2000	10,257,805	7,161,179	2,640,564	456,058
306.0000	18,731,376	13,108,047	4,823,012	800,312
307.0010	7,013,985	4,908,320	1,805,982	299,678
307.0020	40,850,944	28,597,936	10,547,849	1,705,138
307.0030	40,746,048	40,746,048	0	0
307.0040	1,323,985	926,864	341,857	55,264
307.0050	23,295,808	16,673,285	6,622,523	0
307.0060	9,319	6,524	2,406	389
307.0070	0	0	0	0
308.2120	2,794,427	1,860,356	920,919	13,152
308.2210	33,661,872	23,663,616	7,698,222	2,300,048
308.2310	9,155,727	6,553,376	2,411,207	191,142
308.2320	8,383,284	6,039,144	2,233,511	110,626
308.2340	3,332,109	2,387,449	877,129	67,529
308.2410	651,276	453,077	169,056	29,142
308.2421	1,703,419	1,185,028	442,168	76,222

ACCOUNT ALLOCATIONS TO SERVICE CATEGORIES

ACCOUNT NO.	TOTAL	STATE	ISTATE	ISTATEPL
308.2422	2,271,892	1,580,501	589,731	101,659
308.2423	6,331,007	4,404,330	1,643,384	283,291
308.2424	0	0	0	0
308.2430	60,584	42,147	15,726	2,711
308.2440	1,711,492	1,190,644	444,264	76,583
308.2610	3,263,952	2,280,380	983,571	0
308.2640	2,408,205	1,697,172	630,082	80,948
309.2120	-22,894	-15,241	-7,544	-107
309.2210	-865,846	-608,672	-198,012	-59,160
309.2310	-7,445,036	-5,328,918	-1,960,687	-155,427
309.2320	-2,468,495	-1,778,252	-657,667	-32,573
309.2340	-7,174,459	-5,140,485	-1,888,571	-145,397
309.2410	-6,243	-4,343	-1,620	-278
309.2430	172,753	120,180	44,843	7,730
309.2610	-813,812	-568,574	-245,236	0
309.2640	-2,189,593	-1,543,106	-572,883	-73,598
313.0000	2,500,417	1,750,431	645,616	104,369
316.0000	408,452	408,452	0	0
323.0000	0	0	0	0
323.1000	1,319,976	920,478	392,533	6,964
323.2000	293,626	288,010	5,616	0
360.0000	-29,718	-29,718	0	0
370.0000	20,274	20,274	0	0
380.0000	-7,296	-7,296	0	0
500.0000	576,786,688	576,786,688	0	0
501.0000	13,260,464	13,260,464	0	0
503.0000	23,909	23,909	0	0
504.0000	17,853,184	17,294,176	0	558,997
506.0000	4,167,470	4,167,470	0	0
510.0000	377,589,760	150,926,448	226,663,520	0
511.0000	98,760,704	24,075,888	74,684,800	0
512.0000	63,564,768	12,894,464	0	50,670,304
516.0000	10,266,336	321,681	9,944,655	0
521.0000	9,648	9,648	0	0
523.0000	77,816,688	77,816,688	0	0
524.0000	2,125,029	1,113,546	955,228	56,255
525.0000	0	0	0	0
526.0000	1,361,801	1,186,611	175,190	0
530.0000	14,848,321	8,124,999	6,723,321	0
551.0000	0	0	0	0
602.1000	1,673,286	1,164,065	434,347	74,874
602.2000	19,218,064	13,369,549	4,988,568	859,942
602.3000	7,765,849	5,402,516	2,015,836	347,495
602.4000	24,467,440	17,021,408	6,351,185	1,094,833
602.5000	3,178	2,211	825	142
602.6000	458,004	318,622	118,887	20,494
602.7000	2,357,345	1,639,948	611,913	105,483
602.8000	-17,612	-12,252	-4,571	-787
603.0000	12,151,257	8,453,340	3,154,187	543,727
603.1000	27,053,600	19,523,952	6,799,162	730,481

ACCOUNT ALLOCATIONS TO SERVICE CATEGORIES

ACCOUNT NO.	TOTAL	STATE	ISTATE	ISTATEPL
604.0000	70,022,400	49,224,320	16,013,608	4,784,480
605.0000	98,449,984	71,898,272	25,036,544	1,515,146
606.0000	10,903,757	7,259,045	3,593,395	51,317
608.2120	5,817,077	3,872,649	1,917,051	27,377
608.2210	49,216,112	34,597,920	11,255,363	3,362,832
608.2310	33,320,896	23,850,032	8,775,227	695,632
608.2320	21,831,264	15,726,791	5,816,381	288,086
608.2340	21,047,600	15,080,563	5,540,474	426,551
608.2410	2,422,304	1,685,139	628,774	108,390
608.2421	5,389,307	3,749,212	1,398,940	241,153
608.2422	3,342,167	2,325,066	867,550	149,550
608.2423	11,873,074	8,259,815	3,081,977	531,279
608.2424	10,787	7,504	2,800	483
608.2430	569,097	395,907	147,724	25,465
608.2440	1,664,814	1,158,171	432,147	74,495
608.2610	6,592,229	4,605,701	1,986,525	0
608.2640	239,516	168,798	62,667	8,051
609.0000	0	0	0	0
610.0000	5,313,856	3,735,533	1,215,239	363,084
611.0000	0	0	0	0
612.0000	3,995,726	2,835,544	1,012,040	148,142
613.1000	0	0	0	0
613.2000	0	0	0	0
614.0000	0	0	0	0
621.1000	10,377,027	6,785,250	3,591,775	0
622.0000	2,494,954	1,615,096	879,858	0
624.0000	45,760,832	30,067,760	15,693,072	0
626.0000	16,101	10,528	5,573	0
627.0000	842,936	518,299	324,637	0
629.0000	318,616	209,183	109,433	0
630.0000	483,215	317,000	166,215	0
631.0000	3,457,803	2,270,230	1,187,573	0
632.0000	37,484	34,456	3,028	0
633.1000	13,776	9,060	4,716	0
633.2000	0	0	0	0
634.0000	19,995	13,074	6,921	0
635.0000	-582,126	-380,636	-201,489	0
640.0000	23,403,504	16,397,634	6,993,880	11,980
642.0000	7,402,636	4,810,630	2,592,006	0
643.0000	33,131,968	21,538,256	11,593,707	0
644.0000	893,893	524,923	368,970	0
645.0000	47,887,808	35,329,536	12,516,341	41,932
648.0000	3,459,753	1,752,762	1,706,991	0
649.0000	27,251,904	26,622,128	629,768	0
650.0000	2,732	2,038	693	1
661.0000	1,025,262	721,339	303,923	0
662.0000	15,651,024	10,673,878	4,977,146	0
662.1000	14,403,853	10,135,450	4,268,403	0
663.0000	1,064,232	749,064	315,168	0
664.0000	1,889,982	1,330,272	559,710	0

ACCOUNT ALLOCATIONS TO SERVICE CATEGORIES

ACCOUNT NO.	TOTAL	STATE	ISTATE	ISTATEPL
665.1000	15,840,669	11,149,527	4,691,142	0
665.2000	16,933,120	11,854,133	4,372,186	706,797
668.0000	83,508	58,460	21,562	3,486
669.0000	372,564	260,816	96,197	15,551
671.0000	8,338,771	6,127,859	2,210,912	0
672.0000	91,867,312	64,787,680	27,079,632	0
673.0000	675,126	472,626	174,320	28,180
674.0000	18,944,896	12,157,793	6,787,103	0
675.0000	5,836,591	4,085,939	1,507,025	243,622
676.0000	-671,722	-476,380	-195,341	0
677.0000	-3,172,997	-2,232,751	-940,245	0
2001.0000	0	0	0	0
2002.0000	49,677	0	0	49,677
2003.0000	83,432	83,432	0	0
2004.0000	1,706,695	0	0	0
2005.0000	0	0	0	0
2006.0000	373	0	0	0
2602.1000	1,707,025	1,707,025	0	0
2602.2000	0	0	0	0
2602.3000	23,402	0	0	23,402
2602.4000	83,341	83,341	0	0
2602.5000	0	0	0	0
2602.6000	0	0	0	0
2602.7000	0	0	0	0
2602.8000	0	0	0	0
2699.0100	586,904	586,904	0	0
2699.0200	530,182	530,182	0	0
2699.0300	0	0	0	0
2699.0400	143,320	0	0	143,320
2699.0500	172,639	172,639	0	0
2699.0600	1,156,153	0	1,156,153	0
2699.0700	217,579	217,579	0	0
2699.0800	2,566,741	2,566,741	0	0
2699.0900	0	0	0	0
2699.1000	742,702	0	0	742,702
2699.1100	437,863	437,863	0	0
3221.0000	35,174,727,70	31,986,495,50	3,188,232,190	0
3222.0000	35,174,727,70	31,986,495,50	3,188,232,190	0
3244.1000	0	0	0	0
3244.2000	4,430,401,540	2,681,348,100	1,749,053,440	0
3244.3000	4,430,401,540	2,681,348,100	1,749,053,440	0
3244.4000	0	0	0	0
3299.1000	1.000000	0.729078	0.270923	0.000000
3299.2000	34,471,100,40	31,686,885,40	2,784,218,620	0
3299.3000	286,787,568,0	145,815,110,0	140,972,458,0	0
3299.4000	286,787,568,0	145,815,110,0	140,972,458,0	0
3299.6000	0	0	0	0
3699.1000	286,776,689,0	286,776,689,0	0	0
3699.2000	0	0	0	0
3699.3000	0	0	0	0

ACCOUNT ALLOCATIONS TO SERVICE CATEGORIES

ACCOUNT NO.	TOTAL	STATE	ISTATE	ISTATEPL
3699.6000	0	0	0	0
3699.7000	38,649,760	24,136,048	14,513,712	0
3699.8000	38,649,760	24,136,048	14,513,712	0
5000.0000	686,166,528	495,190,272	172,449,040	18,526,752

S U M M A R Y   O F   R E S U L T S

DESCRIPTION	CATEGORY	RESULT
TOTAL PLANT INVESTMENT, ACCOUNTS 201-277	TOTAL	2,804,902,660
	STATE	1,963,589,630
	ISTATE	724,234,752
	ISTATEPL	117,078,064
CENTRAL OFFICE EQUIPMENT, ACCOUNT 221	TOTAL	974,613,760
	STATE	685,133,824
	ISTATE	222,887,056
	ISTATEPL	66,593,456
OUTSIDE PLANT, ACCOUNTS 241-244	TOTAL	832,701,440
	STATE	579,290,624
	ISTATE	216,150,208
	ISTATEPL	37,260,512
TOTAL EXPENSES, ACCOUNTS 600-699	TOTAL	842,903,040
	STATE	597,616,384
	ISTATE	227,656,816
	ISTATEPL	17,629,680
MAINTENANCE EXPENSE, ACCOUNTS 602-606, 610-612	TOTAL	283,815,936
	STATE	201,836,016
	ISTATE	71,341,120
	ISTATEPL	10,638,848
DEPRECIATION EXPENSE, ACCOUNTS 608-609, 613-614	TOTAL	163,336,176
	STATE	115,483,184
	ISTATE	41,913,488
	ISTATEPL	5,939,337
TRAFFIC EXPENSE, ACCOUNTS 621-635	TOTAL	63,240,512
	STATE	41,469,216
	ISTATE	21,771,232
	ISTATEPL	0
COMMERCIAL EXPENSES, ACCOUNTS 640-650	TOTAL	143,431,440
	STATE	106,975,840
	ISTATE	36,401,616
	ISTATEPL	53,912
GENERAL AND ADMINISTRATIVE EXPENSE, ACCOUNTS 661-677	TOTAL	189,082,096
	STATE	131,855,632
	ISTATE	56,228,768
	ISTATEPL	997,636
DEPRECIATION AND AMORITIZATION RESERVE, ACCOUNTS 171 AND 172	TOTAL	412,632,320
	STATE	287,772,416
	ISTATE	110,017,664
	ISTATEPL	14,842,700

S U M M A R Y O F R E S U L T S

DESCRIPTION	CATEGORY	RESULT
TOTAL TAXES, ACCOUNTS 300-399	TOTAL	201,151,376
	STATE	153,588,928
	ISTATE	41,266,368
	ISTATEPL	6,295,808
FEDERAL INCOME TAX 8 OTHER OPERATING TAXES, ACCOUNTS 306-307	TOTAL	131,971,456
	STATE	104,966,976
	ISTATE	24,143,600
	ISTATEPL	2,860,778
TOTAL REVENUES, ACCOUNT 500-599	TOTAL	1,258,433,280
	STATE	888,001,280
	ISTATE	319,145,984
	ISTATEPL	51,285,536
RATE OF RETURN	TOTAL	0.121225
RATE BASE	TOTAL	2,061,050,620
	STATE	1,442,303,740
	ISTATE	530,685,440
	ISTATEPL	88,059,840
REVENUE REQUIREMENT DISTRIBUTION	TOTAL	1,234,483,970
	STATE	884,227,584
	ISTATE	318,640,640
	ISTATEPL	31,614,976
% CHANGE IN TOTAL REVENUES	TOTAL	-0.348846
% CHANGE IN STATE REVENUES	TOTAL	1.665464
REVENUES FROM STATE TOLL	TOTAL	175,324,032
% CHANGE IN STATE TOLL REVENUES	TOTAL	0.000000
REVENUE FROM EXCHANGE SERVICES	TOTAL	350,540,544
% CHANGE IN EXCHANGE REVENUES	TOTAL	1.256369
INTERSTATE USAGE	TOTAL	2,784,218,620
% CHANGE IN INTERSTATE USAGE	TOTAL	0.000000
STATE USAGE	TOTAL	1,639,365,380
% CHANGE IN STATE USAGE	TOTAL	0.000000

S U M M A R Y   O F   R E S U L T S

DESCRIPTION	CATEGORY	RESULT
EXCHANGE USAGE	TOTAL	30,047,522,800
% CHANGE IN EXCHANGE USAGE	TOTAL	0.000000
AVERAGE COST PER LINE	TOTAL	148
% CHANGE IN THE AVERAGE COST PER LINE	TOTAL	1.255703
% OF CUSTOMERS DROPPED OFF	TOTAL	0.000000
% CHANGE IN THE BUSINESS RATE PER LINE	TOTAL	14.824197
% CHANGE IN THE RESIDENTIAL RATE PER LINE	TOTAL	17.669282
SS=FRACTIONAL CHANGE IN STATE TOLL RATES	TOTAL	0.000000
NS=OWN PRICE ELASTICITY FOR SUBSCRIBER LINE MOU OF STATE SERVICE	TOTAL	0.000000
II=FRACTIONAL CHANGE IN INTERSTATE TOLL RATES	TOTAL	0.000000
NI=OWN PRICE ELASTICITY FOR SUBSCRIBER LINE MOU OF INTERSTATE SERVICE	TOTAL	0.000000
NR=CONNECT ELASTICITY FOR RESIDENTIAL CUSTOMERS	TOTAL	0.000000
NB=CONNECT ELASTICITY FOR BUSINESS CUSTOMERS	TOTAL	0.000000
IID=FRACTION OF AVG INTERSTATE TOLL MOU/LINE=AVG INTERSTATE MOU CURTAIL LINE	TOTAL	0.000000
SSD=FRACTION OF AVG STATE TOLL MOU/LINE=AVG STATE MOU CURTAIL LINE	TOTAL	0.000000
EED=FRACTION OF AVG EXCHANGE MOU/LINE=AVG EXCHANGE MOU CURTAIL LINE	TOTAL	0.000000

APPENDIX D

THE DEMAND FOR ACCESS AND USE OF THE TELEPHONE NETWORK: A BRIEF GUIDE TO THE LITERATURE

There exists a very large theoretical and empirical literature on the demand for access to and the use of the telephone network. One recent study [Taylor, 1980][1] lists well above 150 published and unpublished studies. The published studies are easily accessible in academic journals. The unpublished studies are research and consulting reports performed by and for telephone companies. Many of these are not publicly available.

The study of demand is perhaps the oldest branch of applied econometrics. For the most part the methods of analysis are well understood and uncomplicated. Typically, some measure of consumption is regressed on a variety of exogeneous variables such as prices, income, and socio-economic characteristics. In order to make the estimated effects of the independent variables on the dependent variable comparable, the estimated coefficients are transformed into "elasticities." An elasticity, η, is defined as a percentage change in the dependent variable per percentage change in the independent variable:

$$\eta = \frac{dY}{dX} \frac{X}{Y} ;$$

The most common elasticity is the price elasticity of demand. Since consumption is presumed to decrease (a negative number) as the commodity's price increases (a positive number), to make the resulting estimate positive η is defined as a negative number to make the resulting estimate positive. The larger the estimated elasticity the more responsive is the demand to changes in price. Demand with elasticities below one is called inelastic, while demand with η above one is termed elastic.

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[1] L.D. Taylor, Telecommunications Demand: A Survey and Critique (Cambridge, Mass.: Ballinger, 1980).

In the case of telephone services, one of the initial problems in efforts to estimate elasticities is the definition of the commodity. Typically, distinctions are made according to existing methods of pricing telephone services. Tariffs determine the definition of the telephone commodity. Thus, there are residential, commercial, and industrial demands for local, intrastate toll, interstate toll, and other services. One instance of a different approach is in the case of the demand for access to the telephone network. In this case, no separate tariff exists.

Indeed, one of the major problems in attempts to estimate access to the telephone network is absence of data on the price of access. In the absence of local measured service, access price is combined with the price for local calls. One study [Mahan, 1979][2] was based on collected household interview data and the Carolina Telephone and Telegraph Company data. Mahan's estimated price elasticities of demand for access ranged from a low of .15 to a high of .25. Price, according to this study, is not an important determinant of access decisions. A similar estimate of -.14 was contained in a recent testimony of Eric J. Schneidewind [1983][3]. Other studies rely on aggregate, rather than micro data. As a result these studies do not incorporate consumers' characteristics in their estimates.

Absence of data on the basis of which access price elasticities can be estimated means that a similar problem exists in efforts to estimate the price elasticity of demand for local calls. Most researchers use aggregate average price and average use data. A related problem pertains to the applicability of elasticities calculated from data pertaining to some area to another area. Inasmuch as little has been published on telephone usage patterns, such

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[2]G.P. Mahan, "The Demand for Residential Telephone Service" 1979 MSU Public Utilities Papers (Michigan State University: The Institute of Public Utilities, 1979).

[3]"NARUC Testifies in House Overnight Hearings On Universal Telephone Service Costs - Testimony of Eric J. Schneidewind, Chairman of Michigan Public Service Commission," NARUC BULLETIN No. 13-1983, March 18, 1983, pp. 16-21.

extrapolation is fraught with danger. Indeed, there is a need for the application of the same estimation method in a variety of cities and states. The disparity in existing estimates may be due to differences in behavior, differences in the quality of the available data, or differences in estimation methods.

Comprehensive reviews of the existing studies are contained in:

Lester D. Taylor, Telecommunications Demand: A Survey and Critique (Cambridge, Mass.: Ballinger, 1980).

Gary W. Bowman and Wayne A. Morra, "Demand For Access and Use of the Telephone Network: A Critical Review of the Literature," Mimeo, 1982.

Table D-1 contains a summary of some of the existing estimated price and income elasticities as reported in these sources.

TABLE D-1

ESTIMATED ELASTICITIES

Study	Date	Elasticity Price	Elasticity Income
AT&T, EXHIBIT 21, lowest	1975	-0.35	
highest		-0.03	
DAVIS, short run	1973	-0.21	0.25
long run		-0.31	0.38
DOBELL, residential, short run	1972		0.47
residential, long run			2.38
business, short run			0.59
business, long run			1.55
GRIFFIN, state MTS, long run	NA	-0.6	
GTE LABS, local usage	NA	-0.25	
penetration		1.12	
LITTLECHILD, residential	1970	-0.40	
business		-0.20	

Source: AT&T, Davis, Dobell, Griffin, GTE Labs, & Littlechild Studies

APPENDIX E

USE STUDIES: HOUSEHOLD SAMPLING UNIT

In contrast to studies of telephone demand at an aggregate level (e.g., exchange, county, state), this appendix deals with descriptive information of telephone usage obtained at the household level. It further discusses the implication of the sizable variation of usage distributions on the design of studies at that level. Certain aggregate studies and pertinent information are mentioned initially.

Aggregate Studies and Demographics

Taylor[1], in the most comprehensive, published study of telephone demand and usage, mentions three areas of study:

(1) Price and income elasticities,
(2) Time, distance by customer (business, residence, coin),
(3) Customer socio-demographic characteristics as related to usage.

Relative to area 1, with some attention to area 3, table E-1 lists household characteristics, including income, used by two studies [Brandon, 1981, and Mahan, 1979].[2] The dependent variable studied was toll expenditures and a regression model was used. Table E-2

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[1]L.D. Taylor, Telecommunications Demand: A Survey and Critique (Cambridge, Mass.: Ballinger, 1980).

[2]B.B. Brandon, ed. The Effect of the Demographics of Individual Households on their Telephone Usage (Cambridge, Mass.: Ballinger: 1981), G.P. Mahan, "The Demand for Residential Telephone Service" 1979 MSU Public Utilities Papers (Michigan State University: The Institute of Public Utilities, 1979).

illustrates some major findings. Typical of such studies with the households was the observation that R^2, the multiple coefficient of determination, is small (0.35 for the Mahan study, 0.1 to 0.24 for the Brandon study). These studies are mentioned to illustrate the typically low values of R^2 in the regression relationship, stemming from large variation from household to household. Such variation is the topic of the next section.

TABLE E-1

LIST OF HOUSEHOLD CHARACTERISTICS USED IN TELECOMMUNICATIONS CONSUMPTION STUDIES

Study	Variables	
B-M*	X_1	Household Size Sex, Ages of Members
M	X_2	Degree of Urbanization (urban, rural, rural nonfarm)
M	X_3	Education of Household Head
M	X_4	Occupation of Household Head
B-M	X_5	Race W/NW
M	X_6	Geographical Dispersion of Family
M	X_7	Calling Scope (number of "local" main stations, callable without toll)
B-M	X_8	Recency of Residence
B-M	X_9	Income of Household Head (or family income)
		Dependent Variables (consumption) Used In Household Studies
M	Y_1	Access (Y or N)
M	Y_2	Total Toll Expenditures
B	Y_3	Total Bill
B	Y_4	Total Vertical Service Bill
M	Y_5	Extension Service
B	Y_6	Many Local, Toll Descriptions (call duration, frequency, time-of-day)

*B = Brandon, M = Mahan
Source: Brandon and Mahan

The most detailed model related to area 2, time and distance descriptions, is the LDI model[3]. This model relates minutes of use to customer as well as time and distance classifications. Empirical data related to time and distance calling are discussed by Taylor[4].

TABLE E-2

SELECTED FINDINGS OF TWO STUDIES

Dependent Variable	Independent Variables, Effect	Method of Analysis
Total Toll Expenditures in Eight Months*	X_1** (Approx. 20% +/- 20%) X_7 (Approx. 10% +/- 10%) X_9 (Approx. 25% +/- 20%)	Log Linear Model
Total Bill***	X_9 (0.70 per $1,000 Income)	Transformed Linear
Local Calls/Mo.***	X_1, Age of Head of Household (10, % decrease per year)	Marginal Average
	X_9 (1 call per $1,000 income)	Marginal Average
Total Local Conversation Time***	X_5 (Approx. 300% for non-white vs. white)	Marginal Average

* Mahan study, approximately 2,000 households, stratified random sample in eight countries (eight months)
** See Table E-1 for variable description
*** Brandon study, approximately 600 households in urban Chicago, (one month)
Source: Brandon and Mahan

Usage at Household Level

The two primary published sources of household studies were conducted in 1974 [Brandon][5] and 1982 [Cole].[6] The measures compared are:

P = percent subscribers not making a toll call per unit of time

T = total toll minutes of use per unit of time

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[3]Taylor, Telecommunications Demand, p. 97.

[4]Ibid. pp. 10-13.

[5]Brandon, Demographics.

[6]L. Cole and E. Beauvais, "The Economic Impact of Access Charges," presented to the 14th Annual Conference of the MSU Institute of Public Utilities, 1982.

Here, toll will either be interstate or inter plus intrastate, depending on the study quoted. In addition, the unit of time is either one month, or three months (which points out the difficulty in comparisons of published data).

Two other studies are available for comparison of values of P (Rural Telephone Coalition, 78-72).[7] Although it is not mentioned, these studies are probably of residential customers. Table E-3 illustrates the comparisons.

TABLE E-3

COMPARISON OF P% NOT MAKING TOLL CALLS
VALUES, FOUR STUDIES
(RESIDENTIAL CUSTOMERS)

Study	Location	Sample Size (Households)	Duration of Study	P%, subscribers not making toll call
Brandon	Urban Chicago	226	1 month (1974)	50
Cole	Rural Ohio	394	3 months (1982)	2
RTC	Mid-West	7729	1 month (198?)*	51
RTC	Mid-West	1286	1 month (198?)*	55

*From the study description, it probably was residential, in the 1980s
Source: Brandon, Cole, and Rural Telephone Coalition

Notice in the first, third, and fourth studies in table E-3, involving one month, the values of P are quite consistent. Assuming the probability that a subscriber will make a toll call in one month is 0.5, and this event is independent from month to month (and subscriber to subscriber), one would expect (0.5) x (0.5) x (0.5) or 12.5 percent of the subscribers not to make a toll call in three months. The value of two percent (Cole study) is significantly lower than 12.5 percent (such a value, two percent would occur much less than one time in a thousand, if indeed the true fraction of not making calls was 12.5 percent), suggesting non-independence or a difference in P for the Cole study.

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[7]Rural Telephone Coalition "Reply Comments" to 4th Supplemental Notice of Inquiry in Proposed Rule Making FCC CC Docket 78-72.

The two studies of Brandon and Cole present enough information to illustrate the variation between households in toll minutes of use, as well as comparison of demographic groups. As noted in table E-3, the studies were conducted at an eight-year interval, one urban, a one-month study, and one rural, a three-month study. In spite of these differences, little other published data exists, and there are some similarities worth noting.

The quantities used for comparison are:

Q(1) = lower quartile, total toll minutes of use in sample
Q(2) = middle quartile, total toll minutes of use in sample
Q(3) = upper quartile, total toll minutes of use in sample

That is, 75 percent of the subscribers had values of minutes of toll use less than Q(3), 50 percent less than Q(2), 25 percent less than Q(1). These are selected because they are available from both studies (more than three values of the cumulative distribution of minutes of use were not used since extracting these from the Brandon study involved graphical means, inadequate for present purposes). Absolute comparisons across groups will generally not be made because of the different geographic character of the samples. What is of interest is the variation within each strata studied, and the consistency (or lack of it) across the strata and the studies.

Table E-4 shows the values of Q(2), the median, for various strata. Although the one-month study[8] showed approximately a two to one ratio relative to the three-month study, recall that the latter was interstate toll usage only.

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[8] Brandon, Demographics.

TABLE E-4

MEDIAN HOUSEHOLD TOLL (MINUTES PER MONTH)
USE, BY STRATA

Study	Usage Type	Income* Low	Income* High	Age* Low	Age* High
Brandon (one-month)	inter and intra toll use	27	28	25	32
Cole (three-month)	interstate toll use	14	18	18	10

*Brandon, 1974, low income was $9,000 or less annually; for the Cole study, 1982, $15,000 or less annually was "low". In both studies, 65 years or older, head of household, was "high".
Source: Brandon and Cole

Table E-5 illustrates the values of various quartiles for strata based on age groups (less than, or greater than, or equal to 65 years). For these four strata, the ratio of Q(3) to Q(1) is approximately five, illustrating the extreme variation (but consistent) within such groups.

Following Pavarini[9] who assumed a conditional log-normal distribution of household minutes of use, per unit time (conditional on use in prior unit of time), we display the three quartiles on log-normal probability paper (see figures E-1 and E-2) along with a straight line "fit" to these points (a graphical fit, adequate for present purposes). With the exception of "curve 3", figure E-1 (less than 65 years, Brandon study)[10] the lines seem parallel (indicating consistency within group variation, across groups). From this we conclude:

(1) Age differences are bigger than income differences, although the age effects are contradictory in the two samples;

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[9]C. Pavarini, "Identifying Normal and Price-Stimulated Usage Variations of Groups of Customers, part II," Bell Telephone Laboratories Memorandum (October, 1975) as reported in Taylor, Telecommunications Demand.

[10]Brandon, Demographics.

(2) A log-normal distribution of monthly usage seems reasonable, based on three quartile data (for those households making at least one call);

(3) The ratio of the 75 percent cumulative to the 25 percent cumulative, monthly toll usage, ranges from 3:1 to 5:1.

We now consider the implications of planning a study of demographic group differences, in light of the above conclusions.

Considerations in Planning Studies of Toll Usage vs. Demographic Strata

Since the two studies of household toll use are of limited time span, it may be useful in the future to consider longer duration studies (with the household as the basic sampling unit) to assess usage patterns. Billing information has been suggested as a possible surrogate for toll use[11]. Since such data, on a household basis, would exhibit extreme variation as shown in the previous section, some implications of those figures in the planning of such studies seems appropriate.

We assume a log-normal distribution of (household) use, per unit time (probably several months), with a standard deviation of 0.52, derived as follows:

$$\log [Q(3)/Q(1)] = \log (5) = 0.7$$ assuming a 5:1 ratio as mentioned above,

$$= 1.35 \times$$ (standard deviation of $y = \log x$, x = use, normal)

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[11]Ibid.

TABLE E-5

ESTIMATES OF QUANTILES, HOUSEHOLD
MONTHLY TOLL USE (OF THOSE MAKING AT LEAST ONE CALL)

	Study B (three-months)		Study A (one month)	
Age Group	<65	>65	<65	>65
Sample Size	344	50	203	23
25%	10 min.	4.3	11	18
50%	17.5 min.	10	25	32
75%	30 min.	23	55	85
Fraction of Total Sample Not Making a Toll Call	2	4	50*	50*
Ratio, 75% to 25%	3	5.3	5	4.7

*50% for combined age groups, not given for each
Source: Author's Calculations

Therefore, 0.7/1.35 = 0.52 is the standard deviation of y.

Now, assuming we wish to examine two strata, with a true ratio of usage equal to R, we shall require that:

2 (standard deviation of observed difference, in logs) = R, or
2 (0.52) (square root of 2/n) = R,
where n = sample size of each strata.

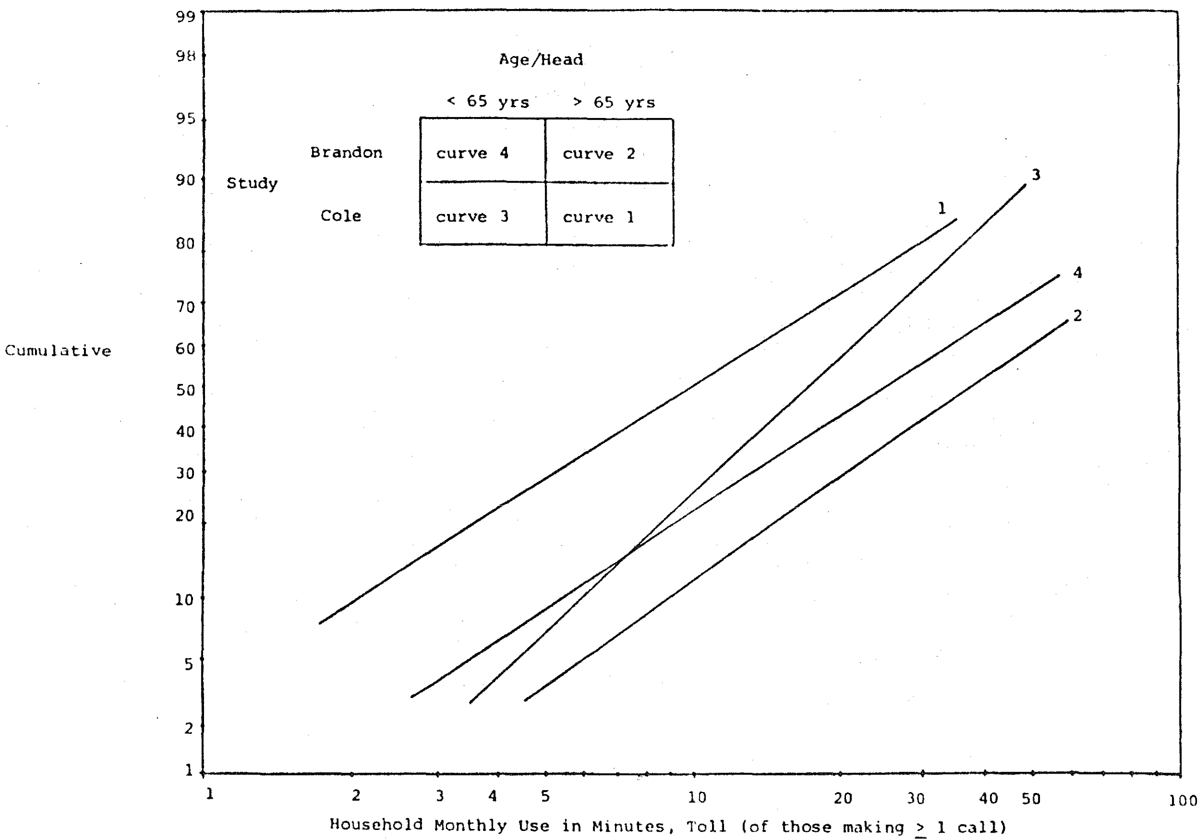

Figure E-1. Cumulative distribution of toll usage for two age groups

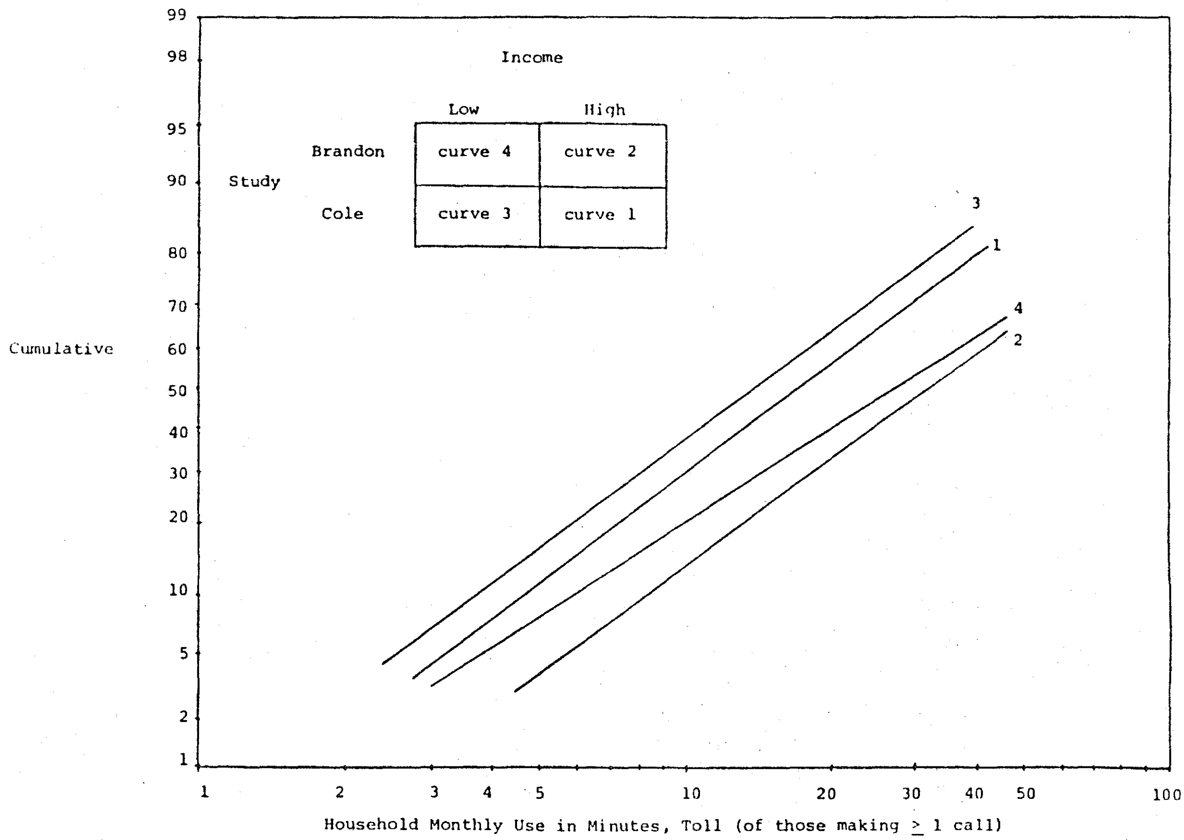

Figure E-2. Cumulative distribution of toll usage for two income groups

This requirement, for various values of R, and corresponding n becomes:

R	2n (total sample size requirement, households)
4:3	1840
3:2	558
2:1	190
4:1	48

APPENDIX F

RELATIONS OF INVESTMENT AND USAGE, BY STATE

This appendix contains a description of the relationships that were derived between switching and trunking investment versus annual minutes of use SLU (subscriber line use) by company, as well as traffic cost versus minutes of use SLU. Aggregate data used for these relationships are shown in table F-1. Notice in table F-1 that "I", "S" and "E" represent inter, intrastate, and local or exchange, respectively. This notation is used throughout this appendix.

It is noted that total investment (summed across companies) is three billion dollars, while switching investment (2.88 billion) represents 95 percent of that total. Further, "IS" switching investment represents 83 percent of the total (2.5 billion).

We use the cross-sectional data shown in table F-1 to obtain constants a, b in the equation F.1.

$$\begin{aligned} y_i &= a x_i^b, \text{ where} \\ y_i &= \text{investment or traffic costs, state } i \\ x_i &= \text{minutes of use, annual (SLU), state } i \qquad \text{(F.1)} \\ i &= 1, 2, 3, 4, 5 \text{ (CODE, in table F-1)} \end{aligned}$$

One additional model was examined:

$$y_i = a x_i^b w_i^c, \text{ where}$$

w_i = state population density, persons per square mile

y_i, x_i as before.

The parameter b represents the elasticity of traffic sensitive cost. The addition of the population density variable was included due to the

TABLE F-1

SWITCHING INVESTMENT AND SLU (SUBSCRIBER LINE USE), BY STATE

State	Code	SLU MOU (Billions $)			Traffic Cost (Millions $)
		E(loc)	S(intra)	I(inter)	
Colo.	1	22.27	1.467	3.156	44.609
Mo.	2	30.048	1.639	2.784	88.609
S.C.	3	15.066	0.846	1.249	56.138
Mich.	4	56.47	5.618	3.238	25.305
Vt.	5	2.251	0.296	0.449	6.4115

State	Code	Investment Switching (Millions $)				Trunk Investment (Millions $)			
		ISE	IS	I	S	ISE	IS	I	S
Colo.	1	3.12	495.0	43.0	3.66	7.286	7.351	4.764	.433
Mo.	2	48.70	599.0	46.8	8.74	25.759	17.684	1.170	9.481
S.C.	3	8.60	266.0	33.1	2.78	15.445	33.437	15.070	2.976
Mich.	4	69.10	1049.0	11.63	87.50	4.216	4.647	3.709	.320
Vt.	5	0.167	96.4	7.08	4.28	1.300	7.230	1.396	.870

Source: Authors' Calculations

relatively poor relationships (as measured by R^2) obtained in the trunking investment equations. Although some marginal improvement was obtained with the inclusion of this variable (see table F-2), the gain was more than offset with the loss in the "effective" number of observations (as measured by the degrees of freedom left for error estimation). It was, therefore, not used (only five observations were available). Further, although the Michigan data seemed somewhat different from the rest of the states for both I and S switching investment, these categories constituted a small portion of the total, and this "outlier" hypothesis was not pursued. Consequences on R^2 of excluding Michigan are shown in table F-2.

The models chosen were:

y_1 = $(.129)(x_1)^{.959}$ (R^2 = .992)
y_2 = $(.0065)(x_2)^{.801}$ (R^2 = .934)
y_3 = $(.0052)(x_2)^{.616}$ (R^2 = .501), where
y_1 = "IS" switching investment, billions of dollars
y_2 = Total investment less ${}_1y$, billions of dollars
y_3 = Traffic costs, billions of dollars
x_1 = Annual minutes of "I + S " use (SLU)
x_2 = Annual minutes of "I + S + E" use (SLU).

With an initial model $y=ax^b$, it is further (by taking logarithms) assumed that the deviations, e, from the model $\ln(y) = \ln(a) + b\ln(x) + e$ are normally distributed, independent, with mean zero and constant variance. One may then calculate 95 percent and 99 percent confidence limits for the parameter b as shown in table F-3.

TABLE F-2

R^2 FOR VARIOUS MODELS

Dependent Variable*	Without Population Density		With Population Density	
	With Mich.	Without Mich.	With Mich.	Without Mich.
SWISE**	.88	.83	---	---
SWIS	.99	.99	---	---
SWI	.37	.90	---	---
SWS	.64	.11	.77	.14
Total SW	.98	.97	---	---
TRISE**	.35	.83	.37	.999
IS	.09	.01	.11	.68
I	.02	.02	.03	.04
S	.06	.11	.12	.88
Total TR	.06	.48	.06	---
Traffic Cost	.502	.989	.560	.997
TOTINV***	.992	.990	.993	.990
TOT LESS SWIS****	.934	.910	.964	.997

*All Logarithmic Models

**"SW" and "TR" prefixes represent switching and trunk investment, respectively

***Total Investment

****Total Investment less IS switching

Source: Authors' Calculations

TABLE F-3

STATISTICS RELATED TO THE PARAMETER b (elasticity of traffic sensitive cost)

Dependent Variable*	R^2	b	S_b, Standard error of b	Confidence Interval for b: 95%	Confidence Interval for b: 99%
ln (y_1)	.992	.959	.05	(.75,1.17)	(.59,1.33)
ln (y_2)	.934	.801	.12	(.30,1.30)	(-.10,1.70)
ln (y_3)	.502	.616	.35	(-.85,2.08)	(-2.00,3.22)
ln (y_3^1)	.939	1.016	.18	(.26,1.77)	(-.33,2.36)

$*y_1$ = "IS" switching investment (billions)

y_2 = All investment less y_1 (billions)

y_3 = Traffic costs (billions), all five states

y_3^1 = Traffic costs (billions), excluding Michigan data

Source: Authors' Calculations

APPENDIX G

EXPERIMENTAL DESIGN ALIAS STRUCTURE

The 2^{6-2} fractional factorial design given in chapter 4 resulted from confounding the terms ACDF, ACE, and AEF with the mean effect. This causes two or more factor interaction terms to be similarly confounded with each other and with the main effects, A, B, C, D, E, F. When terms are confounded with each other, they are called aliases. All aliases of the main effects and two-factor interaction terms resulting from the experimental plan used in this study are given table G-1. The first row of the table gives the terms that were confounded with the mean in order to produce the design. The symbol M stands for the mean effect. The notational conversion used in the table, such as D=ACF=-CE=-ADEF, means that the observed effect of D is indistinguishable from the effects of ACF, and from the negatives of the effects of CE and ADEF. A usual assumption accompanying this type of design is that the effects of interaction terms of several factors are either negligible or zero. In that case they do not need to be distinguished from the more important main effects or two-factor interaction term.

TABLE G-1

ALIAS STRUCTURE FOR MAIN EFFECTS AND FIRST ORDER INTERACTION TERMS OF THE 2^{6-2} FRACTIONAL FACTORIAL EXPERIMENTAL DESIGN

M	=	ACDF	=	−CDE	=	−AEF
A	=	CDF	=	−ACDE	=	−EF
B	=	ABCDF	=	−BCDE	=	−ABEF
AB	=	BDCF	=	−ABCDE	=	−BEF
C	=	ADF	=	−DE	=	−ACEF
AC	=	DF	=	−ADE	=	−CEF
BC	=	ABDF	=	−BDE	=	−ABCEF
D	=	ACF	=	−CE	=	−ADEF
AD	=	CF	=	−ACE	=	−DEF
BD	=	ACF	=	−BCE	=	−ABDEF
CD	=	AF	=	−E	=	−ACDEF
E	=	ACDEF	=	−CD	=	−AF
AE	=	CDEF	=	−ACD	=	−F
BE	=	ABCDEF	=	−BCD	=	−ABF
CE	=	ADEF	=	−D	=	−ACF
DE	=	ACEF	=	−C	=	−ADF
F	=	ACD	=	−CDEF	=	−AE
AF	=	CD	=	−ACDEF	=	−E
BF	=	ABCD	=	−BCDEF	=	−ABE
CF	=	AD	=	−DEF	=	−ACE
DF	=	AC	=	−CEF	=	−ADE
EF	=	ACDE	=	−CDF	=	−A

Source: Authors' Design

APPENDIX H

COMPUTATION OF REGRESSION COEFFICIENTS

Regression coefficients for continuous variables can be determined by a change of variables operation where x_1 replaces the factor A, x_2, the factor B, the product x_1x_2 replaces the interaction of A & B (also treated as a product) and x_3 replaces the factor C. In the standard factorial coding of the data, A, B, and C were coded with -1 when low, and +1 when high. AB was coded with -1 when A and B were at different levels (i.e., one low, one high) and with +1 when set to the same level. For AB, this coding is equivalent to the product of A's code and B's code.

When A is -1, x_1 = .05 and when A is +1, x_1 = -.15. Thus,

$x_1 = -.05 -.10A$,

or $A = -.5 -10x_1$. (H.1)

When B is -1, X_2 = +1.1 and when B is +1, x_1 = -.5. Thus,

$x_2 = -.80 + .30B$,

or $B = 2.67 + .33x_2$. (H.2)

Then, $AB = (-.5 -10x_1)(2.67 + .33x_2)$,

or $AB = -1.33 -26.67x_1 -.17x_2 -33.33x_1x_2$ (H.3)

Finally, when C = -1, $x_3 = (1-.2)^{-1.1} -1 = .278$, and when C = +1, $x_3 = (1-.1)^{-.5} -1 = .054$. Thus, $x_3 = .166 -.112C$,

or $C = 1.482 -8.197\, x_3$. (H.4)

For Colorado, the part of the equation involving A, B, AB, and C is

$2.25A + .83B + 1.65\, AB + 1.61C$. (H.5)

Substituting for A, B, AB, and C in (H.5) and collecting terms yields:

$$1.28 - 66.5x_1 - 33.3\,x_1x_2 - 13.2\,x_3.$$

For Michigan, the part of the equation involving A, B, AB, and C is

$$2.26A + 1.02B + 1.98AB + .56C. \qquad (H.6)$$

Substituting for A, B, AB, and C in (H.6) and collecting terms yields:

$$-.21 - 75.4x_1 - 66\,x_1x_2 - 4.6\,x_3.$$

For Missouri, the part of the equation involving A, B, AB, and C is:

$$2.09A + .73B + 1.37AB + 1.13C. \qquad (H.7)$$

Substituting for A, B, AB, and C in (H.7) and collecting terms yields:

$$.76 - 57.4\,x_1 - 45.7\,x_1x_2 - 9.3\,x_3.$$

For South Carolina, the part of the equation involving A, B, AB, and C is:

$$1.75A + .80B + 1.53AB + .71C. \qquad (H.8)$$

Substituting for A, B, AB, and C in (H.8) and collecting terms yields:

$$.28 - 58.3\,x_1 - 51.0\,x_1x_2 - 5.8\,x_3.$$

And for Vermont, the part of the equation involving A, B, AB, and C is:

$$3.97A + 1.21B + 2.35AB + 2.28C. \qquad (H.9)$$

Substituting for A, B, AB, and C in (H.9), and collecting terms yields:

$$1.49 - 102.4\,x_1 - 78.3\,x_1x_2 - 18.7\,x_3.$$

One may note that none of the resulting equations contain an x_2 term. The reason for this is that once terms were collected, the coefficient for x_2 was smaller than 0.01 in absolute value, thus, it was dropped as being insignificant, relative to the size of the coefficients of the other items.