Telecommunications access in rural Iowa:
A study of local calling areas in the
Southern Iowa Development District

by

Charles Hilarius Heying

A Thesis Submitted to the

Graduate Faculty in Partial Fulfillment of the

Requirements for the Degree of

MASTER OF COMMUNITY AND REGIONAL PLANNING

Major: Community and Regional Planning

Iowa State University
Ames, Iowa

1988

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF MAPS

PREFACE

When Marshall McLuan wrote in 1964, that in the electronic age "...all forms of wealth will result from the movement of information," only a few were aware of the prescience of his remarks. Since that time, the existence of an "information economy" has become widely recognized. Changes have been dramatic. In the two decades between 1950 and 1970, the percentage of national income generated by information industries increased by 60% (Abler, 1977). By 1980, close to 47% of the total labor force in the United States was engaged in information-related occupations (Hahn, 1980).

The expansion of the information economy is changing not only the nature of work, but also the environment in which it occurs. Futurists envision a home-based workplace electronically linked to a central office. An early prophet, J. R. Pierce (1967), commented that in this new era we should be able to "...live where we like, travel for pleasure and communicate to work."

If work and workplace are changing so too must urban form. But what new patterns are emerging? Are growth nodes springing up along major communications thoroughfares or is the network so ubiquitous that development occurs without regard to place?

To date, urban impacts have been complex. Gottmann (1977) writes that the communications network has freed the office from plant operations. Yet, at the same time, this has led to the agglomeration of main offices in specialized locations. Further, he states that the same telephone system that facilitates the intensification of space in a multistory office tower also coordinates the complex urban infrastructure which permits suburban decentralization.

It is inevitable that these changes would impact social relationships as well, but again, a similar paradox is evident. The telephone which allows us to "reach out and touch someone" at a distance also lets us bypass those close at hand. As Wurtzel and Turner (1977) state:

> A person's 'psychological neighborhood,' in this case would not be just a mental landscape beginning at the borders of his actual neighborhood, but one that superimposed itself upon his immediate environs, drawing him into a home-based telephonic web and out of the kind of street life that reduces isolation and makes a neighborhood a more supportive community.

Although it cannot be said that this pervasive restructuring is the sole result of one technology, it is apparent that it could not have taken place without the symbiotic growth of a universal interactive telephone communications system. In the culture which has arisen around this wired environment, the individual's primary connection is through the telephone instrument. Connection is indispensable. To be excluded from this electronic flow is to be stranded in a backwater out of the social and economic main stream.

Herein is derived the theme which underlies the study which follows. For good or ill, full participation in contemporary society requires inexpensive and unhindered access to the telephone network. System designs or pricing structures which inhibit access prevent full participation and impair development.

INTRODUCTION

The broad concern of this study is telecommunications access in rural Iowa. This concern is addressed within a manageable regional context involving nine counties in southwest Iowa which have been designated the Southern Iowa Development District. Within this region, the specific questions relate to local telephone calling area access to communities of interest.

The hypothesis is formulated within the context of social welfare optimality and states that:

> telephone subscribers in the Southern Iowa Development District whose local calling areas do not include predominant communities of interest incur greater relative costs for telephone service and make fewer calls than those whose local calling areas do include predominant communities of interest.

To test this hypothesis, community of interest access criteria are established and each of the telephone exchanges in the project area is evaluated on the basis of these criteria. Subscribers in the project area are then surveyed as to their calling patterns, frequency, and cost. This information is correlated with the community of interest access characteristics by exchange and conclusions are drawn as to the accuracy of the hypothesized statement.

DEVELOPMENT OF RESEARCH CONCERNS AND A REVIEW OF RELATED LITERATURE

Development of Research Concerns

Introduction

This section will discuss the development of the research concerns. It begins with an overview of the telephone system to acquaint readers with some terms which might be unfamiliar and to help clarify the nature of the network, its access characteristics and pricing structure. The system overview is followed by a brief discussion of the historical development of rural telephone networks and of parallel social and economic community developments. The question of concern is then formulated in the context of these historical developments. Is the present configuration of the system relevant to the present or the past? Do the toll-free local calling areas, as presently configured, permit optimal access to communities of interest?

Telephone system overview

Telephone network The telephone system has been physically and corporately organized around two interconnected entities, the local network and the long lines network. This distinction is rooted in the historical development of the industry, and although its relevance in todays integrated environment is being challenged, it remains an accurate description of the working structure of the present telephone network. Our concern in this investigation will focus primarily on the local network and in particular as it relates to rural telephone service in Iowa.

Rural exchange The geographic unit for administration of local telephone service is the exchange. The rural exchange includes the urban and rural areas surrounding and served by a central switching office. Each telephone subscriber is connected to the central switch by a pair of copper wires called the local loop (Model Tariff, 1985).

Extended area service Local exchange service may include communications between two separate exchanges which share a community of interest. The exchanges are joined by a trunking cable between central switches which essentially creates an extended toll-free local calling area (Garfield and Lovejoy, 1964).

Telephone companies Although the telephone system operates as an integrated network, control of its various parts is held by thousands of independent phone companies with diverse ownership structures. Telephone companies vary in size from those that hold one or two local exchanges to those that control many. Control of the local network is dominated by the seven Bell companies, General Telephone Company, and a limited number of other large corporations (Phillips, 1984).

Rate regulation Telephone companies are regulated utilities. Regulation of telephone rates is the joint concern of federal and state governments. The Federal Communications Commission (FCC), established in 1934 by an act of Congress, consolidated the regulation and licensing of a diverse group of communications technologies. In regard to telephone system regulation one of its primary charges has been to encourage universal and efficient telephone service. Until recently, regulation of interstate telephone traffic was the domain of the federal government, and intrastate and local were the concern of state regulators. Following the AT&T anti-trust settlement in the early 1980s which resulted in its divestiture of the Bell operating companies, new jurisdictional divisions were established. Under the new guidelines Local Access Transport Areas (LATAs), which essentially follow area code boundary lines, were set up. All inter LATA toll traffic came under federal jurisdiction and all intra LATA and local remained under state authority (Phillips, 1984).

Not all local telephone companies are rate regulated. Each state establishes its own guidelines. Within Iowa, only companies with more than 15,000 access lines are rate regulated (Administrative Codes, 1986). Only five companies, Central, Continental, General (GTE), Northwestern Bell, and United, of the 168 telephone companies operating in the state, are rate regulated.

Telephone rates

Base rate area   For rate setting purposes the area surrounding the local switch is designated either "base rate area" or "outside the base rate area." The base rate area generally extends to the municipal boundaries. Outside the base rate area is partitioned into roughly concentric zones with approximately two mile widths. Most local telephone rates are flat rates. Flat rates allow unlimited calling within the local calling area. Local flat rates vary by customer and class of service. Three criteria determine flat rate monthly charges; rate group, distance to the central switch, and class of service.

Rate group Research has consistently shown that the greater the number of toll-free access lines, the greater the number of calls per subscriber. Rate group charges are greater, the greater the number of access lines, based on a value of service determination.

Distance to the central switch Those in the base rate area are assessed the lowest flat rate. The further outside the base rate area that the subscriber is located the greater the flat rate. This is based on cost of service consideration.

Class of service Generally class of service is divided into business and residence. Within each of these are subclasses. Residence is subdivided primarily along single party and multiparty offerings. Business rates are highest, residence rates are lower, with multiparty residence having the lowest rates. Class of service rates are based on value of service considerations (Garfield and Lovejoy, 1964).

Value of service - cost of service Prior to recent regulatory decisions by the Federal Communications Commission (FCC) which have resulted in competitive inroads into many segments of the telephone industry, value of service considerations in the setting of local rates were relatively unchallenged. Simply understood, value of service pricing bases the allocation of joint costs on the usage characteristics of a class of service. Those who derive greater value from the service, pay more, even though strict cost considerations do not warrant the higher rates. The most obvious of these price discrepancies is between business and residence. The apparent price discrimination is justified on the grounds that underpricing residential service has encouraged more persons to join the network, thereby increasing the value of the network to all subscribers (Yordon, 1984).

Undoubtedly, value of service pricing served the end for which it was intended, because today, universal telephone service is a reality. But just as this goal is realized, new economic realities have forced a reconsideration of value of service pricing. FCC deregulation decisions have permitted specialized users, primarily business high volume users, to set up private telecommunication systems which bypass the local network. As this type of competition penetrates deeper into once controlled markets, value of service pricing is being abandoned in an attempt to keep heavy users on the existing network. In the new competitive environment cost of service pricing is being given extensive consideration (McCarthy, 1984).

Development of the rural telephone system

Early systems   Telephones were introduced into rural areas in the first decades of the twentieth century. By 1930, there were 14,842 rural exchanges of less than 500 telephones each (Tomblen, 1931). These were primarily operated by the 6,400 independent telephone companies then in existence (Phillips, 1984).

The first systems were constructed by farmers or townsmen who shared some economic or social interest. Sometimes, doctors wishing to maintain contact with patients hired local tradesmen to run lines along main roads. More often, farmer mutuals or coops were formed.

Service in the early systems was unpredictable. Single wire ground return lines were strung on whatever was available from trees to fence posts. Insulators were sometimes no more than bottomless canning jars. The standard telephone was of the magneto crank type that "worked like a coffee grinder and sounded like one too" (Rural Telephones, 1949).

Communal character The communal character of the rural phone system was evident from its inception. Telephones were used to summon neighbors to a fire, call the doctor, hear the news of the neighborhood, or order spare parts from town. The boundaries of the exchange were often the boundaries of the neighborhood. Lines were run as far as interest could be maintained and farmers would cooperate.

Growth and development Rural systems expanded rapidly until the 1930s. Between 1930 and 1945, rural systems declined in coverage and quality due primarily to three events; the Depression, rural electrification, and World War II.

The Depression created a shortage of capital. Local banks were unwilling to finance the modernization of small phone systems that were facing declining populations and uncollectable service fees. Lack of capital led to declining service which in turn resulted in fewer subscribers.

In 1936, the Rural Electrification Act was passed by Congress. Using newly available low interest loans, rural electric associations rapidly expanded electrical service from 11% of the farms in 1935 to 72% in 1948. The unfortunate side effect of rural electrification was to create heavy static on the old ground return rural phone systems, thus contributing to its demise.

World War II contributed to rural phone decline by creating material and labor shortages. The result of these three combined effects was declining rural service. By 1947, only 37% of all farms had telephone service. This was less than had service in 1920.

Tremendous growth occurred in the post-war period. Pent up demand was met with increasing commitment by the telephone companies. Assisted by new low interest government financing and utilizing new technologies such as two strand steel reinforced wire and modern switching, networks were expanded rapidly. By 1949, 79% of Iowa farms had telephone service, the highest in the nation, and on a level equal to urban areas (Rural Telephones, 1949). Expansion and modernization have continued to the present time when universal service is now a reality.

The telephone system and community change

Early community character The rural phone system was conceived and developed along the lines of neighborhood and locality. At the time of its inception, when the boundaries of the exchanges were being established, rural communities were fundamentally self-contained and activity was focused in the neighborhood. Local and township governments were decisionmaking units of importance. The epicenter of social life was the rural school and neighborhood church. Work and entertainment were local and a trip to the county seat was an event.

Fundamental changes Fundamental changes have restructured the rural community as the result of four forces, improved transportation and communications, mechanization and commercialization of agriculture, rural outmigration, and diminished local control.

Transportation and communication The introduction of the automobile and the construction of improved roads reduced the friction of space. The necessity to trade locally was diminished as farmers and small town residents could more easily travel to other trade centers. Improved communications also accelerated social change. The post office provided access to mail order goods and the telephone created an instantly accessible network of social and business contacts beyond the locality. Radio, television, and recently satellite transmission continue to expand the neighborhood and its range of interconnections.

Agricultural commercialization While the roads led people out of local neighborhoods, they also brought in outside influences. Industrial growth in urban areas fueled the expansion and innovation of mechanized agriculture. Electrical and mechanical power supplanted horse power. With increased productivity, farmers were able to farm more land. Specialization replaced diversification and with it came the need for specialized services; creameries, feed stores, veterinarians, implement dealers, egg buyers, salesmen, mechanics, and electricians.

Rural outmigration Increased productivity also reduced the need for labor. From 1910 on, outmigration from rural areas has continued incesscently. Population size has remained stagnant or declined. Even the natural increase of the population that should have occurred, has not occurred, as persons migrated to urban areas. Push-pull factors have affected this outmigration. The lack of opportunity in rural areas has pushed, while the lure of jobs, education, and amenities has pulled migrants to the cities.

<u>Diminishing local control</u> The rural community, once characterized by self-determination, has over time seen the intrusion of state and federal influences. State curriculum guidelines have forced school consolidations. State licensing of everyone from teachers to barbers has diminished local control. Federal food processing inspectors, sewer and water system guidelines, federal grants, farm loan programs, soil conservation districts, regional service agencies, and university extension agents have all hastened the demise of local autonomy (Field and Demit, 1978).

<u>Consequences of social change</u> These combined social changes have led to a restructuring of rural relationships. Rural churches have consolidated. Rural schools have been joined with community schools and these in turn have been reformed into multi-community districts. Farms have expanded as small towns have declined. Regional trade centers, frequently county seat towns, have expanded as they developed into farm and social service centers. County seat towns have become the location of specialized local, state, and federal governmental activities and of associated legal, banking, insurance, and real estate services. Beyond the counties, the larger urban areas continue to increase their influence, as they become the centers for even more specialized trade

and recreation activities.

Community restructuring and telephone exchanges While the structure and boundaries of rural communities have changed and expanded, the rural telephone system has become somewhat locked into a local service network that does not represent the new communities of interest. Although the ownership of local exchanges has been increasingly consolidated (in 1930, there were 6,400 independent phone companies; in 1981, only 1,459 remained) (Phillips, 1984), the exchange boundaries that were formed when communities were primarily local have remained essentially unaltered.

To some extent, rural areas have adapted by expanding local calling areas through the initiation of extended area service to neighboring exchanges. Yet, because of the difficulty and significant time delays involved in the process, the expansion of extended area service has been extremely spotty. Today, the local calling areas of many rural exchanges have not expanded beyond the boundaries of the local exchange areas which were established when the exchanges were first laid out.

Statement of research concerns

Garfield and Lovejoy (1964) in Public Utility Economics, for many years the standard industry text, commented on the original purpose of the telephone exchange area:

> In establishing each exchange area, the basic objective is to include the primary social and economic interest of the people residing in or around a central community.

They further state:

> Exchange service may include communications between exchanges. This 'extended area' local service is furnished where there are two or more exchanges (each including a central community and its surrounding territory) with a substantial community of interest between them. It has been found that customers' requirements are best met by local service areas which include not only their own exchange but the other exchanges in which they are interested.

These comments now begin to focus our attention on the questions that will be the concern of this research. In rural Iowa, does the present configuration of local toll-free calling areas reflect contemporary communities of interest? Does the present configuration of local calling areas encompass the "primary social and economic interests of the people residing in or around a central community," as Garfield and Lovejoy have stated is their purpose? Are present local calling areas ones "...within which the majority of customers have the bulk of their communication requirements" (Garfield and Lovejoy, 1964)?

Using these definitions as a guide, a specific area in rural Iowa will be examined to determine if the local calling area of certain exchanges encompass contemporary communities of interest. A further question will explore whether subscribers in exchanges who lack access to communities of interest are being prevented from optimal use of their phone system because the access characteristics lead to a reduction in numbers of calls and/or higher phone bills.

Review of the Literature on Access Areas and Pricing Characteristics as They Relate to the Socially Optimal Use of the Local Telephone Network

Introduction

The previous sections addressed the historical development of rural exchanges, the social and economic changes that have occurred in these communities, and finally introduced the question as to whether the present arrangement of local calling areas reflects the original purpose of a toll-free community of interest calling area. This question prefaced another which asked if local calling areas should be expanded by the implementation of extended area service. Within this discussion has been the presumption that toll-free extended area access creates a socially optimal situation. Is there a body of literature to support this?

Dansby study

Question of interest

Only one study has been found which directly addresses the social optimality of extended area service. Dansby (1980) considers this question in a two-part study of the application of spatial economics to public utility pricing. In the section dealing with EAS, Dansby states:

> The question of interest is whether an enlargement of a local exchange is economically justified on the basis of cost/benefit criteria. Here the cost/benefit criterion is taken to be social welfare, the sum of consumers' surplus and profit. Thus we compare the social welfare yielded by serving

> intraexchange calls on a flat-rate basis and interexchange calls on a toll basis to the social welfare yielded when both exchanges constitute a single flat-rate calling area.

<u>Dansby's calculation of social welfare</u> Dansby begins his discussion with the understanding that there will be no loss of revenue to the local exchange. Therefore the charge for EAS must equal the loss and gains to the exchange when EAS is put into effect. This may be stated as follows: the new EAS charge will equal (1) the lost toll revenue plus (2) the added fixed cost which could result from a need for new trunking cable or switching equipment minus (3) the savings in toll measurement and traffic related costs. It follows from this that the social welfare of the consumer will equal the (1) consumer surplus from the reduction to zero of toll calls to the EAS exchange, minus (2) the new EAS charge.

<u>First conclusions</u> Dansby draws his first conclusions based on a linear demand for calls after EAS is installed. Given this assumption Dansby concludes that

1. if toll price is above marginal cost, then there will be a net benefit in welfare,
2. at optimal toll prices, net welfare benefit is questionable,
3. if measurement costs are low or additional fixed costs are high, it follows that net social welfare will be diminished.

<u>Inconsistency of linear demand</u> Dansby then questions the validity of the linear demand assumption. Citing empirical studies which recorded EAS usage increases equal to ten times the toll usage

(Pavarini, 1978),[1] and further citing price elasticity studies for short haul toll ranging from -.10 to -1.7 (Taylor, 1978), Dansby concludes that the linear demand function is inconsistent with observations. He reasons that the demand curve is convex.

Alternative approach Given his inability to precisely determine the shape of the demand curve, Dansby abandons his attempt to empirically estimate the social welfare impact of EAS and turns instead to estimating the upper and lower limits at which increased calling demand will result in a social welfare benefit.

Dansby concludes, "...the bounds are quite accurate gauges of the change in social welfare if the ratio of usage under EAS to current toll usage is approximately equal to one minus the current elasticity of toll demand."

Comments

Practical considerations Dansby's interesting work proves of little value for any application which attempts to estimate social welfare prior to the implementation of EAS since his critical final conclusion depends precisely on the increase in usage which can only be

---

[1] A variety of estimates have been made on the increase of EAS usage to toll usage between the same exchanges. Dansby cites Pavarini's ten-fold increases. Mandanis et al. (1973) claim a six-fold increase. Dennis Hockmuth of the Iowa Utilities Division states that the working figure for traffic engineers is a seven- to eight-fold increase. Ione Wilkins, Pricing Manager for Northwestern Bell, indicates an eight-fold increase. One can conclude that the acknowledged range is between a six- and ten-fold increase.

known after EAS is undertaken. The work also ignores some rather relevant practical considerations. Social welfare will be different for each subscriber depending on their individual ratio of toll charges to EAS charges and their own estimate of increased usage after EAS is in place.

As a practical matter, this estimate will be reflected in the vote the subscriber casts when and if EAS is proposed. At the time of the vote, the ballot is required to list the telephone companies' estimate of the new EAS charge (Administrative Codes, 1986). Given this information, the presumption is that the subscribers will have full knowledge of not only their own, but the communal, costs and benefits and will vote accordingly. Any such assumption would be in error, although one hopes that numerous decisions made with imperfect knowledge will, in the aggregate, produce a decision which more or less reflects a consensus of social welfare.

<u>Other shortcomings</u> The study falls short in one other area. In his simplifying assumptions, Dansby chooses to ignore the fact that "consumer surplus derived by a subscriber may depend on the total number of subscribers in the two exchanges." Numerous studies (Comprehensive Study of Telephone Service, 1985; Garfield and Lovejoy, 1964) have shown that the average number of calls per subscriber increases with the size of the local calling area. To ignore this network externality is to ignore one of the primary consumer benefits of EAS, although some of this may be reflected in the six- to ten-fold increase in calling following EAS connection.

Value of Dansby's work The primary benefit of the Dansby work is to illucidate those factors which should be considered in evaluating an EAS proposal. Those factors are:

1. how closely does toll cost reflect optimal pricing,
2. what additional fixed costs will be incurred to implement EAS,
3. what is the extent of toll calling between exchanges and is it sufficient to justify EAS (This cuts two ways. A large number of toll calls will result in greater revenue shortfalls thereby increasing EAS charges. On the other side of the cut, heavy volume toll calling results in greater consumer savings under EAS and a proportionately larger increase in new EAS demand.),
4. to what extent will calling increase after EAS is implemented.

Conclusions The following conclusions can be drawn from the discussion. (Conclusion 1) If revenues remain unchanged and the number of calls does not increase after EAS is implemented, the net result will be to redistribute costs among subscribers. What benefit differential would occur is prescribed by the EAS charge and would be the difference between savings on toll billing and measurement cost and increased fixed cost for installing EAS plus the lost toll revenue. (Conclusion 2) The primary benefit from EAS is the six- to ten-fold increase in calling that results from unmeasured and non-toll access to a larger subscriber group.

EAS and equity issues

Introduction The question that was not addressed in the previous discussion is the extent to which some subscribers benefit more than others from EAS. Do the subscribers in one exchange benefit more than those in the other? Do some subscribers within an exchange benefit more than others?

Interexchange equity Dennis Hockmuth of the Iowa Utilities Division confirmed what seems intuitively obvious. For rural areas when a smaller exchange accesses a larger exchange, especially if the larger exchange is the center of communities of interest, most added calling is initiated in the smaller exchange. This would seem to disadvantage the larger exchange if costs were equally shared. But costs are not equally shared. Although specific implementation policies vary by company, the general procedure is to base costs on a distance and added-access-lines matrix which incorporates new fixed costs and lost toll revenue. The result is that small exchanges pay considerably more than larger exchanges for EAS, reflecting a sort of value of service, cost of service compromise.

Subscriber equity Within the exchange, are there differences among customers? This question was addressed as one part of the recent study of telephone service in Iowa. The Comprehensive Study of Telephone Service is a joint study prepared in 1985 by Northwestern Bell and the Iowa State Commerce Commission (now the Iowa Utilities Division). The purpose of the study was to evaluate local rate designs and rate relationships for business and residential customers in Iowa. The study samples 7,210 customers from eleven Northwestern Bell exchanges and utilized two independent data bases along with compatible income tax and driver's licenses records. With this information they analyzed toll and local phone usage on a customer specific basis.

The study addressed differential usage and cost by customer, one aspect of which related to EAS. The results of the study showed that EAS usage was heavier for business users than for residential. When assessing whether EAS usage represents a higher ratio of business to residence than is typical of non-EAS local calling, the results were inconclusive.

The research also indicated that many customers do not make use of EAS. Only 64% of residence lines used EAS while 90% of business lines used EAS. In all cases the range of EAS usage was at least four times the standard deviation.

When comparing this dispersion of usage patterns to usage patterns for all calling, similarities were evident. The study reported that within an exchange or class of service, 65% of all customers make less than the average number of calls and 35% make more than the average. This skewness of the distribution is further evident in that half of all calls are initiated by only 20% of the customers.

Local measured service - GTE experiment

Changing attitudes to usage sensitive pricing While not specifically recommending a change, the Comprehensive Study of Telephone

Service implied that usage inequities could be rectified by some sort of cost or usage sensitive pricing. This implication reflects a recent resurgence of interest in cost and usage sensitive pricing that has arisen in the new deregulated environment. In the words of one advocate, "Just like water, you pay only for what you use, but you pay for every drop" (Jensik, 1982).

This change in attitude is marked. In 1964, Garfield and Lovejoy could state with assurance,

> The design of telephone rate schedules is determined almost entirely by value-of-service consideration. In fact, there has been next to no interest shown by either regulatory commissions or telephone companies in basing rates for different classes of telephone service, or the rate differentials among them on the results of cost analyses.

Contrast this to the recent comments by Mark McCarthy (1984) of the House Energy and Commerce Committee made during a national workshop on local access. He states:

> One indication of the gap between theory and practice in telecommunications is the near universal acceptance of local measured service by experts. Economists in particular are enticed by the notion of cost-based usage charges in local telephone service as a means of achieving economic efficiency.

Relevance to the present study To bring this back to our present question of EAS, let me clarify the relationship of EAS with cost-based usage pricing in its most common form, local measured service. In the case of two exchanges sharing common communities of interest but lacking EAS, the imposition of toll charges has a parallel affect to local measured service, where each call is metered.

Admittedly, this is an imperfect relationship but the similarities do seem close enough to justify an examination of some of the local measured service research.

The GTE experiment The most recent and comprehensive local measured service experiment, as reported by Jensik (1982), was conducted in three Illinois communities, Tuscola, Jacksonville, and Clinton in 1977. These communities were chosen because they were representative of communities served by General Telephone (GTE), the sponsoring company. After a two year educational period, all three exchanges were converted from flat rate billing for local service to non-optional local measured service billing. This was pure usage sensitive billing with no allowances. Every customer paid for every call. Duration was measured and charged to the thousandth of a minute.

The final agreed upon tariffs were not pure cost based tariffs because certain practical considerations held sway. The first involved the difficulty of allocating costs to classes of service. When joint costs are involved, as they are in the integrated phone system, the separation of cost becomes problematic. What cost is purely local? What cost can be allocated to long distance? Can business and residential costs be truly separated? (The issue of cost separation lies at the heart of nearly all contemporary debate on pricing.) The solution offered in the GTE experiment was to sidestep the cost allocation issue and only consider residual revenue needs remaining after all other sources of revenue had been exhausted.

Second, it was decided that the existing price distinctions among classes of service would be retained. Tariffs would be established which generated proportional amounts as under flat rates. The resulting tariffs established two tiered fixed charges for business and residential customers which resembled flat rate tariffs but at a substantially reduced level. To these fixed charges was added a constant usage charge which was uniform across all levels and classes of service.

The new tariff structure went into effect September 1, 1977. Because of the two year educational campaign, which included sample billings, subscribers were well aware of the situation. The reaction to the new rates was dramatic. The day after the initiation of measured service, there was an overall drop in usage of 30.8%. By class of service, single line resident dropped 36.3%, single line business 15.3%, key line business 6.1%, and PBX, 8.1%. The expected drift upward over time failed to materialize and even after a year, calling remained substantially suppressed.

Jensik's concluding comments were terse. Ignoring any discussion of lost benefits to the customers, Jensik stated, "...given the opportunity to save by cutting back on local phone conversations, customers took it."

<u>Comments on the Jensik report</u> The GTE experiment was a significant test of local measured service, but Jensik's report of it leaves many questions unanswered. No attempt was made to discern how calling patterns were affected on a customer by customer basis. Did all customers cut back equally? Did some save money? Were costs more

equitably distributed, and even if this was the case, was the end result one in which everyone paid more for each minute they used the phone? Certainly, this last case is a potential outcome of local measured service pricing. Given the following:

> a fixed level of revenue must be generated to cover fixed costs,
>
> fixed capital and maintenance costs are very high relative to the cost of call processing,
>
> significant repressive effects can be expected with measured service;

it follows that nearly the same costs are spread over a fewer number of calls. Therefore, it is conceivable that collectively all persons paid more for each minute of service. This is a case of Pureto optimality. With a flat rate covering the same fixed costs, no class of service is worse off and many are better off. With measured service covering the same fixed costs, all classes of service are worse off.

Furthermore, it is possible that a negative spiral can occur. In the event that usage fees do not cover costs, then usage fees would have to be raised. The reaction to higher fees could be a further reduction in usage. This in turn would force higher fees and so on. Taking this argument to the extreme, it is conceivable that, ultimately, only those calls would be made that were of the utmost importance. These calls would be priced extremely high to cover the still existing fixed costs of the phone system. It is unfortunate that this issue was not discussed. Although measured service may allocate costs more equitably, it may do so at a net loss to all.

Another aspect neglected in Jensik's presentation was the additional expense incurred for metering and billing all local calls. This cost is not unsubstantial. Although new technology may substantially reduce these costs, this new equipment may not be in place and its installation would add to the fixed costs.

Rand Corporation study

Introduction Inadequacies in Jensik's presentation were not apparent in a Rand Corporation study which utilized similar data from one of the communities in the Illinois GTE experiment. In the Rand study, Park and Mitchell (1986) attempt to find optimal time of day measured rate prices for local telephone calls.

Marginal cost pricing and peak capacity In earlier work, Mitchell (1983) had begun to recognize that attempts at marginal cost pricing did not account for peak capacity characteristics in telephone plant design. Previous researchers had assumed that each local call had a constant marginal cost. Mitchell (1983) reasoned that only peak capacity calls created incremental costs. Mitchell states:

> At all these [lower volume] hours additional usage occurs when there is some excess capacity - additional calling does not degrade service, no extra equipment is required, and marginal costs are zero (apart from small costs of energy consumed and extra maintenance). Thus for a few hours a year marginal costs of local telephone calls are very high, but, for the most part, local telephone calls are a free good.

Tariff simulation model Based on this earlier insight, Park and Mitchell designed a simulation model which essentially compared alternative tariffs for systems designed around (1) price rationing using feasible (understandable to consumers) local measured service; and, (2) quantity rationing, the traditional flat rate basic service. The model estimated capacity cost savings, measurement costs, loss in consumer benefit due to quantity rationing, and loss in consumer benefit due to price rationing. Ultimately, the model determined the net welfare effects for a number of alternative tariffs.

Conclusion Park and Mitchell (1986) reach two major conclusions. The second is most pertinent to our discussion. They state:

> Measured-rate pricing of local telephone calls is unlikely to increase economic efficiency in most circumstances, even if the tariffs are carefully designed and the costs of measuring calls are minimal. The demand for local telephone calls varies substantially within feasible time-of-day pricing periods, and the marginal costs of additional capacity have fallen with the introduction of digital electronics and optical transmission. In these circumstances, a flat monthly rate with no extra charge for use (a tariff that rations demand during just a few of the highest use hours of the year) is apt to be at least as efficient as feasible price rationing (which rations demand during many hours when excess capacity is available). Efficiency considerations alone do not support a public policy choice of measured rates over flat rates for local telephone service.

Review of the research and its relevance to EAS

Measured service, EAS analogy At this juncture, it is important that we review the research presented thus far and relate it to the question of EAS as an alternative to toll calling to community of interest exchanges. As previously mentioned, toll calling to a community of interest exchange is similar in nature to local measured service. Each customer pays for every call. We have seen in the GTE experiment that local measured service substantially and over time repressed calling, resulting in a significant reduction in consumer benefit. If our analogy holds, we conclude that toll calling likewise is repressed over the non-toll calling that could be expected between exchanges if EAS were in place.

Underutilization of the telephone plant We have reasoned that if fixed costs are to be recovered in an exchange where calling has been substantially repressed, each minute of each call must cost more than before. In like manner, in exchanges with shared communities of interest and no EAS, calling is substantially repressed over what would occur with EAS. If fixed costs are to be recovered in these exchanges, again, each minute of each call must carry a heavier burden. Further, we know from data to be presented later in this study that 60-70% of all revenues for small rural exchanges are derived from tolls. This indicates that toll calls are carrying the weight of the fixed costs of the exchanges.

We have also seen that while calling is suppressed, the telephone plants are underutilized. Mitchell (1983) has observed that for all but a few peak hour calls, "...additional calling does not degrade the service, no extra equipment is required and marginal costs are zero...." In this aspect, the phone system resembles a public good. Use by one does not preclude use by another. Social welfare is sub-optimal where the system could be more fully utilized and costs still recovered.

We have also seen that local measured service is perhaps more equitable but may result in net loss to all. Likewise, toll calling may also be more equitable but also may result in a net loss to all.

Breaking the log jam   Finally, we have seen that this ever compounding log jam of tolls and decreased usage can be broken with the implementation of EAS. Verification from numerous sources confirms that usage will expand six to ten fold. As Dansby has shown, this increase will result in a social welfare benefit if the net consumer benefit is greater than the EAS charge. The EAS charge will be determined by the amount necessary to compensate for loss in toll revenue plus any added fixed cost minus the savings in toll measurement and billing. Individual subscribers will ultimately need to balance these criteria when and if EAS is proposed.

The pleasure principle - an alternative approach

Playfulness and policy   In the previous sections of the review of the literature, the toll versus EAS question has focused exclusively on matters of efficiency, equity, and productivity. These final comments are intended to offer an alternative perspective, i.e., the community and social aspects of the telephone system design. Carolyn Marvin, in her article Telecommunications Policy and the Pleasure Principle (1983), states:

> Modern systems of telecommunications are organized almost entirely around the values of productivity, values that are almost as unchallenged in our culture as they are unacknowledged - at least in areas like telecommunications where the

> possibilities of other frameworks have rarely been discussed. In Western social science, productivity is a measure of efficiency in the use of resources based on a comparison of ratios of outputs to specified inputs of labour and capital. The narrow range within which such inputs are usually defined makes this measure a problematic one, and reflects a history of attitudes about economic rationality that Max Weber introduced into sociological discussion as 'the spirit of capitalism.' Stripped now of its religious moorings, this spirit is hostile to playfulness for its own sake, to the possibility of wasted time, to any evasion of the relentless responsibility to rationalize all activity to pecuniary profit.

Is a consideration of playfulness lacking in how we structure our phone system? Marvin is emphatic.

> Even for basic telephone service, consumer pricing is an increasingly exact function of time on the wire and message distance. Usage-sensitive rate structures do make possible an orderly transition to a more competitive system, but their greatest beneficiaries are telecommunications vendors and their largest-volume users. Precision billing serves efficiency and work, not play. The changing economics of small-consumer communications may also affect the sociability of telephone conversation by encouraging inflation-pressed families to cut back on communication for fun to allow communication for necessity. In any case, precision billing preoccupies telephone users with time. It is an enemy of the unselfconsciousness of time that is part of the true condition of playfulness.

<u>Comments</u> Marvin's insights are challenging. Perhaps we have been floundering, head down, through the maze of allocative efficiency while she flies overhead trailing a banner of enlightenment. Playfulness, discretionary conversations, sociability, community, what better argument can be offered for extending the range of communications and doing it in such a way that people no longer perceive a parsimonious

allocation of a thousandth of a minute.

Perhaps we have defined social optionality so narrowly as to disregard a host of non-economic values such as social cohesion, carefree conversation, and creative communal interaction which cannot be definitely valued or even understood on the individual level which is our usual point of reference.

RESEARCH DESIGN AND METHODOLOGY

Study Area Defined - Hypothesis Stated

Introduction

The review of the literature suggests that limited local calling areas lead to a sub-optimal utilization of the telephone network. This section of the study will describe the research methods which will attempt to assess whether that is the case. The research questions will be addressed in a specific context and formed in a manner which presents a testable hypothesis. The selection of the study area and the statement of the research hypothesis will be followed by a brief overview of the research process and finally by a detailed description of research methods.

Study area

Southern Iowa Development District The Southern Iowa Development District (SIDD) is a nine-county region in southwest Iowa which includes the counties of Adair, Adams, Clarke, Decatur, Madison, Montgomery, Ringgold, Taylor, and Union. The Design Research Institute of Iowa State University, with financial assistance from the Northwest Area Foundation, has undertaken a three-year project to assist SIDD communities and rural areas in the creation of a regional development model.

The SIDD area was chosen as the subject area for this study with the encouragement of researchers associated with the project. It was suggested that this study would contribute to the creation of the SIDD regional development model. The SIDD area offered the advantages of proximity to the university, a predefined project area, and the benefits of ongoing research which could complement the work of this study.

Limitations The region presented some limitations due to the lack of natural boundaries which might confine the community of interest areas. The proximity of the southern tier of counties to the Missouri border also presented possible data gathering difficulties. The size of the region which at first seemed prohibitive, ultimately proved well suited since it was sufficiently large to be representative and yet small enough to be manageable. The nine-county SIDD region seems fairly representative of rural Iowa counties although a disproportionate share of the counties had lower per capita incomes than the statewide average.

Statement of hypothesis

The primary research objective of this study is to determine if some rural telephone subscribers face inhibitions to full participation in the communications network because they lack toll free access to their communities of interest. Specifically, as it relates to the study area it is hypothesized that:

> telephone subscribers in the Southern Iowa Development District whose local calling areas do not include predominant communities of interest incur greater relative costs for telephone service and make fewer calls than those whose local calling areas do include predominant communities of interest.

An Overview of the Research Process

Access area delineation

The process of comparing subscriber cost and usage based on calling area access requires that the access characteristics of exchanges be delineated. To this end, a base map showing the exchange boundaries and EAS connections was created. In addition, a series of overlay maps which geographically outline community of interest criteria were drawn. The base map and overlays formed a composite map which defined the access characteristics by exchange.

Using the composite map and supplemented by data on the total access lines per exchange and per toll-free calling area, a worksheet was created of access characteristics by exchange. This worksheet served a two-fold purpose; (1) it was used to stratify the sample for the survey, and (2) it defined the independent variables against which the dependent variables of cost and usage were regressed.

Survey

With the completion of the access worksheet, the survey phase of the study began. A brief questionnaire was prepared to determine usage and cost of service for subscribers by exchange. Exchanges were sorted by access characteristics into three strata. From these strata, 16 exchanges were randomly selected. Using telephone directories, twenty-five subscribers per exchange were randomly selected and surveys mailed to them.

Testing the hypothesis

The returned surveys were tabulated and ordinary least squares regressions run. The dependent variables, local calls, toll calls, total calls, total amount due, and local toll charge, were each regressed against four independent variables: calling area access lines, per cent of school district accessible, access to the trade capital, and access to the county seat. The results of these correlations were used to test the validity of the original hypothesis.

Access Area Delineation

Creating the base map

As previously stated, the process of comparing subscriber cost and usage based on calling area access required some form of spatial analysis. For this purpose, it was first necessary to create a base map which illustrated exchange boundaries, exchange towns and extended area service.

With the cooperation of staff at the Iowa Utilities Division, a mylar base map of the section of Iowa containing the SIDD study area and which showed the boundaries of telephone exchanges was loaned to the Iowa Department of Transportation (DOT). With the assistance of DOT, the SIDD area was blocked out and photographically reproduced on mylar at the original scale of 1/2" to 1 mile. From this, a second mylar was made, reducing the map in size to 38% of the original.

The reduction of the map created certain problems. The original full size map detailed each county by section, and with reduction, the section lines made the map appear too dense. To create a more visually acceptable base map, it was decided to manually trace the map, detailing only the exchange towns (i.e., the location of the central switch), the exchange boundaries, and the county lines. To complete the base map, extended area service connections were indicated by arrows between exchanges where EAS existed. Information concerning EAS between exchanges was obtained from the respective 1985 Telephone Company Annual Reports to the Iowa Utilities Division.

The tracing of the map required constant and exact alignment of the original reduced exchange map and the mylar overlays used for the tracing. To maintain the alignment precision for the base map and all subsequent overlays, a standard pin bar was employed with holes punched on the overlays by a professional service.

Selection of community of interest criteria

Webs of interaction   With the completion of the base map, some decision was necessary to determine which community of interest criteria would be representative. Garfield and Lovejoy (1964) offered little in the way of specific guidance. Their expression of a socio-economic community of interest would not suffice, and it was apparent that an inclusive listing of extended webs of community interactions would be prohibitive. Each household would have its unique network of family, friends, social, and religious ties, activities associated with meeting the basic needs of food, shelter, health, and mobility, activities associated with education and community governance, and daily activities of work and recreation. It was obvious, at the outset, that only a very limited number of factors could be considered.

To be considered also was the possibility that communities of interest are not spatially bounded. Inherent in the Garfield and Lovejoy statement that exchanges were designed to reflect communities of interest, is the assumption that these webs of interaction are for the most part formed by face to face contact.

Telephone and community Some of the literature on the social impact of the telephone suggests that it has the effect of creating non-territorial communities (Keller, 1977). The observations of other researchers suggest that this may not be as significant as presumed. Mayer (1977) reports that studies of local calling patterns indicate that 40-50% of all calls originating from a household are made within a two mile radius indicating that most are within a neighborhood. Another series of studies of communication contacts by persons working in large government agencies or for national and international corporations has shown that telephones are only one part of a multifaceted network of communication. The telephone is seldom used to create new linkages but most commonly reinforces existing ones that have been created and are maintained by personal face to face contacts in the local environment (Thorngren, 1977).

Final selection The resolution of this intriguing question was not within the scope of this study. Therefore, a simplifying assumption was made that communities of interest are primarily local, i.e., those that constitute the bulk of daily face to face contacts. The existence of readily available data dictated the selection of school districts, trade areas, and county seat town as the relevant community of interest criteria. A justification of these selections follows.

<u>County seat towns</u> County seat towns have been the traditional focus of local government activity. In addition, state and federal government offices such as county extension, FHA, Soil Conservation Services, Regional Planning Agencies, area social and educational services also aggregate in county seat towns. These agencies, plus all the attendant legal, banking, insurance, and real estate support services are heavy users of the telephone system.

<u>School district</u> The choice of school districts as a community of interest seems intuitively correct. Family activities, including intergenerational family activities in rural areas, are dominated by school functions. The determination with which communities resist the closing of a school also attests to its importance as a community focus. As further evidence of its link to communication, demographic studies of telephone use (Comprehensive Study of Telephone Service, 1985) show that the presence of teenagers in a household greatly increase telephone use. The presumption is that most calls are made to classmates.

<u>Retail trade areas</u> Retail trade areas, since they subsume other community characteristics, are important indicators of many other communities of interest. The discovery of an existing study by Marvin Julius, Iowa State University Extension economist, which graphically

delineates the trade territories of Iowa towns and cities over 1500, made the selection as a community of interest indicator immeasurably more acceptable.

Julius utilizes a form of the Reilly model for his delineation. Beginning with a rectangular grid, Julius assumes that "the attractions of the two towns for a customer will be equal at all points where the ratios of distances to the two towns are equal to the ratio of the cube roots of the populations of the towns" (Julius, 1975). This formula establishes the indifference boundary, i.e., the locus of all points at which a customer will be indifferent between two towns. The only data necessary for this delineation are population and distance between cities.

The study has two major limitations; it was completed in 1975, and it does not delineate trade territories of towns under 1500. In regard to the latter, Julius explains that towns under 1500 are "assumed to be a part of the trade territory of some larger town for many items while having their own territory for a limited number of items stocked by their merchants." Two towns in the SIDD area, Lenox with a population of 1317 and Villisca with 1420, were affected most obviously by this decision. Adjustments were made for their influence when establishing community of interest areas by exchange.

No adjustment can be made for the inaccuracies due to the dated nature of the study. The presumption that populations have not changed over time would be inaccurate. The alternative of replicating the study is not possible. The results must be accepted with knowledge of their limitations and with the understanding that approximations are probably acceptable for purposes of this study.

Creating the overlay maps

School districts Having made the decision on community of interest criteria, the overlay maps could be created. the first overlay displayed school districts. School district information was obtained from the Iowa Department of Education map Public School Districts (1984). The scale of the map did not correspond to the scale of the base map so photo-copy enlargements were made of the school district map until its county outlines matched those of the base map. This procedure caused some minor distortion, but the error was acceptable for the purpose of this study. Various patterns of graphic screening were laid down on the overlay and cut to match the school district boundaries. Some simplification of boundary lines was made where preservation of detail would add little to the analysis but would detract from the visual quality of the overlays. Screening patterns used to indicate particular school districts were chosen for graphic distinction and have no other significance and do not correspond in any way with screening patterns used to designate telephone companies on a subsequent overlay.

Retail trade areas The trade territory delineations were also made using the photo copy enlargement process, but in this case, greater distortion occurred. The original trade territory maps, created by Julius, were printed on separate 8 1/2" x 11" sheets and first had to be combined into a composite map large enough to cover the entire SIDD area. This composite map was then enlarged to fit the outline of the base map. Since no county boundaries were designated on the Julius maps, the only means to key the map was to align the location of towns. This was an imperfect method at best and the final map should be seen as an approximation only. Accepting this and other limitations, the trade territory delineation remains acceptable for the purpose of the present study.

Composite map and analysis

Printing the maps   A base map and two overlays, one of school districts, the other of trade territories, now existed. Two additional overlays, one designating telephone company territories and another illustrating switching networks and toll completing centers, were also created. (These latter two will be discussed in a subsequent section.)

Six full size diazo prints of the base map with various combinations of overlays were made. The composite map of interest for the present discussion showed the exchanges, EAS connections, school districts, trade areas, and county seat towns.

Visual analysis   Using a simple visual analysis of the composite map, a computer worksheet was created which recorded community of interest access characteristics by exchange. (On the worksheet, the term trade capital indicated the town around which the trade territory was delineated.) Access to the trade capital or to the county seat by the exchange of interest was designated either yes or no depending on whether or not EAS existed between the exchanges. Access to the school district, also based on the existence of EAS between exchanges, was calculated on a percentage basis.

Majority rule Since exchange boundaries did not often coincide with trade area delineations or county borders, it was decided that majority rule should apply. If most of the exchange of interest, including the exchange town itself lay within a trade territory, that exchange of interest was determined to be associated with that trade territory. Likewise, if most of the exchange of interest, including the exchange town, lay within the county border, it was determined to be associated with that county. Application of this rule was less precise than its statement. Judgement calls will be discussed in the findings on a case by case basis.

In general, the school district boundaries did more closely correspond to exchange boundaries, but school districts often included four or five exchanges. If EAS did not exist between all exchanges in a school district, a visual approximation of the percentage of access that did exist was made. Because this method took into consideration only geography and not population, there was some distortion of true access characteristics. This limitation was mitigated somewhat since exchange areas roughly correspond to exchange populations.

Community of interest access worksheet The end product of this visual analysis was the creation of a worksheet which listed toll-free access characteristics by exchange. To this worksheet was added two additional columns of data; total number of access lines by exchange, and combined number of EAS and exchange access lines by exchange. This data was taken from the respective 1985 Telephone Company Annual Reports. As noted in the review of the literature, total access lines in the toll-free calling area have been shown to correspond to total number of calls per subscriber.

Additional maps

Overview   Two additional overlay maps showing (1) telephone companies and (2) toll completing centers were made. Information from these overlays was used to examine inter-company and inter-LATA extended area service between related exchanges.

Telephone companies   Because most telephone companies operating in the SIDD area own numerous exchanges, it was felt that some relationship might exist between telephone company ownership and EAS between exchanges. The speculation was that EAS would be less likely between exchanges owned by different companies. To test this mini-hypothesis, an overlay was created showing telephone company ownership patterns. In the same manner as previously described, the base map, anchored by the pin bar, was overlain with a separate clear mylar sheet, also anchored by the pin bar. Various patterns of graphic screening were laid down and cut to conform to the boundaries of telephone company ownership. Information was taken from the "State of Iowa Telephone Exchange Area Map" published by the Iowa Utilities Division in 1982.

Toll completing centers   Another overlay map showing toll completing centers and LATA boundaries was also created. Toll completing centers are higher level switching centers directly connected by toll cable to lower level exchange switches. In the SIDD area, Creston, Mt. Ayr, and Osceola are toll completing centers. This information becomes relevant only toward the end of this study. If it is determined that EAS should be offered between certain exchanges, then the existence of a toll cable could be worth noting. If already in place, the present toll cable could be redesignated non-toll and significant cost savings should result.

LATAs Local Access Transport Areas (LATAs) are newly-designated telephone service delivery areas which came into being with the deregulation of long lines service. Under the new designation, inter-LATA calling is now under the jurisdiction of the FCC and is open to competition. LATA areas generally conform to area codes. This is important for the present study because any proposal for cross-LATA extended area service would require some clarification of jurisdiction. Again, this will be relevant only latter in the study. Both the LATA and toll completing centers information was taken from a Northwestern Bell map, "Toll Completing Centers and Tributory Offices," which was reprinted in the Network Information for Iowa Independent Exchange Carriers (1985). The two overlay maps were analyzed from the perspective of inter-company EAS and inter-LATA extended area service.

Complementary research

The thirty-four exchange study As the overlay map for school district access was being created, this researcher noted a striking match between exchange boundaries and school district boundaries. There also seemed to be a high degree of toll-free access within school district areas even when they spanned multiple exchanges. To verify this observation, thirty-four Northwestern Bell exchanges statewide were selected for study on the basis of their similarity in size and distribution to exchanges in the SIDD area. Using a similar process to one described earlier of photo copy enlargements of the map "Public School Districts" published by the Iowa Department of Education in 1984 and overlaying these transparencies on an existing statewide telephone exchange map, a visual correlation analysis was performed to verify the hypothesized relationship of EAS, exchanges, and school district boundaries. A graphic presentation of results is reported in the findings.

Financial status worksheet One final piece of complementary research was undertaken. Using data from the 1985 Telephone Company Annual Reports, a computer spreadsheet was created detailing the financial status of SIDD area telephone companies. This spreadsheet looked at assets, liabilities, revenues, earnings, dividends, taxes, etc., by telephone company. It also presented some relational analysis such as per cent of revenue from toll service and earnings per exchange line which can offer some interesting cross company comparisons. The formulas for the calculations are given with the worksheet. The entire worksheet will be displayed in the findings, but the discussion will focus only on those aspects most relevant to the present study.

Telephone Use Data

Date sources

To test the hypothesis that those subscribers in exchanges that lack toll-free access to communities of interest, call less and pay more than those subscribers in exchanges that have toll-free access to communities of interest, it was necessary to obtain reliable data on telephone usage. Surveying telephone subscribers as to their usage patterns was not the first choice as a data gathering tool. This study was originally designed to use CCS (hundred cycle second) data which telephone companies gather by periodically sampling traffic between exchanges. This data essentially accounts for origin, destination, time of day, and volume of calls aggregated by exchange. This data is not only useful in determining average per subscriber flow between exchanges, it can also be used to derive average cost figures.

This is done through the following process. Total toll charges for calls to neighboring exchanges are derived by finding the product of volume and time of day toll rate. Total flat rate charges for an exchange are obtained from telephone company annual reports. By simply summing total flat rates charges and total toll charges and dividing by the total number of subscribers, the average cost per subscriber is derived. If the sum of total flat rate charges and total toll charges is divided by total seconds of calls, the average cost per second is derived. These averages are then derived for all exchanges. Comparisons were then to be made between comparable exchanges that differed only with respect to toll-free access to community of interest exchanges. This would then have provided a reasonably accurate comparison of relative costs and usage. Since this comparison sums flat rate and toll charges, it takes into account situations where companies have justified extensive toll calling by arguing that these were balanced with low flat rate charges.

Considerable effort was expended to obtain exchange usage data directly from telephone companies. Negotiations with Northwestern Bell to obtain CCS information initially seemed promising. Unfortunately, this early agreement was abandoned when the data sought was determined to be proprietory. Efforts to have the Utility Board request the information also proved fruitless. The only alternative was to seek the data through a subscriber survey. Most of the deficiencies of this study are traceable to the imperfections of the data gathered by this method.

Telephone use questionnaire

At the outset, the decision was made to create a questionnaire that would be brief, readily understandable, and yet be a sufficiently precise tool for gathering the intended data. The final survey was two pages in length. Full-size print was maintained as an aide to elderly participants. The first page cover letter described the reasons for the survey and how it might benefit the participant by ultimately resulting in a larger toll-free calling area. The second page began with a short implied consent statement, continued with the five questions of the questionnaire and finished with a border note giving instructions for folding, sealing, and returning the questionnaire page (Appendix A). The back of the questionnaire was printed with the ISU Mail Service return address and the "postage paid" label.

Questions

Question one A sample questionnaire is reproduced in Figure 1. The first question requests information on the subscriber's telephone service. This information allows survey results to be analyzed by subscriber class of service. In combination with questions two and four, question one was also used to determine total amount paid in local tolls. That process is as follows.

The first exchange listed in question two indicates the survey participant's exchange. Since each exchange has unique rates for location (town or rural) and subscriber class of service (business or residential), knowledge of this information also yields knowledge of base rate for local service for that class of service at that location. Simple subtraction of this base rate plus non-local toll calls (question 5) from "Total Amount Due" (question 4) yields the approximate amount spent on local toll calls to neighboring exchanges.

This is only an approximate amount because there is some loss of precision due to the listing of only two locations (town or rural) and two classifications (business or residential). In many cases, there is more than one residential classification especially in rural areas where two and four party lines are commonly offered. In other cases, there is

QUESTIONNAIRE

1. Is your telephone (choose one)

   rural residential ________ town residential ________
   rural business ________ town business ________

2. Your "local calling area" includes the exchanges listed below. These exchanges can be called toll free. On the average per month how many calls does your household or business make to each of the following exchanges?

   322 Corning ________

3. Below is a list of nearby exchanges which must be called long distance. On the average per month, how many long distance calls does your household or business make to each of these exchanges? If possible use a previous phone bill to verify your estimates.

   782 Creston ________
   537 Gravity ________
   785 Nodaway ________
   763 Grant ________
   774 Cumberland ________
   335 Prescott ________
   333 Lenox ________
   826 Villisca ________
   779 Massena ________

4. What was the Total Amount Due for your last phone bill?
   $________

5. Of the Total Amount Due, how many dollars were for long distance calls to exchanges not listed in question three?
   $________

Figure 1. Telephone use questionnaire

more than one zone outside the base rate area (city limits).

For purposes of clarity, all these possible qualifications were not given. In some cases, this will not result in lack of precision. One telephone company in the SIDD area makes no distinction among class of service or location. All subscribers pay the same flat rate. In cases where a distinction is made, the following decision rule applies. For rural residential, if more than one rate is offered, all service will be considered zone two, two or four party depending on which class is offered in the exchange.

Other errors of precision occur since no question was directed to service charges due for vertical services such as Hawkeye Plan, touch tone, teen line, or special business services.

Questions two and three   Question two lists all the exchanges and their three digit prefix which can be called toll free from the survey participant's phone. The first exchange listed is the participant's exchange. In cases where there was no extended area service, this was the only exchange listed.

The participant was asked to estimate the average number of calls per month made to each of the toll free exchanges. This estimate was subjective, but the alternative of asking the participant to log calls was not possible.

Question three lists the neighboring exchanges and their three digit prefixes which would be toll calls from the survey participant's exchange. An average monthly estimate was again requested, but the survey participant was encouraged to verify the estimate with a previous phone bill.

The exchanges listed in questions two and three were different and appropriate for each of the 16 exchanges that were sampled.

Questions four and five   Question four asked for the total amount due for the last phone bill. Question five asked for the total dollars for long distance calls to exchanges not listed in question three. The purpose of question five was to separate those tolls not made to neighboring exchanges which shared communities of interest.

Asking for total amount due for the previous phone bill introduces a problem of phone bills which reflect a non-typical month for the subscriber. Seasonal variations are also a limitation. Rural residents possibly increase calling activity in spring months more than urban residents.

Selecting the sample

Stratifying the sample   If a simple random sampling of telephone subscribers in the SIDD area had been drawn, the probability was great that most of the names on that sampling would come from the large town exchanges. This would defeat the purpose of comparing exchanges with different community of interest access characteristics. The alternative was to stratify exchanges by access characteristics and then to draw a random sample within the strata.

Community of interest worksheet   The process of stratifying the sample by community of interest access required the completion of the community of interest access worksheet. This worksheet is presented in the findings.

Four criteria were used to stratify the sample: toll-free access to trade capital, county seat town, school district, and total number of EAS access lines. Coding within columns was necessary to avoid an impractical number of possible combinations. School districts were reclassified 1, 2, 3, or 4 depending on the percentage accessible from the given exchange. A code of 1 represented 0-24% access and so forth. The EAS lines category was first divided into five classifications, 1 being 0-999 EAS access lines and 5 being 4000 plus EAS access lines. This later proved unsatisfactory and adjustments were made.

Querying the database Using the computer program query commands, all 80 possible combinations of the four criteria were checked. Nineteen of the 80 combinations had at least one entry and several clusterings were found. After numerous trial and error attempts to fit most of the 51 exchanges into three or four strata, it was decided to regroup the "EAS Lines" criteria into two groups, those below 2600 lines and those above.

Final strata After more trial and error, the final strata were derived. The results of the sort are displayed in Tables 1, 2, and 3. Only two criteria were used in the final sort, trade capital, and EAS code, although other groupings tended to fall out along somewhat complementary lines.

Strata 1 (Table 1) contained those exchanges that lacked access to their trade capital and had an EAS code of 1, i.e., total EAS access lines below 2600. It also fell out that all exchanges in this strata

Table 1. Strata 1: Trade capital no, EAS code 1

EXCHANGE	TRADE CAP.	SD CD	CNTY SEAT	EAS CD	EXCH LINES	CUM COUNT	EAS LINES	% SCH DIS
Thayer	N	1	N	1	105	105	105	15%
Arispe	N	2	N	1	137	242	770	49%
Grant	N	3	N	1	186	428	1998	70%
Nevinville	N	3	N	1	200	628	2588	60%
Grand River	N	2	N	1	217	845	217	49%
Blockton	N	1	N	1	218	1063	218	20%
Bridgewater	N	4	N	1	232	1295	800	99%
Prescott	N	4	N	1	255	1550	455	80%
Truro	N	3	N	1	305	1855	903	55%
Clearfield	N	4	N	1	354	2209	354	99%
St. Charles	N	3	N	1	436	2645	903	55%
Elliot	N	3	N	1	440	3085	1998	70%
Casey	N	2	N	1	448	3533	895	45%
New Market	N	3	N	1	464	3997	464	70%
Murray	N	4	N	1	566	4563	974	98%
Stanton	N	4	N	1	586	5149	656	95%
Afton	N	2	N	1	633	5782	770	49%
Adair	N	3	N	1	706	6488	706	55%

SELECTED EXCHANGES

EXCHANGE	TRADE CAP.	SD CD	CNTY SEAT	EAS CD	EXCH LINES	CUM COUNT	EAS LINES	% SCH DIS
Blockton	N	1	N	1	218	1063	218	20%
St. Charles	N	3	N	1	436	2645	903	55%
New Market	N	3	N	1	464	3997	464	70%
Stanton	N	4	N	1	586	5149	656	95%
Adair	N	3	N	1	706	6488	706	55%
Afton	N	2	N	1	633	5782	770	49%

STRATA 1 TOTAL SAMPLE SIZE = 125 EXCHANGE LINES
A SAMPLE OF 25 ACCESS LINES WILL BE TAKEN FROM EACH OF 5 EXCHANGES

EQUAL CHANCE EXCHANGE SELECTION PROCESS

K=CUMULATIVE COUNT / NUMBER OF EXCHANGES TO BE SELECTED
K=6488/5 K=1298
RS=RANDOM START (RANDOM NUMBER BETWEEN 0-1298)

EXCHANGE SELECTED IS THE FIRST EXCHANGE >= EACH OF THE FOLLOWING

RS=1062	BLOCKTON
RS+K=2360	ST. CHARLES
RS+2K=3658	NEW MARKET
RS+3K=4956	STANTON
RS+4K=6254	ADAIR

* Y - YES
* N - NO
* SD CD - SCH DISTRICT C
* RANGES OF SD CODE
* 0%-24% CODE 1
* 25%-49% CODE 2
* 50%-74% CODE 3
* 75%-99% CODE 4
*
* RANGES FOR EAS CODE
* 0-2599 CODE 1
* 2600+ CODE 2
*
* DESOTO DELETED DUE TO
* EAS TO DES MOINES

Table 2. Strata 2: Trade capital yes, EAS code 1

EXCHANGE	TRADE CAP.	SD CD	CNTY SEAT	EAS CD	EXCH LINES	CUM COUNT	EAS LINES	% SCH DIS
Sharpsburg	Y	4	N	1	92	92	1018	90%
Benton	Y	4	Y	1	111	203	2554	98%
Redding	Y	4	Y	1	112	315	2554	98%
Nodaway	Y	4	N	1	186	501	1188	95%
Garden Grove	Y	2	Y	1	266	767	1767	49%
Gravity	Y	3	Y	1	282	1049	1451	70%
Kellerton	Y	2	Y	1	357	1406	2554	49%
Fontanelle	Y	4	Y	1	568	1974	2427	98%
Lenox	Y	4	N	1	926	2900	1018	90%
Villisca	Y	4	N	1	1002	3902	1188	95%
Stuart	Y	4	N	1	1041	4943	1892	80%
Bedford	Y	3	Y	1	1169	6112	1451	70%
Lamoni	Y	4	N	1	1284	7396	1585	85%
Mt. Ayr	Y	4	Y	1	1337	8733	2554	98%
Leon	Y	4	Y	1	1501	10234	2478	95%
Greenfield	Y	4	Y	1	1627	11861	2395	98%
Corning	Y	4	Y	1	1810	13671	1810	95%

SELECTED EXCHANGES

EXCHANGE	TRADE CAP.	SD CD	CNTY SEAT	EAS CD	EXCH LINES	CUM COUNT	EAS LINES	% SCH DIS
Fontanelle	Y	4	Y	1	568	1974	2427	98%
Stuart	Y	4	N	1	1041	4943	1892	80%
Lamoni	Y	4	N	1	1284	7396	1585	85%
Leon	Y	4	Y	1	1501	10234	2478	95%
Corning	Y	4	Y	1	1810	13671	1810	95%

STRATA 2 TOTAL SAMPLE SIZE = 125 EXCHANGE LINES
A SAMPLE OF 25 ACCESS LINES WILL BE TAKEN FROM EACH OF 5 EXCHANGES

EQUAL CHANCE EXCHANGE SELECTION PROCESS

K=CUMULATIVE COUNT / NUMBER OF EXCHANGES TO BE SELECTED
K=13671/5 K=2734
RS=RANDOM START (RANDOM NUMBER BETWEEN 0-2734)

EXCHANGE SELECTED IS THE FIRST EXCHANGE >= EACH OF THE FOLLOWING

RS=1671	FONTANELLE
RS+K=4405	STUART
RS+2K=7139	LAMONI
RS+3K=9873	LEON
RS+4K=12607	CORNING

* Y - YES
* N - NO
* SD CD - SCH DISTRICT CD
* RANGES OF SD CODE
* 0%-24% CODE 1
* 25%-49% CODE 2
* 50%-74% CODE 3
* 75%-99% CODE 4
*
* RANGES OF EAS CODE
* 0-2599 CODE 1
* 2600+ CODE 2
*
* DESOTO DELETED DUE TO
* EAS TO DES MOINES

Table 3. Strata 3: Trade capital yes, EAS code 2

EXCHANGE	TRADE CAP.	SD CD	CNTY SEAT	EAS CD	EXCH LINES	CUM COUNT	EAS LINES	% SCH DIS
Shannon City	Y	1	Y	2	106	106	5713	10%
Kent	Y	4	Y	2	113	219	5083	95%
Macksburg	Y	2	Y	2	158	377	3301	30%
Peru	Y	1	Y	2	162	539	3305	10%
Diagonal	Y	4	Y	2	282	821	2660	98%
Davis City	Y	4	Y	2	301	1122	3086	85%
Orient	Y	3	N	2	306	1428	5531	65%
Tingley	Y	4	Y	2	355	1783	2660	98%
Dexter	Y	4	N	2	404	2187	2929	85%
Lorimor	Y	1	N	2	408	2595	4117	24%
Weldn-Van Wrt	Y	4	Y	2	410	3005	4946	80%
Earlham	Y	4	Y	2	669	3674	4823	85%
Osceola	Y	4	Y	2	3035	6709	3445	98%
Winterset	Y	4	Y	2	3143	9852	5815	99%
Red Oak	Y	4	Y	2	3922	13774	3922	90%
Creston	Y	4	Y	2	4970	18744	5389	95%

SELECTED EXCHANGES

EXCHANGE	TRADE CAP.	SD CD	CNTY SEAT	EAS CD	EXCH LINES	CUM COUNT	EAS LINES	% SCH DIS
Davis City	Y	4	Y	2	301	1122	3086	85%
Osceola	Y	4	Y	2	3035	6709	3445	98%
Winterset	Y	4	Y	2	3143	9852	5815	99%
Red Oak	Y	4	Y	2	3922	13774	3922	90%
Creston	Y	4	Y	2	4970	18744	5389	95%

STRATA 3 TOTAL SAMPLE SIZE = 125 EXCHANGE LINES
A SAMPLE OF 25 ACCESS LINES WILL BE TAKEN FROM EACH OF 5 EXCHANGES

EQUAL CHANCE EXCHANGE SELECTION PROCESS

K=CUMULATIVE COUNT / NUMBER OF EXCHANGES TO BE SELECTED
K=18744/5 K=3749
RS=RANDOM START (RANDOM NUMBER BETWEEN 0-3749)

EXCHANGE SELECTED IS THE FIRST EXCHANGE >= EACH OF THE FOLLOWING

RS=994	DAVIS CITY
RS+K=4743	OSCEOLA
RS+2K=8492	WINTERSET
RS+3K=12241	RED OAK
RS+4K=15990	CRESTON

* Y - YES
* N - NO
* SD CD - SCH DISTRICT CD
* RANGES OF SD CODE
* 0%-24% CODE 1
* 25%-49% CODE 2
* 50%-74% CODE 3
* 75%-99% CODE 4
*
* RANGES FOR EAS CODE
* 0-2599 CODE 1
* 2600+ CODE 2
*
* DESOTO DELETED DUE TO
* EAS TO DES MOINES

lacked access to their county seat. School district access was mixed for this strata.

Strata 2 (Table 2) listed those exchanges that did have access to their trade capital and had an EAS code of 1. In this strata, access to county seat and school district was mixed, although a school district code 4 was predominant.

Strata 3 (Table 3). This strata contained exchanges with access to their trade capital and an EAS code of 2, i.e., total EAS access lines over 2600. Access to county seat was predominantly positive and school district access was mostly code 4.

Strata 4 would have contained those exchanges with no toll-free access to their trade capital and an EAS code of 2, but no exchanges fit this criteria.

The final sort left three strata with an approximately equal number of exchanges in each strata; 18 exchanges in strata 1, 17 exchanges in strata 2, 16 exchanges in strata 3. These had been sorted from an initial group of 51 exchanges, DeSoto having been omitted because of EAS to Des Moines.

Determining the sample size   The rule of thumb for sampling from phone exchanges is that no sample should be less than 25. Because of cost, an upper limit of 350 to 400 surveys was established. Using these limits as guides, it followed that 15 exchanges could be sampled, five from each of the three strata.

Random selection of exchanges   The guiding principal in random sampling is that each unit in the population have an equal chance of being selected. This is accomplished by using a truly random selection at each level. At the level of exchange selection, this is realized through the following procedure.

Within each strata, the exchanges were entered in ascending order by number of exchange access lines. The total cumulative count of exchange access lines was divided by 5, the number of exchanges to be selected, to yield K, the sampling interval. A random number between zero and K was chosen from a random number table yielding RS, the random start. The first exchange greater than or equal to the random start was the first exchange selected. The next exchange selected was that exchange greater than or equal to the random start plus the sampling interval. The third exchange selected was that exchange greater than or equal to the random start plus twice the sampling interval and so forth. The calculations and the exchanges selected by this process are given at the bottom of the worksheets in Tables 1, 2, and 3.

Selection of an additional exchange   Upon examining the selections and the characteristics of the exchanges chosen by this process, it was noted that school district access codes of 3 and 4 were heavily predominant. This was to be expected since the entire grouping of exchanges is likewise biased. To obtain a slightly better representation and to make it possible to test school district access criteria, the Afton exchange, with its school district code of 2, was added to the sample. This brought the total to 16 exchanges and the total sample size to 400.

Random selection of survey participants Phone books were obtained for the 16 exchanges. For the small exchanges, random numbers were selected and participants chosen by counting to the random number. For the larger exchanges, columns were first randomly selected and then names within columns. Twenty-five names were chosen from each of the 16 exchanges. The 400 names thus selected constituted the survey sample.

Presurvey awareness campaign

First articles Prior to mailing the survey, it was decided that an education campaign was necessary to foster, in SIDD area residents, a base level understanding of the workings of telephone exchanges and EAS access areas and to promote interest in and understanding of the telephone use survey. To this end, an information packet containing the base map and explanatory letter was hand delivered to ten SIDD area newspapers. Prominent news articles such as the one in the Creston News Advertiser which featured the SIDD area base map along with four columns of text (Appendix B) subsequently appeared in all ten papers. This researcher was also interviewed on a morning news program on KSIB, the Creston radio station.

Follow up Two weeks after the first articles appeared, and immediately prior to the first mailing of the survey, a second short news story concerning the survey was released to the ten area newspapers. Again, a taped bulletin was aired on KSIB.

Mailing the survey

Immediately after the follow-up articles, the first 400 surveys were mailed in envelopes with Design Research Institute letterheads and first class postage. This was followed two weeks latter with a second bulk mailing of the survey to the same sample group.

Empirical Analysis

Data

Access criteria   Previous sections have outlined the procedures for determining community of interest access criteria. Four criteria were selected; toll-free access to the trade capital, toll-free access to the county seat, total number of EAS and exchange lines in the toll-free calling area, and the percentage of a subscriber's school district accessible toll-free. As a result of this analysis, exchanges were identified according to these criteria. In the statistical analysis, which will be subsequently described, these four criteria will serve as the independent variables.

Survey data   Survey questions and procedures have also been described in preceding sections. From the questionnaire, the following data were obtained for analysis:

A. subscriber classification

code	classification
1	rural residential
2	rural business

3 town residential

4 town business

B. total number of non-toll local calls per month

C. total number of toll calls to neighboring exchanges per month

D. total amount due for the last monthly phone bill

E. total tolls paid for phone calls to neighboring exchanges during the last month

F. total number of local non-toll and local toll calls per month

In the statistical analysis, items B-F will be the dependent variables. These variables will be grouped and analyzed by subscriber classification.

Selection of statistical technique

The statistical technique here employed to estimate the correlation between the dependent variables and the independent variables is ordinary least squares regression. The functional form of the regression equation used in this analysis assumes a linear relationship between the dependent and independent variable. No mathematical transformations were employed to correct the data when this assumption might be imperfect. Ordinary least squares regression is useful because it indicates both the direction and magnitude of the effect of each explanatory variable on the dependent variable. The unit of analysis will be the individual subscriber. Access criteria, which are given by exchange, will be assigned to individual subscribers from each of the exchanges.

Defining the variables

Table 4 defines the variables and their notations which will be used in the regression equations.

Specifying the hypothesis

The hypothesis is specified in the following regression equations.

Model 1

$$LOC\_CALL = a + b_1TC + b_2CS + b_3EAS\_L + b_4SCH\_DIST$$

Model 2

$$TOLL\_CALL = a + b_1TC + b_2CS + b_3EAS\_L + b_4SCH\_DIST$$

Model 3

$$TOTAL\_C = a + b_1TC + b_2CS + b_3EAS\_L + b_4SCH\_DIST$$

Model 4

$$AMT\_DUE = a + b_1TC + b_2CS + b_3EAS\_L + b_4SCH\_DIST$$

Model 5

$$LTLL\_CHG = a \; b_1TC + b_2CS + b_3EAS\_L + b_4SCH\_DIST$$

The data set will be sorted by subscriber classes given below.

all business subscribers

all residential subscribers

rural residential subscribers

town residential subscribers

Each model will be run for each of the four classes; all business, all residential, all rural residential, all town residential. A total of 20 regressions will be run.

Table 4. Definition of variables in the models

Variable	Definition
TC	Trade capital: the subscriber has toll-free access to his trade capital 1=yes, 0=no
CS	County seat: the subscriber has toll-free access to his county seat 1=yes, 0=no
EAS_L	Extended area service lines: the total number of toll-free lines including both exchange and extended area service lines accessible to the subscriber.
SCH_DIST	School district: the percentage of the school district on a geographical basis that is accessible toll-free to the subscriber.
LOC_CALL	Local calls: the average number of local calls made by the subscriber per month to other subscribers in the toll-free calling area.
TOLL_C	Toll calls: the number of local toll calls made last month by a subscriber to other subscribers in neighboring exchanges.
TOTAL_C	Total calls: the total number of last month's local non toll calls and local toll calls made by a subscriber. This does not include toll calls made to those beyond the neighboring exchanges.
AMT_DUE	Amount due: the total amount due for the subscriber's last month phone bill.
LTLL_CHG	Local toll charge: the subscriber's last month's toll charges for calls to neighboring exchanges. This figure is derived by subtracting the non-local toll charges and the basic flat rate charge from the total amount due. This is only an approximation because it includes other non specified charges.

With Model 1, it is expected that the dependent variable, Local Calls, will increase if there is access to the trade capital and to the county seat and will increase as the number of EAS lines increases and as the percentage of school district accessible increases. For Model 1, all independent variables are expected to show positive beta coefficients.

With Model 2, it is expected that the dependent variable, Toll Calls, will increase if there is no access to the trade capital and to the county seat and will increase as the number of EAS lines decreases and as the percentage of school district accessible decreases. For Model 2, all independent variables are expected to show negative beta coefficients.

With Model 3, the dependent variable, Total Calls, is expected to increase if there is access to the trade capital and to the county seat and will increase as the number of EAS lines increases and as the percentage of school district accessible increases. For Model 3, all independent variables are expected to show a positive beta coefficient.

With Model 4, the dependent variable, Amount Due, is expected to increase if there is no access to the trade capital and to the county seat and will increase as the number of EAS lines decreases and as the percentage of school district accessible decreases. For Model 4, all independent variables are expected to show a negative beta coefficient.

With Model 5, the dependent variable, Local Toll Charge, is expected to increase if there is no access to the trade capital and to the county seat and will increase as the number of EAS lines decreases and as the percentage of school district accessible decreases. For Model 5, all beta coefficients are expected to be negative.

The same explanation is expected to hold true for each model for all of the four classes of subscribers.

Statistical procedures

The SAS statistical computer program was used to sort the data, do the regression analysis, and the Pearson correlation coefficients. The following subprograms were used:

Sort - Sort the data by subscriber class

GLM - General Linear Model: regression analysis

CORR - Pearson correlation coefficients.

Determination of support for the hypothesis

The hypothesis of this research will be more or less supported in proportion to the correctness of the signs of the beta coefficients and their significance, the significance of the regression, and the strength of its explanatory power, and the degree to which the data fulfill the assumptions necessary to obtain these results.

FINDINGS

Introduction

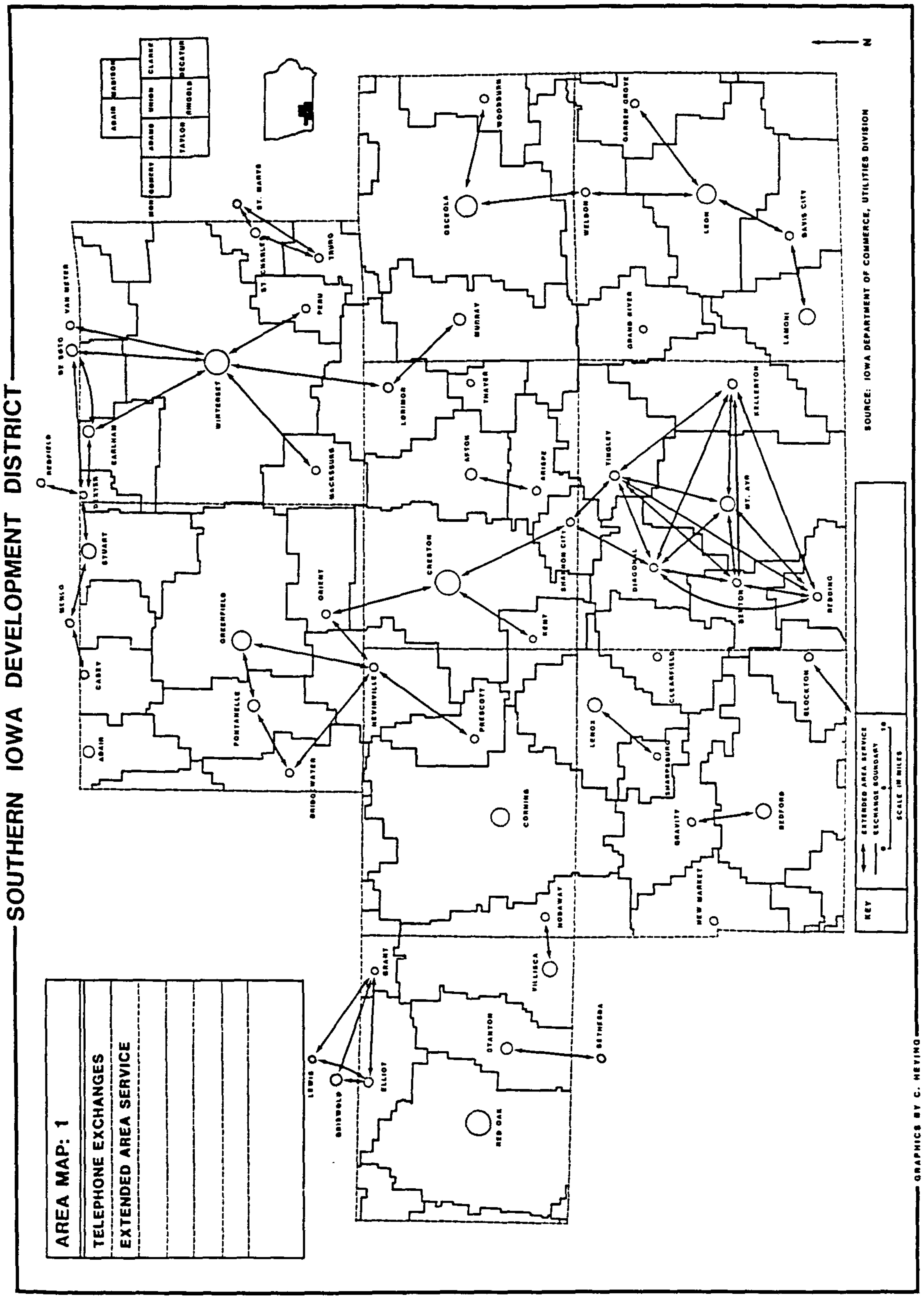
In this chapter, the findings will be reported and discussed. The base map with a derivative table of exchange characteristics, the community of interest overlays, and the composite map with its attendant table of access characteristics will be displayed and implications considered. The two additional maps of the telephone companies and toll completing centers will likewise be presented and examined. Results from complementary research on school districts will be graphically presented, and the telephone company financial status worksheet will be discussed.

Following in order, raw scores from the survey will be presented along with their frequency distributions, ranges and measures of central tendency. Finally, the outcome of the tests of correlation will be given and discussed relative to their support of the proposed hypothesis.

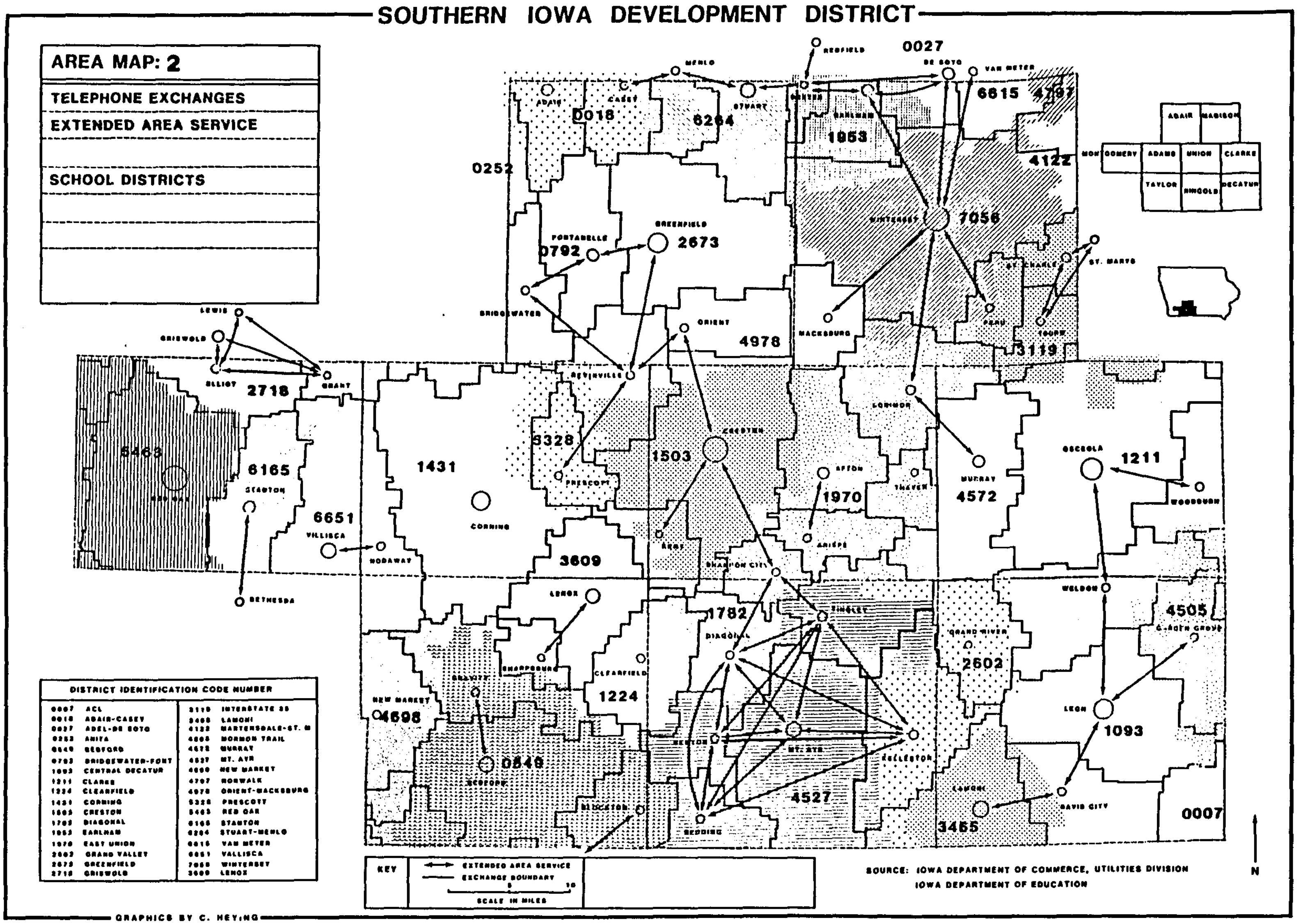
Area Maps and Derivative Tables

Telephone exchange boundaries, local calling areas, and tariffs

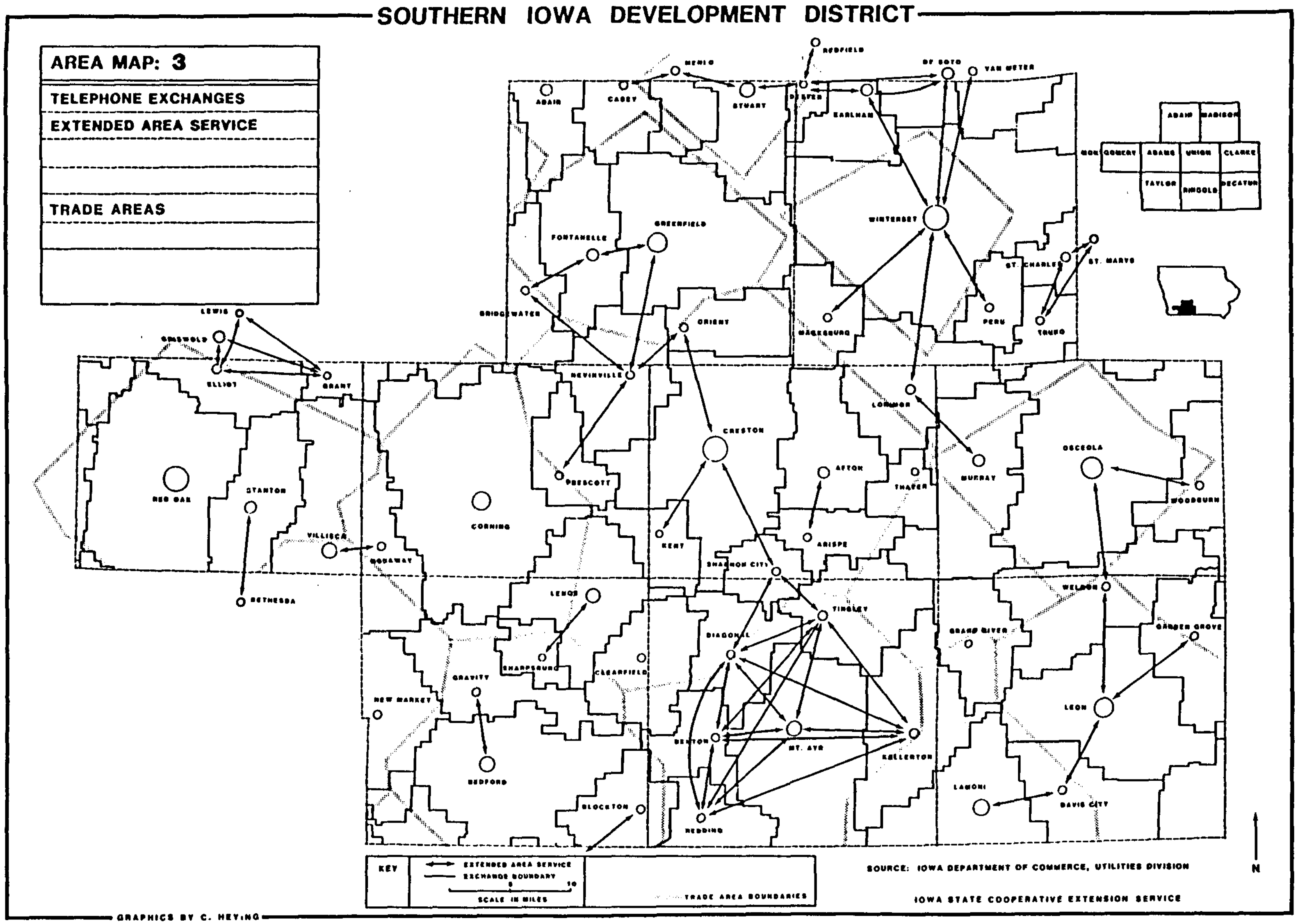
Area Map 1 The six area maps are displayed together, in the following pages, to permit easy cross reference. Area Map 1, the base map, shows the nine counties of the Southern Iowa Development District, the communities where central switching offices are located, the



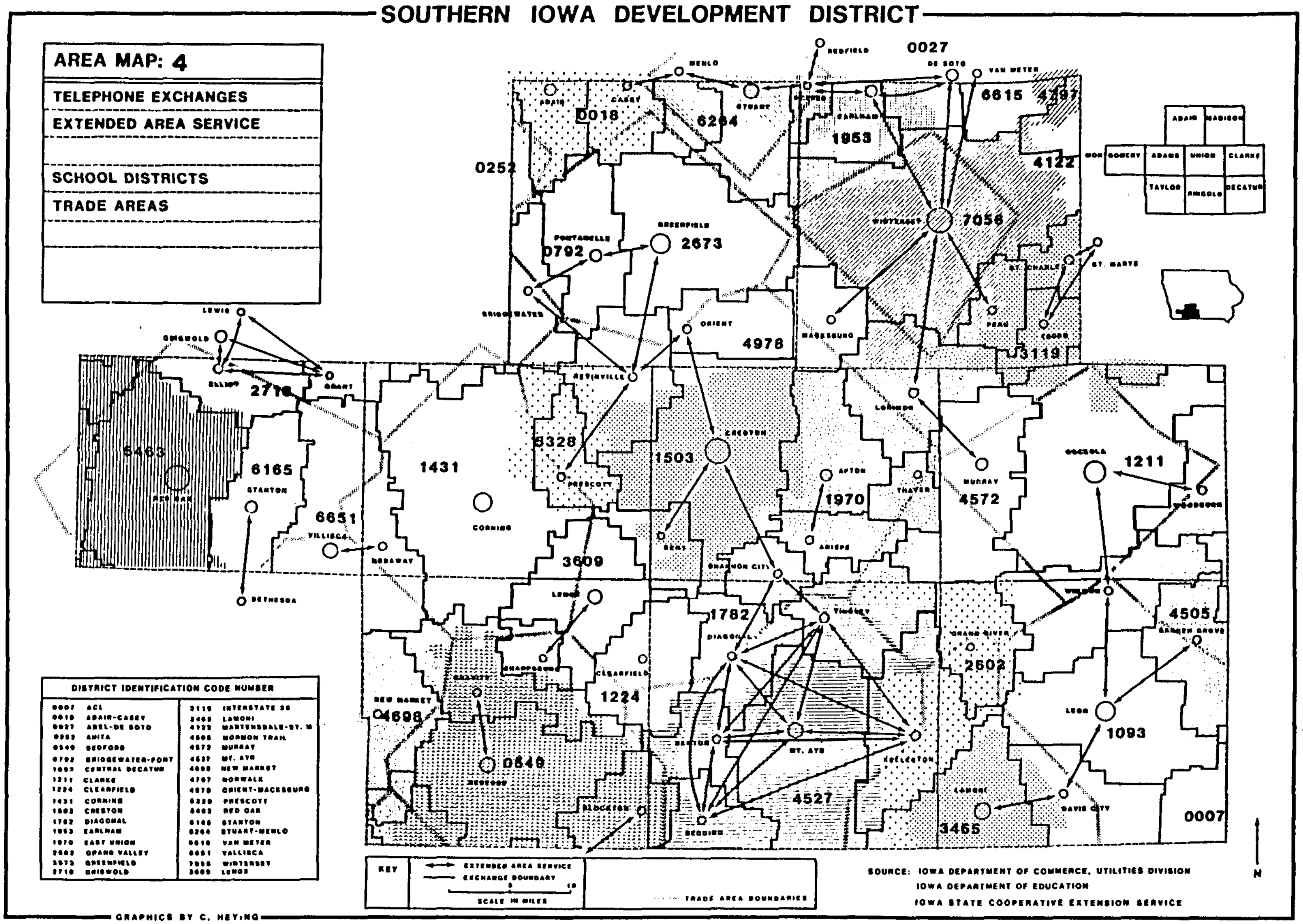
Area Map 1. Base map



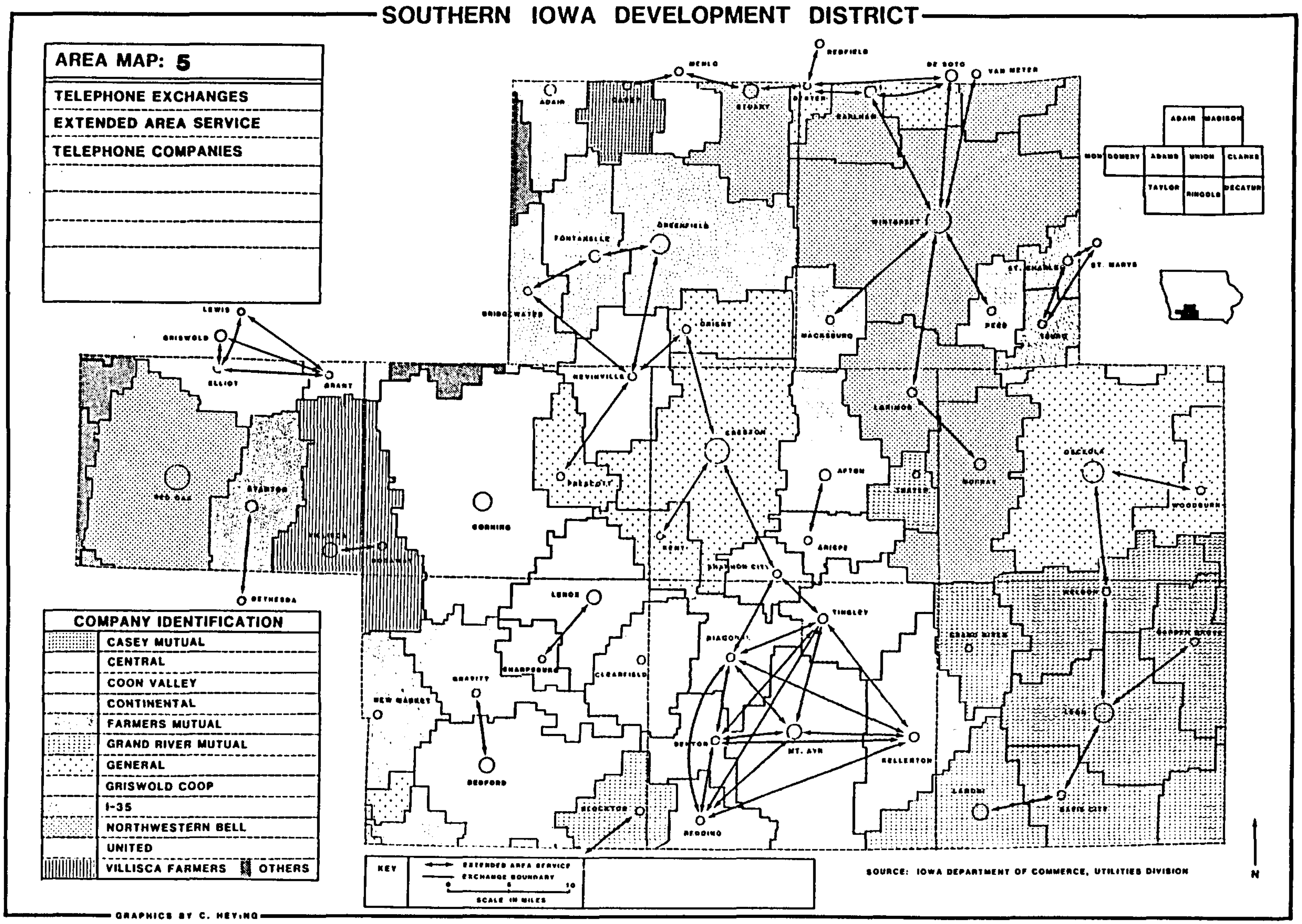
Area Map 2. School districts



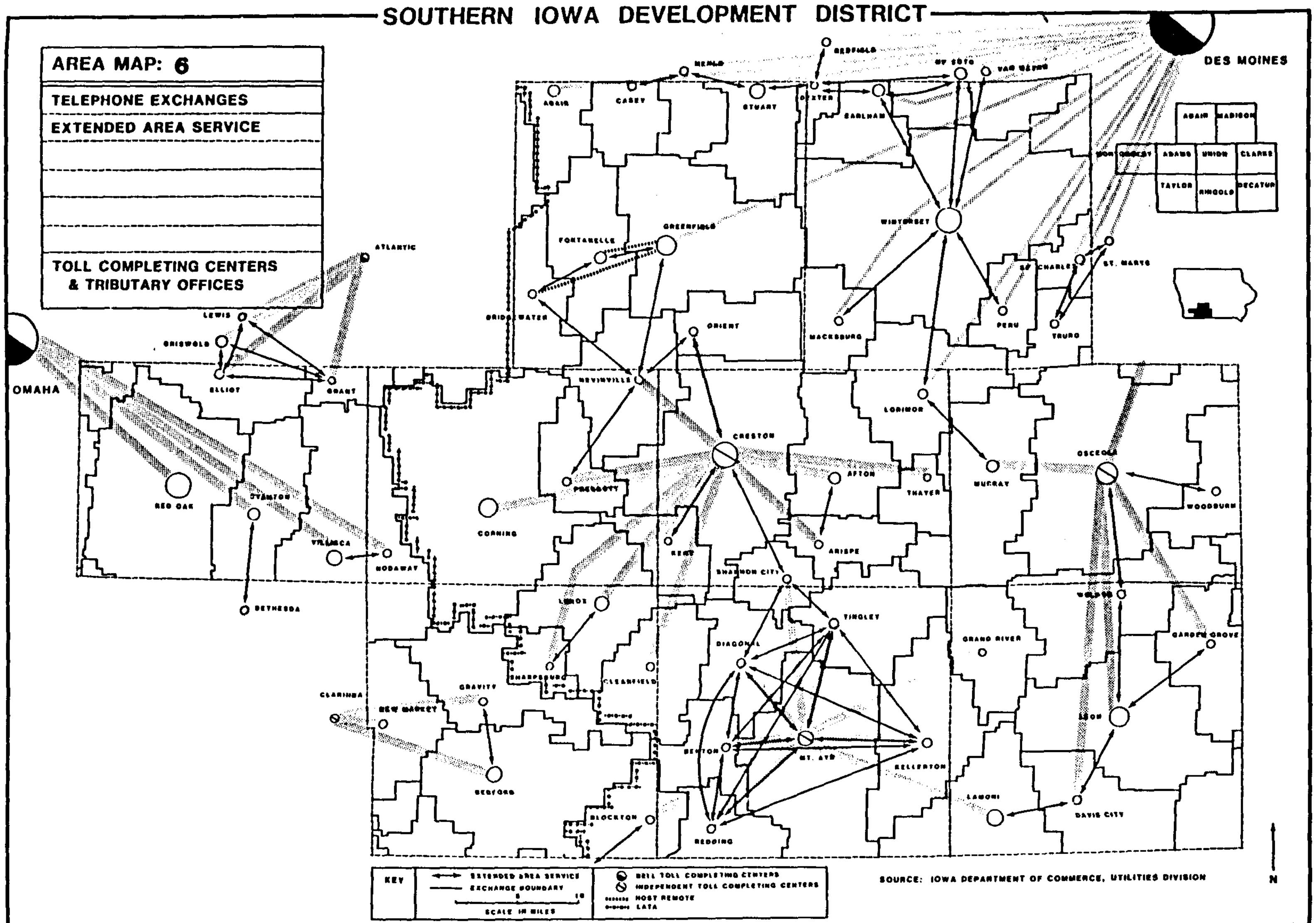
Area Map 3. Trade areas



Area Map 4. Composite map



Area Map 5. Telephone companies



Area Map 6. Toll completing centers

exchange boundaries, indicated by the solid black lines, and existing extended area service, designated by the arrows between exchanges.

Exchanges and local calling areas   Table 5 lists the 52 exchanges serving the SIDD area and the exchanges to which each has EAS. The fourth column of Table 5 lists the number of local access lines by exchange. A wide divergence in size can be noted from Sharpsburg, serving only 92 subscribers, to Creston serving 4970. Of the 52 exchanges, 32 have fewer than 500 exchange access lines. The fourth column indicates the total number of exchange and EAS lines in the toll-free local calling area. The spread of local calling area access lines is extremely wide. Thayer is the lowest at 105 with no EAS lines and DeSoto, which recently began EAS with Des Moines, holding the high of 146,941.

Local rates   As described in the "Questionnaire" section of the methodology, only certain classes of service and locations are being considered in this study. These are listed in the final six columns of Table 5. Three rows of figures are given for each exchange where the information was available. The first row is the total charge to that exchange for all EAS trunks. The second row is the flat rate (FR) by class of service for that exchange. The third row gives the combined monthly charge.

Extended area service   When EAS is established, an additional monthly charge is added to the flat rate to recover the cost of the new trunking between exchange switching offices and in some cases for the new switching equipment necessitated by the increased volume of calls.

Table 5. SIDD telephone exchange tariffs and access areas

EXCHANGE	EAS	PHONE COMPANY	EXCHANGE ACCESS LINES	EAS ACCESS LINES		BRA B1	BRA R1	OSBRA B1-Z2	OSBRA R1-Z2	OSBRA R2-Z2	OSBRA R4
Creston	Kent	GTE	4970	5389	EAS	0.63	0.32	0.63	0.32	NA	0.25
	Orient				FR	13.68	6.94	17.61	10.69	NA	6.92
					TOT	14.31	7.26	18.24	11.01	NA	7.17
Desoto	Adel	GTE	607	146941	EAS	20.22	10.11	20.22	10.11	NA	8.09
	Des Moines				FR	33.45	16.43	37.20	20.48	NA	14.76
	Dexter				TOT	53.67	26.54	57.42	30.59	NA	22.85
	Earlham										
	Van Meter										
	Winterset										
Dexter	Desoto	GTE	404	2929	EAS	11.35	5.68	11.35	5.68	NA	4.54
	Earlham				FR	24.58	12.30	28.33	16.05	NA	11.21
	Redfield				TOT	35.93	17.98	39.68	21.73	NA	15.75
	Stuart										
Kent	Creston	GTE	113	5083	EAS	6.31	3.15	6.31	3.15	NA	2.52
					FR	19.54	9.77	23.29	13.52	NA	9.19
					TOT	25.85	12.92	29.60	16.67	NA	11.71
Orient	Creston	GTE	306	5531	EAS	9.16	4.58	9.16	4.58	NA	3.66
	Nevinville				FR	22.39	11.20	26.14	14.95	NA	10.33
					TOT	31.55	15.78	35.30	19.53	NA	13.99
Osceola	Weldon	GTE	3035	3445	EAS	0.54	0.27	0.54	0.27	NA	0.22
includes					FR	13.77	6.89	17.52	10.64	NA	6.89
Woodburn					TOT	14.31	7.16	18.06	10.91	NA	7.11
Prescott	Nevinville	GTE	255	455	EAS	3.38	1.69	3.38	1.69	NA	1.35
					FR	16.61	8.31	20.36	12.06	NA	8.02
					TOT	19.99	10.00	23.74	13.75	NA	9.37
Afton	Arispe	ConTel	633	770	EAS	0.65	0.65	0.65	NA	NA	0.65
					FR	22.30	11.20	24.90	NA	NA	9.85
					TOT	22.95	11.85	25.55	NA	NA	10.50
Arispe	Afton	ConTel	137	770	EAS	0.65	0.65	0.65	NA	NA	0.65
					FR	20.75	10.35	23.25	NA	NA	9.15
					TOT	21.40	11.00	23.90	NA	NA	9.80
Benton	Diagonal	ConTel	111	2554	EAS	4.30	4.30	4.30	NA	NA	4.30
	Kellerton				FR	20.75	10.35	23.25	NA	NA	9.15
	Mt. Ayr				TOT	25.05	14.65	27.55	NA	NA	13.45
	Redding										
	Tingley										
Clearfield		ConTel	354	354	EAS	0.00	0.00	0.00	NA	NA	0.00
					FR	21.60	10.80	24.05	NA	NA	9.65
					TOT	21.60	10.80	24.05	NA	NA	9.65

Table 5 (Continued)

EXCHANGE	EAS	PHONE COMPANY	EXCHANGE ACCESS LINES	EAS ACCESS LINES		BRA B1	BRA R1	OSBRA B1-Z2	OSBRA R1-Z2	OSBRA R2-Z2	OSBRA R4
Diagonal	Benton	Contel	282	2660	EAS	5.00	5.00	5.00	5.00	5.00	NA
	Kellerton				FR	24.90	12.45	24.90	12.45	11.75	NA
	Mt. Ayr				TOT	29.90	17.45	29.90	17.45	16.75	NA
	Redding										
	Shannon City										
	Tingley										
Gravity	Bedford	ConTel	282	1451	EAS	0.80	0.80	0.80	NA	NA	0.80
					FR	20.75	10.35	23.25	NA	NA	9.15
					TOT	21.55	11.15	24.05	NA	NA	9.95
Kellerton	Benton	ConTel	357	2554	EAS	5.00	5.00	5.00	NA	NA	5.00
	Diagonal				FR	21.60	10.80	24.05	NA	NA	9.65
	Mt. Ayr				TOT	26.60	15.80	29.05	NA	NA	14.65
	Redding										
	Tingley										
Macksburg	Winterset	ConTel	158	3301	EAS	1.10	1.10	1.10	NA	NA	1.10
					FR	20.75	10.35	23.25	NA	NA	9.15
					TOT	21.85	11.45	24.35	NA	NA	10.25
Mt. Ayr	Benton	ConTel	1337	2554	EAS	2.40	2.40	2.40	2.40	2.40	NA
	Diagonal				FR	26.40	13.30	26.40	13.30	12.50	NA
	Kellerton				TOT	28.80	15.70	28.80	15.70	14.90	NA
	Redding										
	Tingley										
Peru	Winterset	ConTel	162	3305	EAS	1.00	1.00	1.00	NA	NA	1.00
					FR	20.75	10.35	23.25	NA	NA	9.15
					TOT	21.75	11.35	24.25	NA	NA	10.15
Redding	Benton	ConTel	112	2554	EAS	5.00	5.00	5.00	5.00	5.00	NA
	Diagonal				FR	24.90	12.45	24.90	12.45	11.75	NA
	Kellerton				TOT	29.90	17.45	29.90	17.45	16.75	NA
	Mt. Ayr										
	Tingley										
Shannon City	Creston	ConTel	106	5713	EAS	2.45	2.45	2.45	NA	NA	2.45
	Diagonal				FR	20.75	10.35	23.25	NA	NA	9.15
	Tingley				TOT	23.20	12.80	25.70	NA	NA	11.60
Tingley	Benton	ConTel	355	2660	EAS	5.00	5.00	5.00	NA	NA	5.00
	Diagonal				FR	21.60	10.80	24.05	NA	NA	9.65
	Kellerton				TOT	26.60	15.80	29.05	NA	NA	14.65
	Mt. Ayr										
	Redding										
	Shannon City										

Table 5 (Continued)

EXCHANGE	EAS	PHONE COMPANY	EXCHANGE ACCESS LINES	EAS ACCESS LINES		BRA B1	BRA R1	OSBRA B1-Z2	OSBRA R1-Z2	OSBRA R2-Z2	OSBRA R4
Bedford	Gravity	Central	1169	1451	EAS	1.20	0.70	1.20	0.70	0.70	NA
					FR	8.65	4.85	12.65	8.85	6.10	NA
					TOT	9.85	5.55	13.85	9.55	6.80	NA
Corning		Central	1810	1810	EAS						
					FR						
					TOT	8.65	4.85	12.65	8.85	6.10	NA
Lenox	Sharpsburg	Central	926	1018	EAS	1.40	0.80	1.40	0.80	0.80	NA
					FR	8.65	4.85	12.65	8.85	6.10	NA
					TOT	10.05	5.65	14.05	9.65	6.90	NA
Sharpsburg	Lenox	Central	92	1018	EAS	1.80	1.00	1.80	1.00	1.00	NA
					FR	8.65	4.85	12.65	8.85	6.10	NA
					TOT	10.45	5.85	14.45	9.85	7.10	NA
Blockton	Shreidan, MO	GRMT	218	218	EAS						
					FR						
					TOT	13.09	7.22	13.09	7.22	NA	NA
Davis City	Lamoni	GRMT	301	3086	EAS						
	Leon				FR						
					TOT	14.76	8.89	14.76	8.89	NA	NA
Garden Grove	Leon	GRMT	266	1767	EAS						
					FR						
					TOT	14.35	8.48	14.35	8.48	NA	NA
Grand River		GRMT	217	217	EAS						
					FR						
					TOT	13.09	7.22	13.09	7.22	NA	NA
Lamoni	Davis City	GRMT	1284	1585	EAS						
					FR						
					TOT	13.93	8.06	13.93	8.06	NA	NA
Leon	Davis City	GRMT	1501	2478	EAS						
	Garden Grove				FR						
	Weldon-Van Wrt				TOT	14.76	8.89	14.76	8.89	NA	NA
Thayer		GRMT	105	105	EAS						
					FR						
					TOT	10.70	6.80	10.70	6.80	NA	NA
Weldn-Van Wrt	Leon	GRMT	410	4946	EAS						
	Osceola				FR						
					TOT	14.76	8.89	14.76	8.89	NA	NA

Table 5 (Continued)

EXCHANGE	EAS	PHONE COMPANY	EXCHANGE ACCESS LINES	EAS ACCESS LINES		BRA B1	BRA R1	OSBRA B1-Z2	OSBRA R1-Z2	OSBRA R2-Z2	OSBRA R4
Casey	Menlo	Casey Mut.	448	895	EAS						
		TelCo			FR						
					TOT	8.70	8.70	8.70	8.70	NA	NA
Nevinville	Greenfield	Coon Val.	200	2588	EAS						
	Prescott	TelCo			FR						
	Orient				TOT	10.00	6.50	10.00	6.50	NA	NA
New Market		Frmrs Mut.	464	464	EAS						
		TelCo			FR						
					TOT	7.00	4.00	7.00	4.00	NA	NA
Stanton	Bethesda	Frmrs. Mut	586	656	EAS						
		TelCo			FR						
					TOT	7.00	4.00	7.00	4.00	NA	NA
Elliot	Grant	Griswold	440	1998	EAS						
	Griswold	Coop			FR						
	Lewis	TelCo			TOT	9.00	5.50	9.00	5.50	NA	NA
Grant	Elliot	Griswold	186	1998	EAS						
	Griswold	Coop			FR						
	Lewis	TelCo			TOT	9.00	5.50	9.00	5.50	NA	NA
St. Charles	Truro	I-35 TelCo	436	903	EAS						
	St. Marys				FR						
					TOT	13.00	10.25	13.00	10.25	NA	NA
Truro	St. Charles	I-35 TelCo	305	903	EAS						
	St. Marys				FR						
					TOT	13.00	10.25	13.00	10.25	NA	NA
Earlham	Desoto	NW Bell	669	4823	EAS						
	Dexter				FR						
	Winterset				TOT	29.65	11.70	36.25	18.30	13.80	NA
Lorimor	Murray	NW Bell	408	4117	EAS						
	Winterset				FR						
					TOT	29.65	11.70	36.25	18.30	13.80	NA

Table 5 (Continued)

EXCHANGE	EAS	PHONE COMPANY	EXCHANGE ACCESS LINES	EAS ACCESS LINES		BRA B1	BRA R1	OSBRA B1-Z2	OSBRA R1-Z2	OSBRA R2-Z2	OSBRA R4
Murray	Lorimor	NW Bell	566	974	EAS						
					FR						
					TOT	25.70	10.70	32.05	17.05	12.55	NA
Stuart	Dexter	NW Bell	1041	1892	EAS						
	Menlo				FR						
					TOT	27.70	11.25	34.30	17.60	13.20	NA
Red Oak		NW Bell	3922	3922	EAS						
					FR						
					TOT	29.65	11.70	36.25	18.30	13.80	NA
Winterset	Desoto	NW Bell	3143	5815	EAS						
	Earlham				FR						
	Lorimor				TOT	31.65	12.40	38.25	19.00	14.35	NA
	Macksburg										
	Peru										
	Van Meter										
Adair		United	706	706	EAS						
					FR						
					TOT	13.65	7.80	18.89	13.04	NA	7.80
Bridgewater	Fontanelle	United	232	800	EAS	4.60	2.63	4.60	2.63	NA	2.63
					FR	13.50	7.70	18.74	12.94	NA	7.70
					TOT	18.10	10.33	23.34	15.57	NA	10.33
Fontanelle	Bridgewater	United	568	2427	EAS	2.63	1.50	2.63	1.50	NA	1.50
	Nevinville				FR	13.65	7.80	18.89	13.04	NA	7.80
					TOT	16.28	9.30	21.52	14.54	NA	9.30
Greenfield	Fontanelle	United	1627	2395	EAS	1.25	0.70	1.25	0.70	NA	0.70
	Nevinville				FR	14.05	8.00	19.29	13.24	NA	8.00
					TOT	15.30	8.70	20.54	13.94	NA	8.70
Nodaway	Villisca	Villisca	186	1188	EAS						
		Farmers			FR						
		TelCo			TOT	13.00	10.00	16.00	13.00	NA	NA
Villisca	Nodaway	Villisca	1002	1188	EAS						
		Farmers			FR						
		TelCo			TOT	13.00	10.00	16.00	13.00	NA	NA

Table 5 (Continued)

EXCHANGE	EAS	PHONE COMPANY	EXCHANGE ACCESS LINES	EAS ACCESS LINES		BRA B1	BRA R1	OSBRA B1-Z2	OSBRA R1-Z2	OSBRA R2-Z2	OSBRA R4
Des Moines	De Soto Van Meter surrounding communities	NW Bell	140154	174269	EAS FR TOT	39.60	15.20	46.20	21.80	16.30	NA

KEY:

EAS Extended Area Service

BRA B1 Base Rate Area, Business One Party

BRA R1 Base Rate Area, Residential One Party

OSBRA B1-Z2 Outside Base Rate Area, Business One Party, Zone 2

OSBRA R1-Z2 Outside Base Rate Area, Residential One Party, Zone 2

OSBRA R2-Z2 Outside Base Rate Area, Residential Two Party, Zone 2

OSBRA R4 Outside Base Rate Area, Residential Four Party

For all rate regulated companies,[1] except Northwestern Bell, EAS costs are allocated using a distance between switches and a customer added matrix. The greater the distance between central switches and the greater the number of newly accessible lines, the greater the cost. The difference in monthly EAS charge for a small exchange relative to a larger exchange can be seen in Table 5. For example, the EAS charge for basic rate area residential one party subscribers (BRA-RI) in the Kent exchange for extended area service to Creston is $3.15 per month. The EAS charge for the same subscriber service in the Creston exchange for extended area service to Kent and Orient is only $.32 per month. This disparity in cost reflects both a value of service consideration and the inability of small exchanges to spread costs over a larger number of subscribers.

When considering EAS, some arrangements are more cost effective than others. Again, referring to Table 5 we see that DeSoto (BRA-RI) subscribers pay $10.11 monthly to access an additional 146,000 Des Moines lines. Dexter pays more than half as much to access only 2500 additional lines.

General, Continental, Central, and United telephone companies itemize EAS on their billings and will assess additional charges by the

---

[1]In the SIDD area, five companies are rate regulated; General (GTE), Continental (Contel), Central, Northwestern Bell, and United. Seven companies are not regulated; Ground River Mutual (GRMT), Casey Mutual, Coon Valley, Farmers Mutual, Griswold Coop, Interstate 35, and Villisca Farmers Telephone Company.

previously discussed method if EAS is extended to a new exchange. Northwestern Bell does not itemize EAS because it has built an EAS adjustment into its rate structure. The only additional charge Northwestern Bell can assess occurs if the added access lines push the exchange into a higher rate group. When a small Northwestern Bell exchange gets EAS to a larger Northwestern Bell exchange, the small exchange often is pushed into a higher rate group and incurs a higher flat rate charge. For the larger Northwestern Bell exchange, the added lines are seldom sufficient to alter its rate group. When DeSoto received EAS to Des Moines, there was no additional charge to Des Moines subscribers. In the case of a small non-Bell exchange getting EAS to a larger Northwestern Bell exchange, Northwestern Bell often must absorb its share of the cost without additional charge to subscribers. If Stanton or Elliot were to access Red Oak, a Northwestern Bell exchange, there would be no additional charge for Red Oak customers.

The non-rate-regulated companies do not itemize EAS and generally charge on a simple cost recovery method.

Comparison of service and rates   It is not the intent of this study to undertake a comprehensive comparison of basic costs and quality of service between exchanges and companies. However, it does seem useful to briefly examine some of the more obvious differences.

Information from Table 5 permits these generalizations. Small non-rate-regulated companies offer higher quality local service at lower flat rate charges. Anecdotal evidence from Utility Division staff has indicated that small companies often have the most modern equipment and service. Table 5 lends support to this assumption. All of the seven small companies offer one party service for all customers. The five large rate-regulated companies still retain two or four party rural residential service.

A comparison of flat rate charges for BRA-RI show that all of the small companies have lower average flat rates than all but Central Telephone Company of the five large companies, and five of the seven small companies have considerably lower rates.

Patterns of linkage Even a cursory perusal of Area Map 1 points to some obvious differences in EAS linkage patterns. Ringgold County exhibits excellent interconnections between exchanges which are linked not only to the county seat town, but to each other. A different pattern is evident in the Winterset area where all linkages are to the county seat. The good pattern of linkages in Ringgold County does not mean that total lines accessible in the local calling area are great. Whereas Diagonal, one of the Ringgold County exchanges, can access 2660 lines, the Shannon City exchange in Union County, because it has EAS to Creston, can access 5713 lines. Ultimately, as was discussed earlier, total number of lines accessible may be more important than other factors.

Some anecdotal evidence might offer an explanation for the different patterns of EAS coverage. According to Bob Osborn of the Iowa Utilities Division, Ringgold County received EAS in the early 1960s when an entrepreneur negotiated to buy out the small single exchange companies. As part of the inducement, he offered to help secure a network of extended area service. He was successful in both purchasing the small companies and securing EAS. Within a few years, he resold the new company to Continental but the EAS legacy remained.

The Winterset, Clarke County, pattern was the result of a different impetus. Ione Wilkins, Pricing Manager for Northwestern Bell, explained that in the 1960s, before the advent of direct distance dialing, Northwestern Bell was encouraging communities to adopt EAS even to the point of proposing and lobbying for statewide EAS which would have established toll-free calling throughout Iowa. At the time, all toll calls were operator assisted and were becoming increasingly expensive to handle. Statewide EAS was seen as a cost reduction move. With the advent of direct distance dialing, the rationale for a statewide network, at least from Northwestern Bell's perspective, no longer existed, but residuals of the effort such as in the Clarke County, Northwestern Bell exchanges still remain.

As to the other patterns of linkages, we will see from the school district map that most are explainable as links between exchanges of the same school district.

School districts

Area Map 2   Area Map 2 illustrates the thirty-four school districts which serve the SIDD area. The four digit labels are the official Iowa school district codes and are identified in the legend in the lower left corner of the map. A visual analysis reveals a fairly high degree of access among exchanges within a school district, although there are many exceptions, some notable. Adair and Casey are not linked. Peru is isolated from the rest of the Interstate 35 district as is Macksburg from the Orient-Macksburg School District and Grand River from the rest of the Grand Valley district. Blockton lacks access to 80% of the Bedford district. The worst access exists in the East Union School District where only Afton and Arispe are linked and where the Lorimor, Thayer and Shannon City exchanges are cut off. Access percentages for all exchanges are given in the last column of Table 6.

Contiguous boundaries An examination of the school district access column of Table 6 illustrates the high degree of interexchange access within school districts. Further, there seems to be a remarkable contiguity of exchanges and school district boundary lines. On Area Map 2, observe the school districts especially in Montgomery County but also in Adams and Taylor counties. Indeed, throughout the area, the parallels are striking, especially given the fact that no geographical or other apparent limits determined either exchange or school district boundaries.

The 34 exchange study As previously presented in the methods chapter, the coincidence of access and school districts seemed worthy of further examination. Therefore, an analysis was undertaken to determine the school district access characteristics of 34 exchanges randomly selected from other parts of Iowa whose character and size resembled that of the SIDD area exchanges. The results of the 34 exchange study are displayed in Figure 2. As can be seen from the graph, 58% of the exchanges had toll-free access to 100% of the school district and 80% of

Table 6. SIDD telephone exchange access delineations

EXCHANGE	TRADE CAP.	SD CODE	CNTY SEAT	EAS CODE	EXCH LINES	EAS LINES	% SCH DIS
Adair	N	3	N	1	706	706	55%
Afton	N	2	N	1	633	770	49%
Arispe	N	2	N	1	137	770	49%
Bedford	Y	3	Y	1	1169	1451	70%
Benton	Y	4	Y	1	111	2554	98%
Blockton	N	1	N	1	218	218	20%
Bridgewater	N	4	N	1	232	800	99%
Casey	N	2	N	1	448	895	45%
Clearfield	N	4	N	1	354	354	99%
Corning	Y	4	Y	1	1810	1810	95%
Creston	Y	4	Y	2	4970	5389	95%
Davis City	Y	4	Y	2	301	3086	85%
Desoto	Y	4	Y	2	607	146941	99%
Dexter	Y	4	N	2	404	2929	85%
Diagonal	Y	4	Y	2	282	2660	98%
Earlham	Y	4	Y	2	669	4823	85%
Elliot	N	3	N	1	440	1998	70%
Fontanelle	Y	4	Y	1	568	2427	98%
Garden Grove	Y	2	Y	1	266	1767	49%
Grand River	N	2	N	1	217	217	49%
Grant	N	3	N	1	186	1998	70%
Gravity	Y	3	Y	1	282	1451	70%
Greenfield	Y	4	Y	1	1627	2395	98%
Kellerton	Y	2	Y	1	357	2554	49%
Kent	Y	4	Y	2	113	5083	95%
Lamoni	Y	4	N	1	1284	1585	85%
Lenox	Y	4	N	1	926	1018	90%
Leon	Y	4	Y	1	1501	2478	95%
Lorimor	Y	1	N	2	408	4117	24%
Macksburg	Y	2	Y	2	158	3301	30%
Mt. Ayr	Y	4	Y	1	1337	2554	98%
Murray	N	4	N	1	566	974	98%
Nevinville	N	3	N	1	200	2588	60%
New Market	N	3	N	1	464	464	70%
Nodaway	Y	4	N	1	186	1188	95%
Orient	Y	3	N	2	306	5531	65%
Osceola	Y	4	Y	2	3035	3445	98%
Peru	Y	1	Y	2	162	3305	10%
Prescott	N	4	N	1	255	455	80%
Red Oak	Y	4	Y	2	3922	3922	90%
Redding	Y	4	Y	1	112	2554	98%
Shannon City	Y	1	Y	2	106	5713	10%
Sharpsburg	Y	4	N	1	92	1018	90%

Table 6 (Continued)

EXCHANGE	TRADE CAP.	SD CODE	CNTY SEAT	EAS CODE	EXCH LINES	EAS LINES	% SCH DIS
St. Charles	N	3	N	1	436	903	55%
Thayer	N	1	N	1	105	105	15%
Tingley	Y	4	Y	2	355	2660	98%
Truro	N	3	N	1	305	903	55%
Villisca	Y	4	N	1	1002	1188	95%
Weldn-Van Wrt	Y	4	Y	2	410	4946	80%
Winterset	Y	4	Y	2	3143	5815	99%

Y - YES

N - NO

SD CODE - SCHOOL DISTRICT CODE

RANGES OF THE SCHOOL DISTRICT CODE

0-24%	CODE 1
25%-49%	CODE 2
50%-74%	CODE 3
74%-99%	CODE 4

RANGES OF EAS CODE

0-2599	CODE 1
2600+	CODE 2

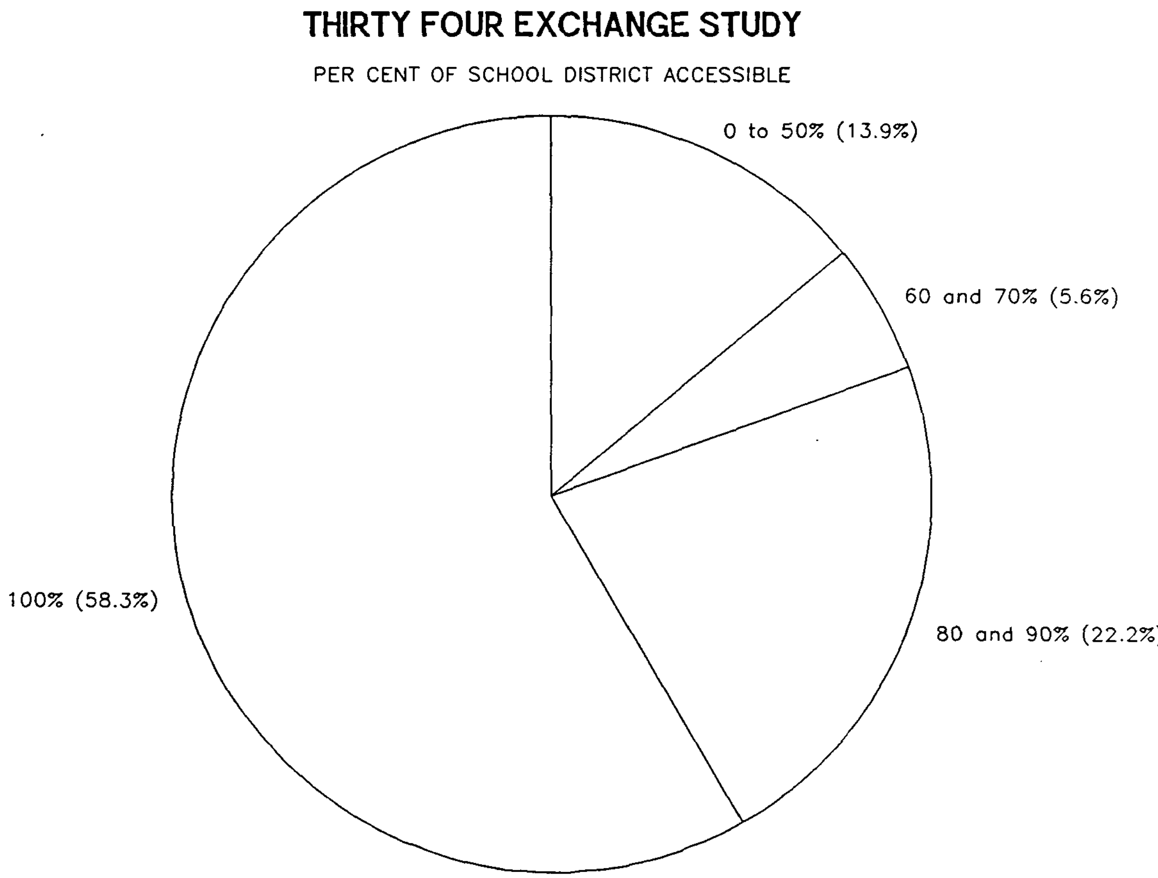


Figure 2. Thirty-four exchange study

the exchanges had access to at least 80% of the school district on a geographic basis. This supports the original observation of school district access among exchanges in the SIDD area. Although no statistical verification has been undertaken, it seems from casual observation that neither access to trade capital or to county seat town is as prevalent.

Trade territories

Area Map 3 Area Map 3 is the delineation of trade territories in the SIDD area. The impact of Des Moines can be seen in Adair, Madison, and Clarke counties and especially as it impacts Winterset and extends beyond to create an indifference boundary with the Creston area. The importance of the Des Moines trade territory was ignored in determining access to trade capital to be consistent with the local community of interest criteria used in the rest of the SIDD.

Another anomaly occurs in the four corner area of Union, Clarke, Decatur, and Ringgold counties. The existence of this no-man's-land was verified by the circulations manager of the Leon newspaper who noted that the area had always been considered unattached to a particular community.

Creston stands out as dominating the region. Corning appears larger than it probably is because of the discrepancy of not including Lenox in the delineation. Red Oak, as well, is probably diminished by the unnoted impact of Villisca. New Market is associated with Clarinda, although Clarinda is not shown on the map. Likewise, Bridgewater and

Grant are associated with unmarked Atlantic, and Adair and Casey with Guthrie Center. As can be seen, trade capital is not always the same as county seat, although it is often so. It should be noted that trade area boundaries are fluid and vary according to merchandise or service group. Perhaps this explains why access has been more consistent relative to boundaries for school districts which are hard and fast, than to trade territories whose boundaries are not.

Exceptions explained The second column of Table 6 lists the results for trade capital access employing the previously stated "majority rule" methodology. Some judgement calls need explanation. Diagonal was determined to be mostly with Mt. Ayr and therefore had access. As previously noted, the effect of Des Moines was ignored and those exchanges in Clarke County were considered to associate with Winterset. Garden Grove was considered part of the Leon trade area. Grand River was linked with Lamoni. By looking at the highway access, Kellerton seemed more associated with Mt. Ayr than Lamoni. Nodaway was linked with Villisca. Because Sharpsburg shared school district boundaries with Lenox, its trade territory was presumed likewise to be associated.

County seat access

Table 6, column four, lists the results of the county seat access analysis. The "majority rule" worked very well. Most decisions were clear cut.

Community of interest composite map

Area Map 4 - Table 6   Area Map 4 is the composite map which illustrates graphically what Table 6 gives in table form. Table 6 includes columns for the EAS codes and school district codes whose purposes were previously discussed in the "Querying the database" section. All information contained on the composite maps and in Table 6 has been sufficiently discussed in preceding sections.

Additional maps

Area Map 5 - Telephone companies   Each of the 52 exchanges in the SIDD area was at one time an individual telephone company. Casey Mutual Telephone Company in Adair County is the only SIDD area company to retain that unique identity. Although now privately owned, Casey Mutual is a highly profitable company serving only the 448 customers within the exchange boundary. The remainder of the SIDD area is served by eleven other phone companies. Area Map 5 graphically designates the exchanges served by the various companies. A listing of exchanges by telephone company was previously given in Table 5. As is evident from Area Map 5, a process of ownership consolidation has evolved as private or mutual owners have sold to larger operations.

Five of the companies with a significant presence in the area, Central, Continental, General, Northwestern Bell, and United, are large corporations with substantial holdings in many parts of Iowa, throughout the midwest and the nation. The remaining seven are small independent locally-owned companies. Although more numerous, the small independents do not serve a proportional area. More than three-fourths of the SIDD area is covered by the five major companies each with roughly equal holdings. Of the remaining one quarter held by small independents, nearly one half is covered by one independent company, Grand River Mutual.

One final observation on the distribution of EAS access relative to phone companies indicates that most often EAS has not crossed telephone company boundaries. A count of EAS connections reveal that 45 of 61, or 74%, of all EAS connections in the SIDD area are within company boundaries.

Area Map 6 - Toll completing centers   Area Map 6 shows the toll completing centers. Those centers that are half darkened are Northwestern Bell centers. Those centers divided by a single line are non-Bell centers. The shaded lines indicate the presence of a trunking cable which carries toll calls from the exchange to the toll completing center. At the toll center, calls are switched either to a higher level toll completing center such as Des Moines, or if the call is on the local net, directly to that exchange. The map does not show the cable linkages between the first level toll centers such as Creston and the higher level centers such as Des Moines. At the level of the Des Moines switch, the toll call is either routed back to some intra-LATA toll center or routed up to the inter-LATA long lines network which is now served by numerous long distance carriers.

Area Map 6 shows the LATA boundary in the SIDD area as the heavy dotted line generally following the west boundary of Adair County and the Corning exchange. LATAs often follow to area code boundaries. The 714 area code lines are switched out of Omaha and the 515 out of Des Moines. Since cross LATA calling is now under the jurisdiction of the FCC, any cross-LATA extended area service would cause some jurisdictional problems. As discussed in the methodology, knowing the toll cable locations can be useful later in the study. There are a number of instances where toll cable could be redesignated for EAS use.

Complementary Research

Telephone company financial statements

Introduction In Table 7, the telephone company financial statements are presented in five sections; Assets, Liabilities, Operating Income, Other Income, and Significant Ratios. Each section is displayed on a separate page, with a final page containing the key and an explanation of the calculations used. There are numerous insights to be mined from this treasure of figures relative to the comparative financial structures and operations of the telephone companies, but only those most relevant to the present study will be discussed.

Organizational form Most companies in the region are investor or privately owned. There are two cooperatives, Coon Valley Coop and Griswold Coop; and one mutual, Farmers Mutual. Subscribers must own 50% of a mutual company.

Table 7. SIDD telephone company financial statements for year ending 12-31-85

			ASSETS						
			PLANT	INVESTMENTS	OTHER	CURRENT			
COMPANY IDENTIFICATION	ORG. FORM		NET TELEPHONE PLANT	INVESTMENTS AND FUND ACCOUNTS	PREPAYMENTS & DEFERRED CHARGES	CASH & TEMP. CASH INVESTMENTS	OTHER	TOTAL CURRENT	TOTAL ASSETS
CASEY MUTUAL	I	VALUE	380,332	109,922	3,133	617,958	57,582	675,540	1,168,927
		%OF ASSETS	32.5%	9.4%	0.3%	52.9%	4.9%		
CENTRAL	I	VALUE	631,155,440	319,457,990	11,400,502	4,324,161	53,567,939	57,892,100	1,019,906,032
		%OF ASSETS	61.9%	31.3%	1.1%	0.4%	5.3%		
COON VALLEY	C	VALUE	547,315	10,129	3,705	424,279	43,005	467,284	1,028,433
		%OF ASSETS	53.2%	1.0%	0.4%	41.3%	4.2%		
CONTINENTAL OF IOWA	I	VALUE	86,836,760	1,647,523	213,974	2,086,365	3,914,445	6,000,810	94,699,067
		%OF ASSETS	91.7%	1.7%	0.2%	2.2%	4.1%		
FARMERS MUTUAL	M	VALUE	996,977	238,333	6,093	392,014	97,163	489,177	1,730,580
		%OF ASSETS	57.6%	13.8%	0.4%	22.7%	5.6%		
GRAND RIVER MUTUAL	I	VALUE	32,596,362	1,278,513	12,515	4,511,586	2,330,906	6,842,492	40,729,882
		%OF ASSETS	80.0%	3.1%	0.0%	11.1%	5.7%		
GENERAL	I	VALUE	279,036,000	5,597,000	3,348,000	(7,955,000)	30,155,000	22,200,000	310,181,000
		%OF ASSETS	90.0%	1.8%	1.1%	-2.6%	9.7%		
GRISWOLD COOP	C	VALUE	1,587,798	77,135	6,201	1,301,439	163,229	1,464,668	3,135,802
		%OF ASSETS	50.6%	2.5%	0.2%	41.5%	5.2%		
I-35	I	VALUE	1,038,036	646,900	(1660)	121,574	30,891	152,465	1,835,741
		%OF ASSETS	56.5%	35.2%	-0.1%	6.6%	1.7%		
NORTHWESTERN BELL	I	VALUE	4,221,317,317	14,180,633	52,251,860	10,800,117	411,853,134	422,653,251	4,710,403,061
		%OF ASSETS	89.6%	0.3%	1.1%	0.2%	8.7%		
UNITED OF IOWA	I	VALUE	62,312,751	1,076,358	230,853	(414,843)	6,631,254	6,216,411	69,836,373
		%OF ASSETS	89.2%	1.5%	0.3%	-0.6%	9.5%		
VILLISCA FARMERS	I	VALUE	788,865	42,622	0	141,776	45,945	187,721	1,019,208
		%OF ASSETS	77.4%	4.2%	0.0%	13.9%	4.5%		

Table 7 (Continued)

	LIABILITIES										
	SHAREHOLDERS EQUITY				LONG TERM DEBT				OTHER	
COMPANY IDENTIFICATION	ALL STOCK	ACCUMULATED RETAINED EARNINGS	OTHER	TOTAL CAPITAL AND RETAINED EARNINGS		TWO PERCENT REA LOAN	OTHER	TOTAL LONG TERM DEBT	CURRENT LIAB. DEFERRALS CRED. & RESERVE	TOTAL LIABILITIES
CASEY MUTUAL	7,920	711,712	0	719,632	VALUE	362,612	0	362,612	86,683	1,168,927
					%OF LT DEBT	100.0%	0.0%			
CENTRAL	368,196,000	108,312,730	1,676,647	478,185,377	VALUE	0	296,186,372	296,186,372	245,534,283	1,019,906,032
					%OF LT DEBT	0.0%	100.0%			
COON VALLEY	6,830	394,952	0	401,782	VALUE	609,069	0	609,069	17,582	1,028,433
					%OF LT DEBT	100.0%	0.0%			
CONTINENTAL OF IOWA	6,520,860	15,954,588	7,554,982	30,030,430	VALUE	7,484,903	23,023,617	30,508,520	34,160,117	94,699,067
					%OF LT DEBT	24.5%	75.5%			
FARMERS MUTUAL	12,080	836,415	24,146	872,641	VALUE	656,145	0	656,145	201,794	1,730,580
					%OF LT DEBT	100.0%	0.0%			
GRAND RIVER MUTUAL	80,375	3,442,363	0	3,522,738	VALUE	28,440,292	7,330,516	35,770,808	1,436,336	40,729,882
					%OF LT DEBT	79.5%	20.5%			
GENERAL	63,000,000	48,958,000	0	111,958,000	VALUE	0	100,837,000	100,837,000	97,386,000	310,181,000
					%OF LT DEBT	0.0%	100.0%			
GRISWOLD COOP	40,425	2,323,010	0	2,363,435	VALUE	641,501	0	641,501	130,866	3,135,802
					%OF LT DEBT	100.0%	0.0%			
I-35	72,000	599,642	0	671,642	VALUE	0	928,015	928,015	236,084	1,835,741
					%OF LT DEBT	0.0%	100.0%			
NORTHWESTERN BELL	1,565,060,240	189,745,919	523,015	1,755,329,174	VALUE	0	1,290,297,440	1,290,297,440	1,664,776,447	4,710,403,061
					%OF LT DEBT	0.0%	100.0%			
UNITED OF IOWA	6,862,425	17,238,275	2,481,911	26,582,611	VALUE	0	16,916,000	16,916,000	26,337,762	69,836,373
					%OF LT DEBT	0.0%	100.0%			
VILLISCA FARMERS	62,790	851,738	0	914,528	VALUE	0	0	0	104,680	1,019,208
					%OF LT DEBT					

Table 7 (Continued)

COMPANY IDENTIFICATION		REVENUE: LOCAL SERVICE	REVENUE: ACCESS & TOLL SERVICE	REVENUE: OTHER	TOTAL OPERATING REVENUE	EXPENSES: FEDERAL AND STATE INCOME TAX	EXPENSES: OTHER	TOTAL OPERATING EXPENSE	NET OPERATING INCOME
		OPERATING REVENUE LESS EXPENSE = INCOME							
CASEY MUTUAL	VALUE	48,835	144,929	20,753	214,517	6,488	138,067	144,555	69,962
	%OF OP.REV	22.8%	67.6%	9.7%					
CENTRAL	VALUE	116,281,000	153,275,000	49,807,000	319,363,000	38,768,000	214,203,000	252,971,000	66,392,000
	%OF OP.REV	36.4%	48.0%	15.6%					
COON VALLEY	VALUE	51,764	142,884	18,243	212,891	0	182,687	182,687	30,204
	%OF OP.REV	24.3%	67.1%	8.6%					
CONTINENTAL OF IOWA	VALUE	14,696,000	23,190,000	2,558,000	40,444,000	4,048,000	28,697,000	32,745,000	7,699,000
	%OF OP.REV	36.3%	57.3%	6.3%					
FARMERS MUTUAL	VALUE	57,090	335,827	18,263	411,180	0	283,291	283,291	127,889
	%OF OP.REV	13.9%	81.7%	4.4%					
GRAND RIVER MUTUAL	VALUE	2,404,000	6,139,000	584,000	9,127,000	0	7,023,000	7,023,000	2,104,000
	%OF OP.REV	26.3%	67.3%	6.4%					
GENERAL	VALUE	39,118,000	79,977,000	18,763,000	137,858,000	12,772,000	100,105,000	112,877,000	24,981,000
	%OF OP.REV	28.4%	58.0%	13.6%					
GRISWOLD COOP	VALUE	147,677	554,468	37,872	740,017	0	510,753	510,753	229,264
	%OF OP.REV	20.0%	74.9%	5.1%					
I-35	VALUE	109,608	297,066	25,680	432,354	(4,211)	324,718	320,507	111,847
	%OF OP.REV	25.4%	68.7%	5.9%					
NORTHWESTERN BELL	VALUE	926,663,000	1,006,227,000	186,673,000	2,119,563,000	236,159,000	1,480,571,000	1,716,730,000	402,833,000
	%OF OP.REV	43.7%	47.5%	8.8%					
UNITED OF IOWA	VALUE	9,259,000	19,441,000	2,452,000	31,152,000	3,313,000	21,550,000	24,863,000	6,289,000
	%OF OP.REV	29.7%	62.4%	7.9%					
VILLISCA FARMERS	VALUE	161,018	242,137	41,635	444,790	28,390	366,313	394,703	50,087
	%OF OP.REV	36.2%	54.4%	9.4%					

Table 7 (Continued)

Company Identification		Interest and Dividends	Other Other	Total Other Revenue		Total Other Expense	Net Other Income	Net Earnings 1985	Dividends
		OTHER REVENUE LESS EXPENSE = INCOME						EARNINGS	DIVIDENDS
		REVENUE				EXPENSE			
CASEY MUTUAL	VALUE	50,153	17,472	67,625		46,280	21,345	91,307	DR
	%OF ALL REV	17.8%			% INT.	0.0%			
CENTRAL	VALUE	2,279,000	70,534,000	72,813,000		29,295,000	43,518,000	109,910,000	77,002,281
	%OF ALL REV	0.6%			% INT.	84.8%			
COON VALLEY	VALUE	40,350	17,830	58,180		39,942	18,238	48,442	DR
	%OF ALL REV	14.9%			% INT.	0.0%			
CONTINENTAL OF IOWA	VALUE	146,000	1,142,000	1,288,000		2,993,000	(1,705,000)	5,994,000	5,233,318
	%OF ALL REV	0.3%			% INT.	71.0%			
FARMERS MUTUAL	VALUE	46,054	97,388	143,442		153,417	(9,975)	117,914	DR
	%OF ALL REV	8.3%			% INT.	0.0%			
GRAND RIVER MUTUAL	VALUE	277,000	342,000	619,000		1,912,000	(1,293,000)	811,000	DR
	%OF ALL REV	2.8%			% INT.	82.7%			
GENERAL	VALUE	891,000	5,998,000	6,889,000		13,936,000	(7,047,000)	17,934,000	12,325,444
	%OF ALL REV	0.6%			% INT.	0.0%			
GRISWOLD COOP	VALUE	87,099	77,901	165,000		59,094	105,906	335,170	DR
	%OF ALL REV	9.6%			% INT.	0.0%			
I-35	VALUE	15,364	17,755	33,119		110,636	(77,517)	34,330	0
	%OF ALL REV	3.3%			% INT.	87.0%			
NORTHWESTERN BELL	VALUE	17,668,000	94,000	17,762,000		133,294,000	(115,532,000)	287,301,000	288,121,594
	%OF ALL REV	0.8%			% INT.	82.2%			
UNITED OF IOWA	VALUE	20,000	1,879,000	1,899,000		3,433,000	(1,534,000)	4,755,000	5,853,754
	%OF ALL REV	0.1%			% INT.	39.6%			
VILLISCA FARMERS	VALUE	10,358	19,902	30,260		8,881	21,379	71,466	25,320
	%OF ALL REV	2.2%			% INT.	0.0%			

Table 7 (Continued)

			SIGNIFICANT RATIOS								
COMPANY IDENTIFICATION	SHARES	EARNINGS PER SHARE	EXCHANGE LINES	LOCAL REV. PER EXCHNG LINE	TOLL REV. PER EXCHNG LINE	TOTAL REV. PER EXCHNG LINE	EARNINGS PER EXCHNG LINE	EARNINGS AS A % OF NET TELE. PLANT	DEBT TO ASSET	LIQUID ASSETS TO FIXED ASSETS	INCOME TAXES AS A % OF EARNINGS
CASEY MUTUAL	264 AT 30.00	345.86	424	115.18	341.81	456.99	215.35	24.0%	0.38	1.38	7.1%
CENTRAL	9,466,734 VARIOUS	11.61	591,986	196.43	258.92	455.34	185.66	17.4%	0.53	0.06	35.3%
COON VALLEY	683 AT 10.00	70.93	648	79.88	220.50	300.38	74.76	8.9%	0.61	0.84	0.0%
CONTINENTAL OF IOWA	398,286 VARIOUS	15.05	67,612	217.36	342.99	560.34	88.65	6.9%	0.68	0.07	67.5%
FARMERS MUTUAL	453 AT 20.00	260.30	1,144	49.90	293.56	343.46	103.07	11.8%	0.50	0.40	0.0%
GRAND RIVER MUTUAL	16,075 AT 5.00	50.45	18,023	133.39	340.62	474.01	45.00	2.5%	0.91	0.20	0.0%
GENERAL	2,385,000	7.52	239,519	163.32	333.91	497.23	74.88	6.4%	0.64	0.08	71.2%
GRISWOLD COOP	1,617 AT 25.00	207.28	1,949	75.77	284.49	360.26	171.97	21.1%	0.25	0.88	0.0%
I-35	5,000 AT 20.00	6.87	894	122.60	332.29	454.89	38.40	3.3%	0.63	0.09	-12.3%
NORTHWESTERN BELL	78,253,012	3.67	3,479,778	266.30	289.16	555.46	82.56	6.8%	0.63	0.10	82.2%
UNITED OF IOWA	134,600	35.33	61,542	150.45	315.90	466.35	77.26	7.6%	0.62	0.10	69.7%
VILLISCA FARMERS	6,279 AT 10.00	11.38	1,164	138.33	208.02	346.35	61.40	9.1%	0.10	0.23	39.7%

Table 7 (Continued)

SOURCE: TELEPHONE COMPANY REPORTS TO THE UTILITIES DIVISION OF THE IOWA DEPARTMENT OF COMMERCE AND ALSO ANNUAL REPORTS TO THE FEDERAL COMMUNICATIONS COMMISSION FOR THE YEAR ENDING DECEMBER 31, 1985

KEY:

M MUTUAL (50% or more are subcribers)
C COOPERATIVE
I INVESTOR OR PRIVATELY OWNED
DR DIVIDENDS RESTRICTED BY REA MORTGAGE

RATIOS:

EARNINGS PER SHARE: NET EARNINGS / TOTAL SHARES
LOCAL REVENUE PER EXCHANGE LINE: LOCAL SERVICE REVENUE / EXCHANGE LINES
TOLL REVENUE PER EXCHANGE LINE: TOLL AND ACCESS REVENUE / EXCHANGE LINES
TOTAL REVENUE PER EXCHANGE LINE: LOCAL SERVICE REVENUE + TOLL AND ACCESS REVENUE / EXCHANGE LINES
EARNINGS PER EXCHANGE LINE: NET EARNINGS / EXCHANGE LINES
EARNINGS AS A PERCENT OF NET TELEPHONE PLANT: NET EARNINGS / NET TELEPHONE PLANT GIVEN AS A PERCENTAGE
DEBT TO ASSET: TOTAL LIABILITIES - TOTAL CAPITAL AND RETAINED EARNINGS / TOTAL ASSETS
LIQUID ASSETS TO FIXED ASSETS: TOTAL CURRENT ASSETS / NET TELEPHONE PLANT + INVESTMENTS AND FUND ACCOUNTS
INCOME TAXES AS A PERCENT OF EARNINGS: STATE AND FEDERAL INCOME TAXES PROVIDED FOR / NET EARNINGS AND GIVEN AS APERCENTAGE

Location of assets   Generally, small independent companies keep a large share of their assets in cash. From the assets section on Table 7, we can see that Casey Mutual has 52.9% in cash, Coon Valley 41.3%, Farmers Mutual 22.7%, Grand River Mutual 11.1%, Griswold Coop 41.5%, I-35, 6.6%, and Villisca Farmers 13.9%. In contrast, large companies keep few cash assets. Continental has 2.2% in cash, the highest of the "big five."

The explanation seems to reside in the structure of their debts. Most of the small company debt is held in 2% REA loans (liabilities section Table 7). Paying 2% interest does not create an incentive to prepay loans, although in numerous cases, they have. Secondly, the 2% REA loans carry certain restrictions which limit the distribution of dividends. The original purpose of these restrictions seems to have been to encourage the build up cash reserves for expansion or improvement. With declining populations, there are few opportunities for expansion and as previously mentioned, the small companies already have some of the most modern equipment. Some are expanding in new telecommunication areas. Casey Mutual recently paid cash to purchase and install its own cable TV station.

In contrast, the large companies keep few assets in cash. Most earnings are immediately dispersed as dividends often to the parent company. The large companies receive loans from commercial lenders and so are not restricted on the dispersal of dividends.

This situation presents some interesting redistribution issues. From a narrow regional perspective, it is encouraging that the small companies are bringing in subsidies from the federal treasury in the form of low interest loans. In addition, earnings are being retained in the region by the local owners, coop, or mutual members. In contrast, the large companies do not bring in subsidies but do remove earnings by way of dividend payouts to stockholders throughout the nation. There is no certainty that these earnings ever return proportionately to the region. In fact, this seems unlikely since incomes are relatively low regionwide.

Operating revenues For small rural telephone companies, the percentage of operating revenues derived from tolls has been increasing over time. Figure 3 shows the change nationwide in sources of revenue for REA telephone loan recipients (U.S. Congress, House of Rep., 1982). Because of the restricted nature of this loan program, these recipients can be presumed to be predominantly small independent telephone companies serving rural areas. Figure 3 shows that from 1965 to 1980, toll calling revenues increased from 36% to 61% of total operating revenues.

Refering to the operating revenues section of Table 7, we see that by 1985, for the SIDD region sample of seven small companies, toll revenues averaged 69% of operating revenues. In contrast, the five large companies in the SIDD region generated only 55% of total operating revenues from toll. This represents a 14% disparity between large and small companies. The figures for the large companies were statewide or in the case of Northwestern Bell, nationwide, and probably reflect a much different urban-rural mix than the "small seven."

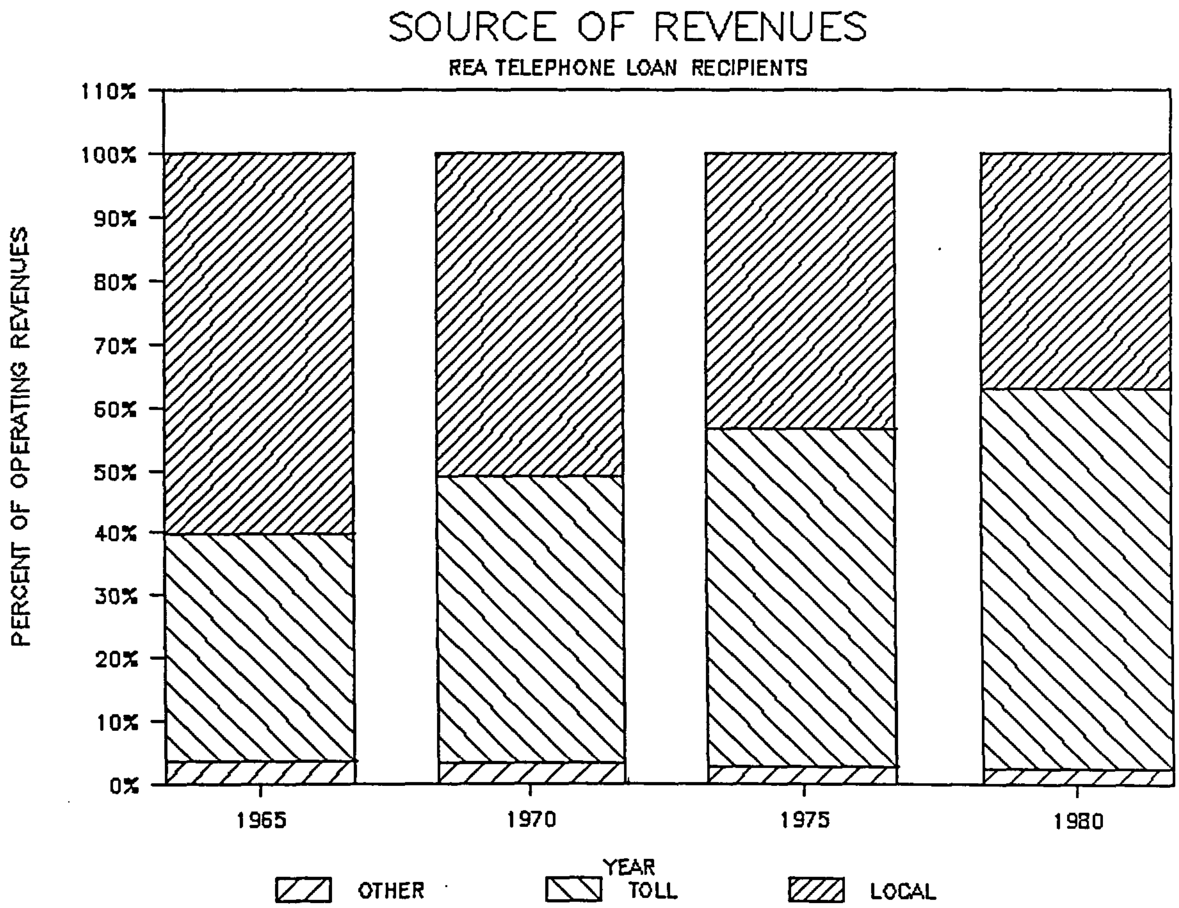


Figure 3. Sources of revenue for REA telephone loan recipients

As previously noted, the flat rates for the "small seven" are overall much lower than the flat rates for the big five. The explanation for the related phenomenon of lower flat rates and higher percentage of toll revenues for the "small seven" seems to have several aspects. First, the small companies were probably more insular and local in their outlook and made few efforts to encourage EAS thereby limiting toll-free calling areas. As we have observed, EAS was usually extended within telephone company boundaries and much less often to exchanges outside company boundaries. Since the small companies only covered a few exchanges, the likelihood of wide area EAS was diminished, thereby resulting in more toll revenue and less local revenue.

Second, it is much easier to placate a generally uninformed public by offering low local rates than by expanding service areas. Even if local subscribers realized that they paid high tolls or had restricted calling patterns, few subscribers realize that mechanisms exist for changing the situation. Neither the phone companies nor the regulatory agencies make any effort to inform the public on this matter.

Third, under the old "separations and settlements" procedures which separated costs and allocated settlements between local inter-state and intra-state there is some consensus that toll revenues were subsidizing local revenues. Under that system, it was financially prudent, from a company point of view, to keep as much traffic in tolls as possible thereby increasing their share of the national pool. From a company perspective, this was wise and the results seem evident in the extremely sound financial situation of most small companies. From a consumer perspective, it may have been unwise because of the higher overall charges and lower usage.

Since deregulation, the old "separations and settlements" procedures are being replaced by new pooling arrangements to which all the long lines carriers will contribute. There are also new universal subscriber line fees, now at $2.00 but scheduled to rise, which contribute to this pool. This pool is then divided on lines somewhat similar to the old "separations and settlements procedure." This entire situation of allocating costs and revenues among the different parts of the system, local, intra exchange carriers, and long lines carriers is in transition, and no one is certain how it will all shake out. Since there seems to be at present such a strong inclination to eliminate perceived cross subsidies and to base service on cost and ignore public good, equity, and access issues, it seems likely that rural areas will be victimized in the new arrangements.

<u>Other revenues</u> Because the "small seven" hold a large share of assets in cash, it is to be expected that interest revenues would be high. Casey Mutual and Coon Valley derive 18% and 15% of all revenues respectively from interest payments (other revenue section, Table 7). Griswold Coop and Farmers Mutual also derive 8% and 10% respectively from interest. Villisca Farmers is a unique case since it has chosen to eliminate debt rather than retain cash and profit from the interest. This is a questionable strategy when the interest differential between the 2% REA loans and interest on retained earnings could be 3-5% or even higher depending on investment strategies.

The "big five" all derive less than 1% of total revenues from interest.

Comparative earnings   All twelve companies report profits. The standard measure of earnings for rate regulation purposes is to allow earnings to be 10% of the net telephone plant. Although the procedures used in this analysis are only an approximation of the accounting procedures used to determine net utility plant, we can see in the "Significant Ratios" section of Table 7 that the "big five" fall well within these guidelines. Central Telephone is the exception with a 17.4% earnings to net telephone plant ratio. This is probably due to a very large investment noted in the Investments and Fund amounts columns (assets section, Table 7) which was unaccounted for in the procedure adopted in this simple analysis.

The "small seven" again exceed the "large five" in earnings as a per cent net telephone plant. Casey Mutual and Griswold Coop each exceeded the 20% ratio. The ratios for Coon Valley, Farmers Mutual, and Villisca Farmers were all higher than the "big five" excluding Central Telephone Company.

Grand River Mutual and I-35 with 3.3% were dramatic exceptions to the above, showing the lowest ratios of all twelve companies. I-35 does not appear to be doing well. For an undetermined reason, it has decided not to borrow the 2% REA money and therefore is paying much higher interest rates. A possible explanation is that it is family owned and desires not to have the distribution of earnings restricted.

Grand River Mutual also appears to be less robust. It has the highest debt to asset ratio and even though it generates one of the highest amounts of revenues per exchange line, it has the lowest earnings per exchange line. The high debt, 20% of which is from commercial lenders, probably accounts for the low earnings. The high debt may represent a recent plant modernization.

By all measures, two companies are not doing as well, Grand River Mutual and I-35; and two companies are doing extremely well, Casey Mutual and Griswold Coop. At the present rate of earnings, Griswold Coop could retire its entire debt in two years and Casey Mutual in four years. In fact, both companies have more than enough cash on hand to cover their entire long-term debt. As a general characterization, it can be said that all other companies are prospering.

Results of the Telephone Use Survey

Questionnaires were mailed to 400 subscribers. Ten of the surveys were returned to sender unopened due to change of address or to the subscriber being deceased. One hundred and sixty-seven surveys were completed and returned for a 43% rate of return. Of the 167 surveys returned, two were determined to be unusable leaving 165 usable observations. The results of the survey are reported in Appendix C, columns 7-12.

Results of the Regression Analysis

Results reported

The results of the regression analyses, the Pearson correlation coefficients and the means, standard deviations and ranges are given in Appendices D-G. The appendices are grouped into four subscriber classifications; all-business and all-residential, rural residential and town residential. Summary tables of the results are reported in this section.

Pearson correlation coefficients

The results of the correlation matrix analysis for the four subclasses, which is summarized in Table 8, indicates a consistently high correlation between all the independent variables for all subclasses. All of the correlations in Table 8 had predictive probabilities of at least .0001.

Table 8. Pearson correlation summary table

Correlation	Range of coefficients
trade capital with county seat	.80 - .82
trade capital with EAS lines	.73 - .78
trade capital with school district	.62 - .91
county seat with EAS lines	.76 - .81
county seat with school district	.57 - .83
school district with EAS lines	.56 - .71

The magnitude and consistency of these corelations is highly undesirable. It indicates a high level of multicollinearity between variables and violates the assumption that the variables act independently. High correlations between independent variables result in high standard errors in the beta coefficients. This would indicate that even if one of the models was found to be significant, the beta coefficients for the individual variables would probably not be significantly different than zero, making these coefficients unpredictable.

Regression analyses

Summary table The results of the regression analyses are given in Table 9. The results are reported by subclass and model and include the values of the two tailed t tests for the individual variables. A separate column expresses the sign that is expected if the results are to support the proposed hypothesis.

All-business models The F values for the regressions were not significant for any of the five models of the all-business subclass at even the .10 level. EAS lines is the only independent variable which showed a t statistic significant at the .05 level, but in the two models, Local Calls and Total Calls where this t statistic was significant, the sign of the beta coefficient was opposite that predicted. It must be concluded that the models, as specified, show no relationship between the dependent and independent variables. Therefore, the hypothesis for the all-business subclass is not

Table 9. Regression analysis summary table

Model	F Value	PR > F	R Square	Variable	Beta Coefficient	T Value	PR > T	Exp. Sign
<u>All Business</u>								
Local Calls	1.92	0.14	0.24	TC	13.33	0.14	0.45	Pos
				CS	137.81	1.84	0.08	Pos
				EAS-L	-0.04	-2.27	0.03	Pos
				SCH-DIST	39.33	0.17	0.87	Pos
Toll Calls	1.25	0.32	0.17	TC	-21.90	-0.85	0.41	Neg
				CS	20.48	1.05	0.31	Neg
				EAS-L	-0.01	-1.13	0.27	Neg
				SCH-DIST	0.06	0.00	1.00	Neg
Total Calls	1.90	0.14	0.25	TC	-17.20	-0.16	0.87	Pos
				CS	155.63	1.93	0.07	Pos
				EAS-L	-0.06	-2.43	0.02	Pos
				SCH-DIST	56.21	0.23	0.82	Pos
Amount Due	0.08	0.99	0.01	TC	-28.66	-0.31	0.76	Neg
				CS	6.60	0.10	0.93	Neg
				EAS-L	0.01	0.43	0.67	Neg
				SCH-DIST	-7.27	-0.03	0.97	Neg
Local Toll Chg	0.24	0.91	0.04	TC	3.77	0.08	0.94	Neg
				CS	18.62	0.51	0.61	Neg
				EAS-L	-0.00	-0.45	0.66	Neg
				SCH-DIST	-53.64	-0.55	0.59	Neg
<u>All Residential</u>								
Local Calls	2.45	0.05	0.08	TC	30.92	1.39	0.17	Pos
				CS	-40.72	-1.78	0.08	Pos
				EAS-L	0.01	0.96	0.34	Pos
				SCH-DIST	41.32	1.05	0.30	Pos
Toll Calls	6.34	0.0001	0.17	TC	-10.39	-1.65	0.10	Neg
				CS	-14.21	-2.18	0.03	Neg
				EAS-L	0.00	0.29	0.77	Neg
				SCH-DIST	22.61	2.06	0.04	Neg

Table 9 (continued)

Model	F Value	PR > F	R Square	Variable	Beta Coefficient	T Value	PR > T	Exp. Sign
All Residential (continued)								
Total Calls	1.89	0.12	0.07	TC	17.76	0.07	0.48	Pos
				CS	-55.44	-2.13	0.04	Pos
				EAS-L	0.01	0.94	0.35	Pos
				SCH-DIST	71.95	1.60	0.11	Pos
Amount Due	2.24	0.07	0.07	TC	-1.27	-0.23	0.82	Neg
				CS	-9.38	-1.64	0.10	Neg
				EAS-L	-0.00	-0.22	0.82	Neg
				SCH-DIST	17.94	2.04	0.04	Neg
Local Toll Chg	3.67	0.007	0.10	TC	1.83	0.21	0.84	Neg
				CS	-30.68	-3.34	0.001	Neg
				EAS-L	0.00	1.31	0.19	Neg
				SCH-DIST	25.91	1.75	0.08	Neg
Rural Residential								
Local Calls	2.41	0.06	0.18	TC	30.23	0.93	0.36	Pos
				CS	-43.89	-1.21	0.23	Pos
				EAS-L	0.02	1.35	0.19	Pos
				SCH-DIST	41.07	0.93	0.36	Pos
Toll Calls	2.61	0.05	0.18	TC	-14.93	-1.21	0.23	Neg
				CS	-23.22	-1.71	0.09	Neg
				EAS-L	0.00	0.92	0.36	Neg
				SCH-DIST	34.29	2.04	0.05	Neg
Total Calls	1.93	0.12	0.15	TC	15.60	0.41	0.69	Pos
				CS	-68.64	-1.60	0.12	Pos
				EAS-L	0.02	1.46	0.15	Pos
				SCH-DIST	75.98	1.46	0.15	Pos
Amount Due	1.66	0.17	0.12	TC	8.75	0.54	0.59	Neg
				CS	-39.94	-2.21	0.03	Neg
				EAS-L	0.01	0.88	0.39	Neg
				SCH-DIST	33.63	1.55	0.13	Neg

Table 9 (continued)

Model	F Value	PR > F	R Square	Variable	Beta Coefficient	T Value	PR > T	Exp. Sign
Rural Residential (continued)								
Local Toll Chg	1.59	0.19	0.12	TC	-1.36	-0.21	0.83	Neg
				CS	-7.44	-1.02	0.31	Neg
				EAS-L	-0.00	-0.28	0.78	Neg
				SCH-DIST	18.32	2.18	0.03	Neg
Town Residential								
Local Calls	0.69	0.60	0.04	TC	29.04	0.81	0.42	Pos
				CS	-37.59	-1.21	0.23	Pos
				EAS-L	0.00	0.37	0.71	Pos
				SCH-DIST	32.68	0.37	0.71	Pos
Toll Calls	3.38	0.01	0.16	TC	-0.93	-0.15	0.88	Neg
				CS	-6.64	-1.14	0.26	Neg
				EAS-L	-0.00	-0.14	0.89	Neg
				SCH-DIST	-8.41	-0.60	0.55	Neg
Total Calls	0.51	0.73	0.03	TC	25.09	0.64	0.53	Pos
				CS	-43.51	-1.27	0.21	Pos
				EAS-L	0.00	0.27	0.79	Pos
				SCH-DIST	34.49	0.36	0.72	Pos
Amount Due	1.93	0.11	0.10	TC	0.60	0.06	0.96	Neg
				CS	-23.16	-2.30	0.02	Neg
				EAS-L	0.00	1.26	0.21	Neg
				SCH-DIST	6.32	0.28	0.78	Neg
Local Toll Chg	0.72	0.58	0.04	TC	-0.46	-0.05	0.95	Neg
				CS	-10.01	-1.17	0.24	Neg
				EAS-L	-0.00	-0.05	0.96	Neg
				SCH-DIST	16.17	0.90	0.37	Neg

supported.

<u>All-residential models</u> The all-residential subclass includes all of the residential observations. Of the five models, three were significant at or below the .05 level. The Local Calls model was significant at .05 with an R Square of .08. The Toll Call model was significant at .0001 with an R Square of.10. The Local Toll Charge model was not significant at .05 but was at .07. The Total Calls model was not significant. In fact, the Total Calls model was not significant for any of the four subclasses of subscribers, indicating that this was the most poorly specified of all models.

Most often the t statistic for all variables for all five of the all-residential models was not significant nor was the sign predictable. An exception was the county seat variable which was significant at the .10 level for two models and at the .05 level for three models. The sign was negative for all models which was opposite of that expected in the Local Calls and Total Calls models but correct in the other three models.

The general unpredictability of the t statistic for the variables is attributable to the high correlation between independent variables. Because of the lack of predictability for the t statistics and the low R Square values for all the models, with the exception of the Toll Call model, the correlations between dependent and independent variables could be considered neither reliable nor strong. The only model which is strong relative to the others is the Toll Call model.

An examination of the Toll Call model for the three residential subclasses The all-residential Toll Call model was significant at the .0001 level with an R Square of .17. This was the highest level of significance and the second highest R Square for any of the twenty models examined. The Toll Call model for rural residential was also significant at the .048 level and had an R Square of .18. The Toll Call model for town residential was significant as well at .01 with an R Square of .16.

Even though an R Square value of .17 is not large, it should not be discounted. Mahan (1978) suggests that researchers should not be disturbed by relatively low R Square values. In his very explicit demand study of toll calling which specified 25 explanatory variables, he achieved an R Square of only .35. Citing other researchers who had achieved similar results, he stated that low R Squares are probably due to the many individual taste factors of subscribers and little is to be gained in trying to specify all of these.

For the Toll Call models, the t statistic for the school district variable was significant for the all-residential and rural residential subclasses but the sign was incorrect. For town residential, the sign was correct, but the t statistic was not significant. For all three residential Toll Call models, the EAS lines variable was inconsistent in sign and not significant throughout. The only variable that was significant in two of the three models and had the correct sign was the county seat variable. As explained earlier, the strong multicollinearity between variables is influencing the significance of the t statistic, so even though the F values are significant and the R Squares ranged between .16 and .18, little can be said with certainty because either the signs of the beta coefficients are incorrect or the t statistic is insignificant.

Other rural residential and town residential models With the exception of the Toll Call models, none of the other rural residential or town residential models were significant at the .05 level.

EAS lines variable It seems appropriate to examine the independent variables to see if any patterns emerge. The EAS lines variable was significant in only two of the twenty models. Its significance level was often .5 and above and its sign was inconsistent. It is interesting that it showed so poorly since other research has shown that an increase in EAS lines usually means an increase in calling. The explanation possibly lies in the fact that the sign differentials indicated in the studies cited, such as the Comprehensive Study of Telephone Service (1985), were much larger than those in the SIDD area. In the cited studies, small towns accessed larger cities, expanding their number of access lines a hundred-fold rather than doubling or tripling them as in the present study. The size variation in the present study was possibly not large enough to be significant.

School district variable The school district variable was very insignificant for the business models in one case having a 0.00 t value. This is probably reasonable since it would not be expected that school district access would be important for business. It was significant in several of the rural residential and all-residential models but its sign was opposite that expected. It can be speculated that school districts are so small or that the share of the population with school children is so small that schools are relatively less important. It is also possible that the geographic basis of determining access did not accurately reflect population access. Another possibility is that most of the areas studied had reasonably good access and that a well-defined comparison was not possible.

Trade capital and county seat variables The trade capital variable was not significant in any of the twenty models. On the other hand, the county seat variable was the one most often significant. At the .10 level, it was significant in 10 of twenty models.

Rebuilding the Toll Call models

One and two variable models The all-residential, rural residential, and town residential Toll Call models seem to be the best of all models tested and offer some possibilities for model rebuilding by elimination of redundant variables. To explore this possibility, these Toll Call models were run, once with only the county seat variable, once with only the school district variable, and once with both variables. The results are displayed in Appendix H. The summary table of results is given in Table 10.

County seat models are significant Only the models which included the county seat variable were highly significant for all three subclasses. The beta coefficients were also significant and the correct sign. The models which included only the school district variable was

Table 10. Regression analysis summary table, revised models

Model	F Value	PR > F	R Square	Variable	Beta Coefficient	T Value	PR > T	Exp. Sign
<u>All Residential</u>								
Toll Calls	19.87	0.0001	0.14	CS	-14.35	-4.46	0.0001	Neg
Toll Calls	3.39	0.07	0.03	SCH-DIST	-14.25	-1.84	0.07	Neg
Toll Calls	11.24	0.0001	0.15	CS	-19.05	-4.31	0.0001	Neg
				SCH-DIST	15.43	1.54	0.125	Neg
<u>Rural Residential</u>								
Toll Calls	4.74	0.03	0.09	CS	-15.34	-2.18	0.03	Neg
Toll Calls	0.04	0.84	0.00	SCH-DIST	2.68	0.20	0.84	Neg
Toll Calls	4.35	0.02	0.15	CS	-25.11	-2.94	0.01	Neg
				SCH-DIST	30.17	1.92	0.06	Neg
<u>Town Residential</u>								
Toll Calls	13.15	0.0005	0.15	CS	-10.38	-3.63	0.0005	Neg
Toll Calls	10.69	0.0016	0.13	SCH-DIST	-24.99	-3.27	0.002	Neg
Toll Calls	6.91	0.0018	0.16	CS	-7.50	-1.69	0.09	Neg
				SCH-DIST	-9.91	-0.85	0.39	Neg

significant at the .05 level in only the town residential model.

Combined model, all-residential subclass The models containing both variables, county seat and school district, was significant for the all-residential subclass, but the beta coefficient for school district was not significant at the .05 level and the sign was incorrect. The inclusion of the school district variable increased the R Square by only 0.01, indicating that its inclusion added little to the model. The simple model containing only the county seat variable produced the best results, yielding an R Square of 0.15, which was only .02 less than the original model containing all four independent variables.

Rural residential models The rural residential model which contained only the county seat variable was significant at .03, but the R Square was only .09. The beta coefficient was also significant and the correct sign. The rural residential model with only the school district variable was not significant. The combined model for rural residential was significant, and the R Square was much improved at 0.15, but it must be assumed that the improvement was the result of the interaction of the two variables. The rural residential model is the least strong of the three residential models. This would indicate that rural residential subscribers are not as affected by lack of access to communities of interest as are town residential subscribers. Possibly this reflects the fact that rural residential calling patterns are not well captured in the access areas as defined. Rural respondents may be oriented to different communities than the exchange as a whole, resulting in more diversity of response.

Town residential models The town residential model which contained only the county seat variable was significant and had an R Square of 0.15. This was the strongest of the county-seat-only models for the three subclasses. The beta coefficient was significant and the correct sign. The school district model was also significant, and the beta coefficients significant and the correct sign. The combined model was significant but added only 0.01 to the R Square of the county-seat-only model.

Strongest model Overall, the model which was most reliable and which explained the greatest amount of variation in the dependent toll call variable was the county-seat-only, town residential model. The county seat variable seems able to explain nearly as much as all the other variables combined.

CONCLUSIONS, RECOMMENDATIONS, FINAL COMMENTS

Conclusions

Introduction

The broad concern of this study has been telecommunications access in rural Iowa. This broad concern has been addressed by examining the various aspects of telephone system origins and design in a nine county region in southern Iowa. This region was chosen because it can be considered representative of rural Iowa and because the information and recommendations developed would contribute to a larger research project in the area.

It was the intent of this study to (1) develop a comprehensive understanding of the telephone system in the SIDD area, (2) to test the hypothesis that telephone subscribers who lacked toll-free access to communities of interest called less and paid more for their phone service, and (3) to make appropriate recommendations for policy action. The approach of this study has primarily been deductive, i.e., to test the support for the hypothesized statement. From the need to develop an adequate data base to test the validity of the hypothesis came a comprehensive delineation of telephone system characteristics.

This delineation was unique in several ways. It attempted to examine the relationship of telephone system design to community of interest criteria. In so doing, it utilized a combination of overlay and statistical techniques common to the disciplines of economic geography and regional science but which had not previously been used to understand telephone system characteristics.

Comprehensive delineation of the regional telephone system

As a result of this study, a comprehensive historical, financial, and spatial data base of the SIDD region telephone system now exists. This record offers an explanation of (1) how the historical development of the rural telephone system and the agricultural community have produced the existing spatial arrangement of telephone service areas, (2) how the existing spatial arrangements are interrelated with the financial and organizational status of the present telephone companies, and (3) how this combination of circumstances and events has affected the access characteristics of the present system, especially as they relate to larger community systems.

Six maps have been developed: a base map of the nine county SIDD region which delimits the telephone exchange areas and the EAS linkages, maps which show the telephone company service areas and the toll centers, and maps of retail trade areas and school district boundaries. These maps provide a useful beginning for what could be a more comprehensive analysis of regional systems in the SIDD area. To the original maps developed for this project could be added an extensive series of overlays which identify systematic regional linkages. Some areas which might be examined are: industrial and agricultural distribution systems, television and radio coverage areas, various political jurisdictions, industrial control linkages, roads, railroads and topography, soils and agricultural production, and social and community organization networks.

Additional analysis has also been presented of the financial and organizational structures of telephone companies in the SIDD region. It has been shown that the seventeen telephone companies operating in the area are presently financially sound and profitable. Most of the small companies appear to be very profitable. They hold significant cash reserves which generate substantial revenues, or they carry little debt, or both. It has also been shown that small companies have smaller service areas and lower flat rates. Because of this, there has been a substantial reversal in sources of revenue for small companies. Over 60% of all revenues now come from toll calls.

Statistical analysis - Importance of variables

The statistical analysis gave limited support to the original hypothesis. It was determined that of the four independent variables (number of access lines, access to county seat, access to trade capital and access to school district), the county seat variable was most consistently significant over all classes of service in terms of explaining variations in calling and cost. This is an important finding because subscribers in half of all exchanges in the SIDD area lack toll-free access to their county seat towns.

As to possible explanations for the lack of importance of the other independent variables, this author concludes that: (1) there was simply not enough size variation in the access lines variable to make a difference, (2) school districts were difficult to test for a similar reason; there was simply not enough variation (as was shown in the 34 exchange study, there is a remarkable confluence between school district boundaries and telephone access areas), (3) it is likely that trade capital represents, for the most part, the same variable as county seat. It is also a possibility that the Reilly model no longer accurately specifies retail trade relationships, or that the analysis was outdated, or that the decision to ignore the affects of Des Moines biased the results.

Of the five dependent variables (local calls, toll calls, total calls, amount due, and local toll charge), the toll call variable was the most significant. This supported the hypothesis that those who lacked access would make more toll calls. This support was additionally strengthened because it was for this variable that the survey generated the most reliable data. This could reasonably be assumed from the specificity of the replies. As requested in the questionnaire, participants referred to previous phone bills when determining numbers of calls made to neighboring exchanges.

In contrast to this, participant estimates of number of local calls were very speculative. Participants ventured only rough estimates. This imprecision, in turn, impacted on the total calls variables, leaving interpretation of both of these models, for all classes of service, inconclusive.

The amount due variable also showed some support for the hypothesis, especially for the residential models. When examining the all-variable residential models (Table 9), it can be seen that the county seat variable for the rural and town residential model shows levels of significance below .05, the correct signs and high beta coefficients. This study only undertook to rebuild the toll call model with the county seat independent variable. It might have been useful if this had also been done for the amount due model using the county seat independent variable.

Models were developed for four different classes of service. The best models were the all residential and town residential models. Rural residential models were less reliable probably because the spatial analysis was unable to pick up the multiplicity of orientations for individual subscribers. Little relationship to local access variables was found in the business classes of service. It is likely that most businesses did not lack access since they are primarily located in the county seat towns. It is also possible that much of their toll calling was to places outside the region. In some cases, businesses also noted that they had 800 numbers.

Statistical analysis - Strength of the relationships

As previously stated, when the toll call model was rebuilt and when only the county seat independent variable was used, a high level of significance was attained, especially for the town residential model. Although the R Square was not high, .15 R Square for the one variable model, it should not be discounted. Mahan (1978) suggests that researchers should not be disturbed by relatively low R Square values. Mahan's 25 variable model achieved an R Square of only .35. Citing other researchers who achieved similar results, Mahan stated that little would be gained by trying to specify all the individual taste factors that might affect individual demand. It should be noted that the studies by Mahan and others have only included social and economic variables such as income, size of family, presence of teenagers, etc. and have not accounted for spatial access variables. The results of this study might contribute to a better specification of variables for future demand studies.

Recommendations

Introduction

This study was a first attempt to determine the relationship of exchange access characteristics and subscriber calling patterns. It applied assessment techniques in a unique way to a previously undefined problem. It should have been expected that many of the research directions employed would result in incomplete or inadequate analysis. It could even have been expected that it would fail entirely. But this was not the case. In fact, this author believes that this study has produced an analysis sufficiently comprehensive and integrated that he is justified not only in recommending directions for future research, but that policy recommendations can also be supported.

Short term recommendations

There are two short term recommendations. The first is a recommendation that the Utility Division of the Iowa Department of Commerce undertake a regional study of cost and usage by exchange. The Utility Division could utilize CCS (hundred cycle seconds) data which telephone companies gather by periodically sampling traffic between exchanges. These data are available to the Utility Division on request. These data are not only useful in determining average per subscriber flow between exchanges, it can also be used to derive average cost figures. (A full description of this methodology is given in the body of this paper.)

These averages could be derived for all exchanges. Comparisons could then be made between comparable exchanges that differed only with respect to toll-free access to county seat exchanges. This would then provide a reasonably accurate comparison of relative costs and usage. Since this comparison sums flat rate and toll charges, it takes into account situations where companies have justified extensive toll calling by arguing that these were balanced with low flat rate charges.

If the Utility Division is unwilling to undertake such a study, the second recommendation is that subscribers in the exchanges who lack access to their county seat exchanges petition the Iowa Utilities Board for Extended Area Service. This recommendation is based on (1) the arguments that were developed in the literature review which pointed to the sub-optimal utilization of a telephone system which relies extensively on toll calling revenues and (2) the support for the hypothesis which was demonstrated in this study. Those exchanges who choose to petition the Board should examine the financial section of this study to determine the financial status of the telephone company or companies involved. In particular, they should look to the level of telephone company debt, cash reserves, and return to capital. If any of these are exceptionably favorable for the company, it could serve to strengthen their petition for EAS. Those who choose to petition should also examine Area Map 6 to see if a toll cable is already in place between the exchanges involved in the EAS proposal. In cases where a toll cable is already in place, it is quite possible that those lines which are now designated to carry toll calls between exchanges could be reassigned for local calls. This could eliminate a large share of the cost (except for some main switch adjustments) associated with providing for EAS between exchanges. Identifying an existing toll cable can also be used as a supporting argument in the petition to the Utilities Board.

Using these and other criteria which have been developed in this study, the following short list of potential EAS candidate exchanges is proposed:

Afton, Arispe and Thayer to Creston

Murray to Osceola

Stanton and Elliot to Red Oak

Prescott to Corning

Bridgewater to Greenfield.

This is only a suggested list. There are numerous other exchanges in the region for which an equally strong case could be developed, and subscribers in those exchanges are encouraged to use this study for that purpose.

Long term proposals

Extended Area Service may provide some benefit for selected exchanges, but consideration should be given to more comprehensive solutions. It seems obvious from the historical and systems analysis that regional phone service is offered through a fragmented patchwork of competing networks. An analogy to a multiplicity of toll roads does not seem inaccurate. It must be granted that if a telecommunications system were designed today it would be quite different than the system in place.

For this reason a regional phone system should be considered. If intralatta deregulation becomes a reality, as it has in other states such as Nebraska, a competing network could be established which by-passes the local network. This proposal is not as speculative as it may seem. The state of Iowa is actively pursuing the development of an Educational Telecommunications Network. This system will essentially be a statewide interactive network with voice, video and data transmission capabilities. The first part of the system is being designed to be installed in the area covered in this study. In addition, other new technologies such as cellular mobile telephones are rapidly being introduced which could eventually make rural line carriage obsolete. On the eve of these radical technological and regulatory changes, it would seem appropriate to take a comprehensive look at the entire regional system.

Final Thoughts

Communities of interest

Early in this study, an assumption was made that communities of interest were primarily local, and therefore access limitations to exchanges which shared common interests would have a significant impact on subscriber calling and cost. Within this was the implicit assumption that all other factors which affect calling would be held equal. While the results of this study indicate that the hypothesized relationship did exist, its strength was not so great as to justify the continuation of this "ceteris paribus" assumption.

If communities of interest are not local, what are they and where are they? Do we now interact in "psychological neighborhoods" as Wurtzell and Turner (1977) suggest? It would be interesting to examine this possibility. One proposed method would be to have persons systematically log their social interactions in terms of their relationship to the other party or parties, the nature, quality and duration of the interaction, and the medium over which the interaction takes place (face to face, written, electronic). Such a study might provide some interesting insight into the extensiveness of the social contacts made through the various medium. If this assessment included personal and psychological profiles, it might be possible to establish some correlation between media choice and personal and personality characteristics.

Economic development

This study did not directly address the relationship of local access to economic development, but the topic has been addressed by others. For example, the Triangle J Council of Governments in the Raleigh-Durham-Chapel Hill, North Carolina area has organized a substantial effort to promote regional toll-free access to Research Triangle communities. Numerous articles have appeared by residents and area business leaders making the case that a unified regional telephone system is necessary to promote high tech industrial growth (Helwig, 1987; White, 1987). In Iowa, the River City Planning Council has requested EAS for the cities of Clinton and Comanche, Iowa and Fulton, Illinois, citing its importance for business, commercial, and industrial expansion (Hockmuth, 1987).

As to the general importance of telecommunications to economic development, a recent report issued by the Southern Growth Policies Board states,

> Telecommunications is becoming an increasingly important factor in economic development. Up until the 1980s it was rarely considered significant; telecommunications was merely an item on a checklist.... Today, however, many more companies are dependent on data communications for internal operations - especially companies with extensive product distribution networks, large financial transaction-processing operations, or customer service networks (Powers, 1987).

Is this relevant to present or potential industries in southern Iowa? Are there data dependent companies in the SIDD region? State Senator Calvin Hultman of Red Oak stated in an interview (Hultman, 1987) that a company from his district was already anticipating the utilization of the Iowa Educational Telecommunications Network to provide a satellite data link to its Atlanta, Georgia corporate headquarters. Certainly, one example does not make a case, but it is an indication of the growing importance of telecommunications capabilities.

Reflections

It seems appropriate to end with a brief reflection on the process of this study. What began as a fairly straightforward testing of a hypothesis ended as a baptism by immersion into the complexities of the telephone network, its development and regulation. This baptism was the initiation, and the questions left unanswered are the challenges that remain.

SOURCES CONSULTED

Abler, Ronald. "The Telephone and the Evolution of the American Metropolitan System." In The Social Impacts of the Telephone, pp. 318-341. Edited by Ithiel de Sola Pool. Cambridge: MIT Press, 1977.

Administrative Codes. Rates Charged and Service Supplied by Telephone Utilities. Des Moines: State of Iowa, 1986.

Comprehensive Study of Telephone Service. ISCC Docket PRP-85-7. Iowa State Commerce Commission and Northwestern Bell Telephone Company, Des Moines, 1985.

Dansby, Robert E. "Spatial Considerations in Public-Utility Pricing." In Issues in Public-Utility Pricing and Regulation, pp. 125-43. Edited by Michael A. Crew. Lexington, Mass.: Lexington Books, 1980.

Field, D. R., and R. M. Demit. "Population Change in South Dakota Small Towns and Cities, 1949-1960." In Change in Rural America, pp. 305-11. Edited by Richard D. Rodefield, Dan Flora, Donald Voth, Isao Fujimoto, and Jim Converse. St. Louis: C.V. Mosley Co., 1978.

Garfield, Paul J. and Lovejoy, Wallace F. Public Utility Economics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964.

Gottmann, Jean. "Megalopolis and Antipolis: The Telephone and the Structure of the City." In The Social Impact of the Telephone, pp. 303-17. Edited by Ithiel de Sola Pool. Cambridge: MIT Press, 1977.

Hahn, Walter A. "The Post-Industrial Boom in Communications." In Working in the Twenty-first Century, pp. 30-38. Edited by C. Stewart Sheppard and Donald C. Carroll. New York: John Wiley & Sons, 1980.

Helwig, Richard A. "Triangles Phone Service Choked by Tolls, Lag Technology." Leaders' Forum, 28 May 1987, 9.

Hockmuth, Dennis. Staff, Utilities Division, Iowa Department of Commerce, Des Moines. Interview by author, 8 April 1987.

Hultman, Calvin, Iowa State Senator. Interview by author, 22 January 1987, Des Moines.

Iowa. Telephone Company Annual Report(s) to the Commerce Commission and Department of Revenue, December 31, 1985:

Casey Mutual Telephone Co.
Central Telephone Co.
Continental Telephone Co.
Coon Valley Coop Telephone Association, Inc.
Farmers Mutual Telephone Co.
General Telephone of the Midwest
Grand River Mutual Telephone Corp.
Griswold Coop Telephone Co.
Interstate 35 Telephone Co.
Northwestern Bell Telephone Co.
United Telephone Co. of Iowa
Villisca Farmers Telephone Co.

Jensik, John. "Some Changes in Local Calling Habits Because of Conversion to Local Measure Service," in Telecommunciations Policy Handbook, pp. 142-58. Edited by Jorge Reina Schement, Felix Gutierriz, and Marvin A. Sirbu, Jr. New York: Praeger Publishers, 1982.

Julius, Marvin. "An Overview of Rural Retailing: Part 2, Trade Territory Delineations." Training Manual of Iowa State University Cooperative Extension Service, Ames, Iowa, September, 1975. Photocopied.

Keller, Suzanne. "The Telephone in New (and Old) Communities," in The Social Impact of the Telephone, pp. 281-99. Edited by Ithiel de Sola Pool. Cambridge: MIT Press, 1977.

Mahan, Gary Paul. "The Demand for Residential Local and Long-Distance Telephone Service: An Analysis of Household Data." Ph.D. dissertation, North Carolina State University at Raleigh, 1978.

Mandanis, G. P.; Lane, R. N.; Meyers, J. R.; Starek, P.; and M. Melinick. Domestic Communications Industry and Public Policy. Prepared for the Office of Telecommunications Policy, Executive Office of the President, by Systems Applications Inc., Washington, D.C., December 28, 1973.

Marvin, Carolyn. "Telecommunications Policy and the Pleasure Principle." Telecommunications Policy Vol. 3 (March, 1983): 43-49.

Mayer, Martin. "The Telephone and the Uses of Time," in The Social Impact of the Telephone, pp. 225-45. Edited by Ithiel de Sola Pool. Cambridge: MIT Press, 1977.

McCarthy, Mark. "Panel: The Policymakers Respond." Published panel comments in Telecommunications Access and Public Policy: Proceedings of the Workshop on Local Access held in St. Louis, Missouri September 1982. Edited by Alan Baughman and Gerald R. Faulhaber. Norwood, New Jersey: Ablex Publishing Corp., 1984.

McLahan, Marshall. Understanding Media. New York: McGraw-Hill, 1964.

Mitchell, Bridger M. "Local Telephone Costs and the Design of Rate Structures." In Economic Analysis of Telecommunications: Theory and Applications, pp. 47-64. Edited by L. Courville, A. R. Dobell, A. deFontenay. Lansing, Mich.: North Holland Publishing Company, 1983.

Model Tariff. Des Moines: Iowa Telephone Association. 1985.

Network Information for Iowa Independent Exchange Carriers. Exchange Carriers Market, Des Moines, June, 1985.

Osborne, Bob. Staff, Utilities Division, Iowa Department of Commerce, Des Moines. Interview by author, 3 February 1987.

Park, Rolla Edward and Mitchell, Bridger M. Optimal Peak-Load Pricing for Local Telephone Calls. The Rand Corporation, R-3404-RC, June 1986.

Pavarini, C. "The Effect of Flat-to-Measured Rate Conversions on Local Telephone Usage." Proceedings of Mountain Bell Economics Seminar, Keystone, Colo., August, 1978.

Phillips, Charles F., Jr. The Regulation of Public Utilities. Arlington, Virginia: Public Utilities Reports, Inc., 1984.

Pierce, John D. "Communications." In Toward the Year 2000, pp. 909-1021. Edited by Daniel Bell. New York: Daedelus, 1967.

Powers, Garry. Telecommunications and Economic Development. (Research Triangle Park, North Carolina: Southern Growth Policies Board, 1987).

Public School Districts. Map. Iowa Department of Education, 1984.

"Rural Telephones." U.S. Congress. Senate. Committee on Agriculture and Forestry. A Bill to Authorize the Appropriation of $300,000,000 to Assist in Providing Telephone Facilities in Rural Areas. 81st Cong., 1st Sess., 11 June and Aug. 3-10, 1949.

Taylor, L. D. "The Demand for Telephone Service: A Survey and Critique of the Literature." Monograph. University of Arizona, Tucson, November, 1978.

Thorngren, Bertil. "Silent Actors: Communications Networks for Development." In The Social Impact of the Telephone, pp. 374-85. Edited by Ithiel de Sola Pool. Cambridge: MIT Press, 1977.

Tomblen, R. L. "Population Changes in Small Communities and Rural Areas." Bell Telephone Quarterly 10 (Fall, 1931): 115-31.

U.S. Congress. House of Representatives. Committee on Appropriations. Hearings before the Subcommittee on Agriculture, Rural Development and Related Agencies Appropriations for 1983. 97th Cong., 2nd Sess., 24 March 1982.

U.S. Department of Commerce. Office of Telecommunications. The Pricing of Local Telephone Service. OT Special Publication 77-14, April 1977.

White, Jesse L. "Triangles Fragmented Phone System Hurts Image as Technology Capital." Leaders' Forum, 17 December 1987. 15.

Wilkins, Ione. Pricing Manager, Northwestern Bell Telephone Company, Des Moines. Interview by author, 26 March 1987.

Wurtzel, Allan H., and Turner, Colin. "Latent Functions of the Telephone: What Missing the Extension Means." In The Social Impact of the Telephone, pp. 246-61. Edited by Ithiel de Sola Pool. Cambridge: MIT Press, 1977.

Yordon, Wesley J. "Telephone Rates: Economic Theory and Current Issues." Chap. in Telecommunications: An Interdisciplinary Text, pp. 237-71. Edited by Leonard Lewin. Dedham, Mass.: Artech House, Inc., 1984.

ACKNOWLEDGEMENTS

This author acknowledges with gratitude the generous assistance of many who helped bring this project to fruition. Staff members of the Iowa Utilities Division deserve special thanks for their patience and consideration. In particular, Bob Osborne, who was the first to offer help and whose advice and direction encouraged me to pursue the research; Sandra Makeeff, who painstakingly explained the intricacies of separations, access charges, pooling, and other arcane cost al4location arrangements I have yet to master; Aaron Beckerman, whose clear explanations and ready wit brought life to telephone company financial reports; Dennis Hockmuth, whose engineering expertise was a valuable supplement to my meager technical background; and John Burnett, who always seemed to be working nearby when I needed a question answered.

This research relied heavily on graphic presentation which could not have been accomplished without the cooperation of Harriet Sheldahl of the Utilities Division and Randy Peterson of the Iowa Department of Transportation. Harriet's assistance with the base map and graphic advice was greatly appreciated. Randy's quality work and understanding of this author's needs were invaluable.

Technical assistance with the survey came from Mary Kihl, Associate Dean of the Design College, whose early prodding got this and numerous other research projects underway; and Harold Baker whose help with sampling techniques created clarity from confusion. To both I am grateful.

Financial assistance came from many sources. This author thanks the Design Research Institute and the Graduate College for their grants to help cover expenses; the Iowa Department of Transportation for its donation of time and materials to produce the base maps; and the SIDD project for graphic supplies and the use of a telephone, that invaluable tool for the contemporary researcher.

Contact in the SIDD project area was maintained with the assistance of Lois Hunt, Regional Coordinator for the Southern Iowa Development District. Lois was to a great extent responsible for the excellent regional news coverage the survey received.

There are many others who made time available for sometimes lengthy conversations. of these, I especially would like to thank. Kent Jerome, Secretary/Treasurer of the Iowa Telephone Association; Jim Hamilton, Director of Iowa State University Extension Communication Services; Gil Nobel, Educational Technology Specialist of the Green Valley Area Education Agency; Andrew Varley, Chair of the Iowa Utilities Commission; and Ione Wilkins, Pricing Manager for Northwestern Bell.

The members who served on my thesis committee deserve special thanks. Jerry Knox, SIDD Project Director, early on saw the potential contribution the research could make and encouraged its incorporation into the SIDD project design. Jim Prescott, Professor of Economics, offered valued advice which helped to clarify the research questions and their analysis. I sincerely thank my major professor, Dean Thomas Galloway, who encouraged open-ended exploration, but when this led to bewildering complexity, was able to focus the project and move it

forward to a realizable conclusion.

Finally, I thank my family. Thank you Corrina, Kristin, Benjamin, and especially Lois. You have done well the simple things that families do, support when it means sacrifice to yourselves, listen when it is hard to listen, and share when it's not easy to share.

APPENDIX A: TELEPHONE USE SURVEY

TELEPHONE USE SURVEY

Thank you for taking time to complete this survey. This survey is being conducted as part of a research project of the Design Research Institute of Iowa State University. Surveys are being sent to randomly selected households in a nine county area in Southwest Iowa.

WHY IS THIS SURVEY NECESSARY?

Some telephone exchanges* in Southwest Iowa have very limited "local calling areas". (Your "local calling area" is the area that can be called from your phone without paying a long distance charge.) If your "local calling area" is limited, sometimes calling to a neighboring town where you shop or where your children go to school is a long distance call.

Other telephone exchanges in Southwest Iowa have much larger "local calling areas". In these exchanges most local area calls are not long distance.

The purpose of this survey is to compare telephone usage and cost of service between exchanges. Exchanges with large "local calling areas" will be compared to exchanges with limited "local calling areas".

*Exchange (An exchange is the area surrounding a central switching office. Each exchange has a separate three number prefix such as 782 for the Creston exchange.)

WHAT WILL THIS SURVEY SHOW AND HOW MIGHT IT BENEFIT YOU?

The results of this survey might show that telephone users in some exchanges have good access and reasonable cost of service.

On the other hand, the results of this survey might show that telephone users in some exchanges could save money or would increase their telephone usage if their "local calling area" were made larger.

If the latter is the result of the survey, telephone users in these exchanges would be encouraged to petition the Iowa Utilities Board for Extended Area Service (EAS) to another exchange. If this petition succeeds, the telephone company would be required to survey telephone users to determine by majority vote if EAS is desired. If so, EAS would be offered resulting in an expanded toll free calling area.

TELEPHONE USE SURVEY

HOW CAN YOU HELP?

You can help by answering the questions below as accurately as possible and returning the questionaire promptly. Although your response is entirely voluntary, we urge you to take time today to complete the form. Please be assured that your individual answers will remain confidential. Results will only be reported in the aggregate.

QUESTIONNAIRE

1. Is your telephone (choose one)

rural residential	________	town residential	________
rural business	________	town business	________

2. Your "local calling area" includes the exchanges listed below. These exchanges can be called toll free. On the average per month how many calls does your household or business make to each of the following exchanges?

   322 Corning .________

3. Below is a list of nearby exchanges which must be called long distance. On the average per month, how many long distance calls does your household or business make to each of these exchanges? If possible use a previous phone bill to verify your estimates.

782	Creston	________	335	Prescott	________
537	Gravity	________	333	Lenox	________
785	Nodaway	________	826	Villisca	________
763	Grant	________	779	Massena	________
774	Cumberland	________			

4. What was the Total Amount Due for your last phone bill?
   $____________

5. Of the Total Amount Due, how many dollars were for long distance calls to exchanges not listed in question three?
   $____________

APPENDIX B: PRE-SURVEY NEWSPAPER ARTICLE

Phone survey may help cut bills

By STEVE EXLEY
CNA managing editor

Reach out and touch more people for less money.

A survey being mailed out this week may help telephone users in a nine-county area, including Union County, do just that.

Research assistant Chuck Heying said the survey is being conducted in the Southern Iowa Development District to help determine what telephone habits people in the area have.

Heying said his study will focus on existing telephone exchanges and determining where those exhanges match up with certain demands for service. For instance, does a community such as Afton have toll-free calling to other towns within its trade area, or other towns in its school district, or its county-seat town?

His study already has determined that Afton has toll-free calling to Arispe, and the two towns cover much of its school district. However, Afton callers don't have toll-free access to their county seat or their "trade capital" at Creston.

Other communities which don't have access to several of those services, Heying has determined, include Blockton, New Market, Arispe, Nevinville, Prescott, Thayer, Grand River and Murray.

"Blockton scored the highest," he said. "They have no access to 80 percent of their school district, over 50 percent have no access to Bedford and so no access to their trade capital.

"So essentially, in terms of telecommunications, Blockton is very isolated in terms of access to the things they want to have access to."

Heying notes that Ringgold County for years has had a large "extended area service" network. Most phone users in Ringgold County can dial any other town in the county toll-free.

The extended area service (EAS) ties Mount Ayr with its neighboring towns in the county, providing callers in Redding, Diagonal, Benton, Tingley and Kellerton with toll-free calling to their school district, county seat and trade capital.

Telephone users are permitted by law to petition the Iowa Utilities Board to demand extended area service to other towns, Heying said, but many consumers are not aware of it.

"The results of this survey might show that telephone users in some exchanges could save money or would increase their telephone usage if their 'local calling area' were made larger," Heying said in a letter explaining his survey.

"If this is the result of the survey, telephone users in these exchanges could petition the Iowa Utilities Board for extended area service to another exchange. If this petition is successful, the telephone company is required to survey telephone users to determine by majority vote if EAS is desired. If so, EAS must be offered within a given period of time."

Heying said sometimes a charge is required to provide EAS service, such as when no telephone cable is present between towns. In other cases, however — such as the connection between Thayer, Afton and Arispe to Creston — those cables exist and presently carry toll calls.

"If Afton gets access to Creston, it could be that telephone use will increase," Heying said. Usually, telephone users in the smaller town make more calls to the larger town.

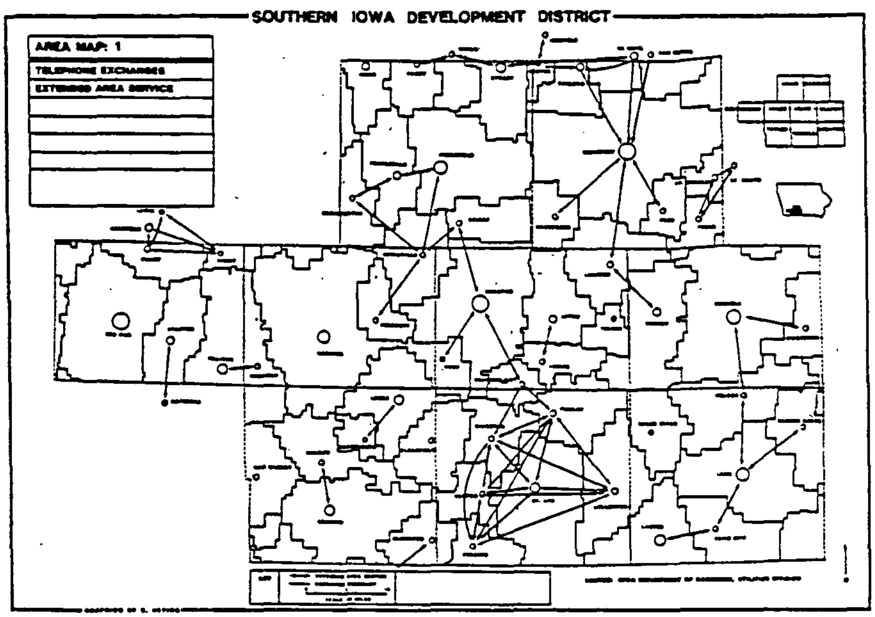
Lenox and Clearfield are towns which likely could benefit from having EAS connections to each other, he said.

Heying will be mailing 300 to 500 surveys to people in the area, and estimated a survey takes 10 to 15 minutes to complete. He will ask those surveyed to refer to a recent phone bill to determine the cost of calls which might be provided toll-free.

"I expect to see that people in Diagonal with extended area service call many more times per month than people in Thayer" for needed services, Heying said.

The Southern Iowa Development District (SIDD) is a nine-county area being studied by Iowa State University in a three-year project designed to provide development models which could be used in other rural areas. The study is underwritten by a $600,000 grant from the Minneapolis-based Northwest Area Foundation.

Other counties included are Montgomery, Adair, Adams, Taylor, Madison, Clarke and Decatur.



A map of telephone services in the area shows "expanded area service" which exists between towns. The number of arrows in Ringgold County, for instance, reflects the fact that free calls are available between all county towns, while other communities have limited toll-free exchanges.

APPENDIX C: DATA BASE

OBS	CODE	TC	CS	EAS_L	SCH_DIST	TELE	LOC_CALL	TOLL_C	TOTAL_C	AMT_DUE	NONL_CHG	BAS_CHG	LTLL_CHG
1	AD	0	0	706	0.55	1	.	62	.	46.00	15.00	7.80	23.20
2	AD	0	0	706	0.55	1	40	26	66	50.16	30.00	7.80	12.36
3	AD	0	0	706	0.55	1	1	2	3	37.02	22.04	7.80	7.18
4	AD	0	0	706	0.55	1	30	24	54	58.91	38.57	7.80	12.54
5	AD	0	0	706	0.55	1	.	14	.	43.70	22.84	7.80	13.06
6	AD	0	0	706	0.55	3	180	16	196	21.39	3.78	7.80	9.81
7	AD	0	0	706	0.55	1	10	19	29	36.06	20.14	7.80	8.12
8	AD	0	0	706	0.55	1	90	10	100	27.30	3.30	7.80	16.20
9	AD	0	0	706	0.55	2	50	63	113	65.00	10.00	18.89	36.11
10	AD	0	0	706	0.55	4	100	126	226	484.81	280.00	13.65	191.16
11	AD	0	0	706	0.55	2	30	.	.	50.00	20.00	18.89	11.11
12	AF	0	0	770	0.49	3	40	2	42	21.65	4.89	11.85	4.91
13	AF	0	0	770	0.49	4	7	23	30	45.00	12.00	22.95	10.05
14	AF	0	0	770	0.49	3	105	15	120	43.96	14.44	11.85	17.67
15	AF	0	0	770	0.49	3	25	16	41	27.21	9.30	11.85	6.06
16	AF	0	0	770	0.49	3	42	10	52	30.24	9.20	11.85	9.19
17	AF	0	0	770	0.49	3	40	10	50	24.64	9.28	11.85	3.51
18	AF	0	0	770	0.49	1	40	28	68	17.70	1.00	10.50	6.20
19	AF	0	0	770	0.49	4	18	47	65	75.61	3.00	22.95	49.66
20	AF	0	0	770	0.49	4	330	22	352	75.43	25.87	22.95	26.61
21	AF	0	0	770	0.49	3	25	40	65	55.04	.	11.85	.
22	AF	0	0	770	0.49	1	126	18	144	28.33	15.00	10.50	2.83
23	AF	0	0	770	0.49	3	70	60	130	51.52	35.63	11.85	4.04
24	AF	0	0	770	0.49	3	2	33	35	55.21	37.75	11.85	5.61
25	AF	0	0	770	0.49	3	6	4	10	21.81	4.25	11.85	5.71
26	AF	0	0	770	0.49	3	50	11	61	96.00	70.00	11.85	14.15
27	AF	0	0	770	0.49	4	60	42	102	91.90	25.00	22.95	43.95
28	BL	0	0	218	0.20	3	.	.	.	22.00	10.00	7.22	4.78
29	BL	0	0	218	0.20	3	64	19	83	20.00	10.00	7.22	2.78
30	BL	0	0	218	0.20	1	1	30	31	35.00	6.00	7.22	21.78
31	BL	0	0	218	0.20	1	100	22	122	25.74	2.54	7.22	15.98
32	BL	0	0	218	0.20	2	110	60	170	78.00	15.00	13.09	49.91
33	BL	0	0	218	0.20	1	22	21	43	17.59	6.00	7.22	4.37
34	BL	0	0	218	0.20	1	6	13	19	16.71	4.24	7.22	5.25
35	BL	0	0	218	0.20	1	15	10	25	19.46	7.27	7.22	4.97
36	CO	1	1	1810	0.95	3	200	30	230	59.00	30.00	4.85	24.15
37	CO	1	1	1810	0.95	4	300	31	331	59.00	8.00	8.65	42.35
38	CO	1	1	1810	0.95	2	100	68	168	83.18	25.00	12.65	45.53
39	CO	1	1	1810	0.95	3	35	18	53	20.70	12.00	4.85	3.85
40	CO	1	1	1810	0.95	4	400	55	455	73.87	6.72	8.65	58.50
41	CO	1	1	1810	0.95	1	40	13	53	34.29	14.69	6.10	13.50
42	CO	1	1	1810	0.95	1	40	14	54	45.00	22.00	6.10	16.90
43	CO	1	1	1810	0.95	2	150	49	199	100.00	50.00	12.65	37.35
44	CO	1	1	1810	0.95	1	50	2	52	15.56	4.03	6.10	5.43
45	CO	1	1	1810	0.95	3	10	6	16	13.76	3.96	4.85	4.95
46	CO	1	1	1810	0.95	3	150	1	151	45.00	32.50	4.85	7.65
47	CR	1	1	5389	0.95	3	100	1	101	29.68	18.60	7.26	3.82
48	CR	1	1	5389	0.95	3	120	0	120	17.90	4.97	7.26	5.67
49	CR	1	1	5389	0.95	3	0	0	0	54.76	47.50	7.26	-0.00
50	CR	1	1	5389	0.95	1	27	6	33	43.41	25.98	7.17	10.26
51	CR	1	1	5389	0.95	4	87	16	103	80.65	48.00	14.31	18.34
52	CR	1	1	5389	0.95	1	111	6	117	40.72	22.02	7.17	11.53
53	CR	1	1	5389	0.95	3	.	0	.	14.96	4.28	7.17	3.51
54	DC	1	1	3086	0.85	3	70	0	70	20.02	5.46	8.89	5.67
55	DC	1	1	3086	0.85	3	115	1	116	28.82	16.87	8.89	3.06

OBS	CODE	TC	CS	EAS_L	SCH_DIST	TELE	LOC_CALL	TOLL_C	TOTAL_C	AMT_DUE	NONL_CHG	BAS_CHG	LTLL_CHG
56	DC	1	1	3086	0.85	2	95	10	105	117.06	61.54	14.76	40.76
57	DC	1	1	3086	0.85	3	.	6	.	20.37	6.63	8.06	5.68
58	DC	1	1	3086	0.85	3	60	2	62	15.00	3.00	8.89	3.11
59	FO	1	1	2427	0.98	3	80	0	80	25.69	10.98	9.30	5.41
60	FO	1	1	2427	0.98	1	64	2	66	13.03	.	9.30	.
61	FO	1	1	2427	0.98	3	115	1	116	20.00	5.00	9.30	5.70
62	FO	1	1	2427	0.98	4	28	25	53	125.00	100.00	16.28	8.72
63	FO	1	1	2427	0.98	3	.	.	.	13.34	0.29	9.30	3.75
64	FO	1	1	2427	0.98	1	26	0	26	16.87	.	9.30	.
65	FO	1	1	2427	0.98	3	.	.	.	20.25	.	.	.
66	FO	1	1	2427	0.98	1	70	0	70	43.19	17.92	9.30	15.97
67	FO	1	1	2427	0.98	1	72	5	77	27.40	3.72	9.30	14.38
68	FO	1	1	2427	0.98	3	38	.	.	19.95	9.00	9.30	1.65
69	FO	1	1	2427	0.98	1	35	13	48	32.90	10.52	9.30	13.08
70	FO	1	1	2427	0.98	2	55	16	71	74.98	36.78	21.52	16.68
71	LA	1	0	1585	0.85	1	7	46	53	41.68	12.19	8.06	21.43
72	LA	1	0	1585	0.85	3	50	6	56	41.50	25.48	8.06	7.96
73	LA	1	0	1585	0.85	3	220	44	264	61.15	26.42	8.06	26.67
74	LA	1	0	1585	0.85	4	68	10	78	40.87	6.31	13.93	20.63
75	LA	1	0	1585	0.85	3	35	12	47	44.44	38.73	8.06	-2.35
76	LA	1	0	1585	0.85	1	320	66	386	175.00	130.00	8.06	36.94
77	LA	1	0	1585	0.85	1	30	6	36	32.61	12.67	8.06	11.88
78	LA	1	0	1585	0.85	1	130	5	135	23.46	9.36	8.06	6.04
79	LA	1	0	1585	0.85	2	80	33	113	148.00	100.00	13.96	34.04
80	LA	1	0	1585	0.85	3	5	0	5	55.00	5.00	13.93	36.07
81	LE	1	1	2478	0.95	1	.	23	.	43.73	24.36	8.89	10.48
82	LE	1	1	2478	0.95	3	90	2	92	16.06	.	8.89	.
83	LE	1	1	2478	0.95	3	60	0	60	18.38	4.79	8.89	4.70
84	LE	1	1	2478	0.95	4	.	.	.	18.40	6.97	14.76	-3.33
85	LE	1	1	2478	0.95	3	28	6	34	15.64	3.89	8.89	2.86
86	LE	1	1	2478	0.95	3	.	11	.	18.11	6.60	8.89	2.62
87	LE	1	1	2478	0.95	3	10	10	20	.	30.00	8.89	.
88	LE	1	1	2478	0.95	4	70	6	76	22.74	1.40	14.76	6.58
89	LE	1	1	2478	0.95	3	.	0	.	25.09	10.14	8.89	6.06
90	LE	1	1	2478	0.95	4	375	55	430	157.00	50.00	14.76	92.24
91	NM	0	0	464	0.70	3	75	32	107	21.50	3.30	4.00	14.20
92	NM	0	0	464	0.70	3	125	13	138	30.33	22.38	4.00	3.95
93	NM	0	0	464	0.70	4	150	14	164	34.00	18.18	7.00	8.82
94	NM	0	0	464	0.70	3	64	13	77	11.67	5.74	4.00	1.93
95	NM	0	0	464	0.70	3	20	4	24	20.00	9.00	4.00	7.00
96	NM	0	0	464	0.70	3	0	0	0	16.48	8.53	4.00	3.95
97	NM	0	0	464	0.70	3	.	4	.	11.47	2.29	4.00	5.18
98	NM	0	0	464	0.70	1	10	5	15	10.04	3.21	4.00	2.83
99	NM	0	0	464	0.70	1	12	27	39	17.70	3.68	4.00	10.02
100	NM	0	0	464	0.70	3	30	20	50	150.00	16.00	4.00	130.00
101	NM	0	0	464	0.70	2	120	79	199	106.47	50.17	7.00	49.30
102	OS	1	1	3445	0.98	3	75	0	75	19.72	4.16	7.16	8.40
103	OS	1	1	3445	0.98	3	5	27	32	44.99	4.56	7.16	33.27
104	OS	1	1	3445	0.98	3	4	0	4	10.10	1.00	7.16	1.94
105	OS	1	1	3445	0.98	1	250	2	252	25.83	12.00	7.11	6.72
106	OS	1	1	3445	0.98	1	170	17	187	22.40	17.40	7.11	-2.11
107	OS	1	1	3445	0.98	3	45	3	48	27.29	11.20	7.16	8.93
108	OS	1	1	3445	0.98	4	130	19	149	85.45	50.00	14.31	21.14
109	OS	1	1	3445	0.98	3	60	1	61	10.62	.	7.16	.
110	OS	1	1	3445	0.98	3	.	5	.	24.63	7.73	7.16	9.74

OBS	CODE	TC	CS	EAS_L	SCH_DIST	TELE	LOC_CALL	TOLL_C	TOTAL_C	AMT_DUE	NONL_CHG	BAS_CHG	LTLL_CHG
111	OS	1	1	3445	0.98	3	15	0	15	29.51	16.69	7.16	5.66
112	OS	1	1	3445	0.98	3	40	0	40	24.93	14.96	7.16	2.81
113	OS	1	1	3445	0.98	3	.	.	.	49.46	37.82	7.16	4.48
114	RO	1	1	3922	0.90	3	25	9	34	17.83	.	11.70	.
115	RO	1	1	3922	0.90	3	80	0	80	13.93	.	11.70	.
116	RO	1	1	3922	0.90	4	95	10	105	66.73	2.92	29.65	34.16
117	RO	1	1	3922	0.90	3	68	5	73	30.09	4.00	11.70	14.39
118	RO	1	1	3922	0.90	3	8	47	55	64.00	3.00	11.70	49.30
119	RO	1	1	3922	0.90	4	.	66	.	294.15	130.00	29.65	134.50
120	RO	1	1	3922	0.90	4	20	22	42	52.00	18.00	29.65	4.35
121	RO	1	1	3922	0.90	1	100	20	122	45.02	16.56	13.80	14.66
122	RO	1	1	3922	0.90	1	150	5	155	39.86	14.07	13.80	11.99
123	RO	1	1	3922	0.90	3	95	2	97	22.38	7.99	11.70	2.69
124	RO	1	1	3922	0.90	3	35	0	35	16.00	2.00	11.70	2.30
125	RO	1	1	3922	0.90	3	90	4	94	27.11	13.18	11.70	2.23
126	SC	0	0	903	0.55	4	25	13	38	33.67	7.71	10.25	15.71
127	SC	0	0	903	0.55	3	31	22	53	52.33	18.47	10.25	23.61
128	SC	0	0	903	0.55	1	55	27	82	37.26	23.00	10.25	4.01
129	SC	0	0	903	0.55	1	17	14	31	87.00	20.00	10.25	56.75
130	SC	0	0	903	0.55	1	135	35	170	73.63	51.00	10.25	12.38
131	SC	0	0	903	0.55	3	25	3	28	29.00	15.00	10.25	3.75
132	SC	0	0	903	0.55	1	4	33	37	32.86	6.99	10.25	15.62
133	SC	0	0	903	0.55	1	1	9	10	36.32	24.00	10.25	2.07
134	SC	0	0	903	0.55	4	13	40	53	53.70	.	13.00	.
135	SC	0	0	903	0.55	1	62	41	103	40.79	26.46	10.25	4.08
136	SC	0	0	903	0.55	1	43	7	50	18.75	.	10.25	.
137	SC	0	0	903	0.55	3	65	30	95	50.66	27.45	10.25	12.96
138	SR	1	0	1892	0.80	.	360	135	495	128.00	60.00	.	.
139	SR	1	0	1892	0.80	2	36	17	53	42.37	20.52	.	.
140	SR	1	0	1892	0.80	3	140	15	155	39.25	10.58	11.25	17.42
141	SR	1	0	1892	0.80	3	6	8	14	45.00	.	11.25	.
142	SR	1	0	1892	0.80	3	165	22	187	40.00	8.00	11.25	20.75
143	SR	1	0	1892	0.80	3	137	6	143	21.35	4.20	11.25	5.90
144	SR	1	0	1892	0.80	1	24	0	24	36.11	12.59	13.20	10.32
145	ST	0	0	656	0.95	1	85	38	123	66.00	27.00	4.00	35.00
146	ST	0	0	656	0.95	1	51	20	71	16.29	1.63	4.00	10.66
147	ST	0	0	656	0.95	1	.	.	.	15.03	3.45	4.00	7.58
148	ST	0	0	656	0.95	1	40	3	43	14.44	3.62	4.00	6.82
149	ST	0	0	656	0.95	1	80	26	106	163.26	112.90	4.00	46.36
150	ST	0	0	656	0.95	1	30	7	37	19.39	10.68	4.00	4.71
151	ST	0	0	656	0.95	1	102	64	166	44.00	15.00	4.00	25.00
152	ST	0	0	656	0.95	3	100	30	130	22.00	4.00	4.00	14.00
153	ST	0	0	656	0.95	1	45	55	100	94.79	43.34	4.00	47.45
154	ST	0	0	656	0.95	1	108	140	248	45.00	15.00	4.00	26.00
155	ST	0	0	656	0.95	3	.	19	.	31.40	21.31	4.00	6.09
156	ST	0	0	656	0.95	3	.	3	.	44.38	35.32	4.00	5.06
157	WI	1	1	5815	0.99	3	56	0	56	32.84	14.01	12.40	6.43
158	WI	1	1	5815	0.99	3	.	9	.	15.75	.	12.40	.
159	WI	1	1	5815	0.99	3	.	5	.	39.39	27.00	12.40	-0.01
160	WI	1	1	5815	0.99	3	349	40	389	105.33	64.90	12.40	28.03
161	WI	1	1	5815	0.99	2	30	29	59	102.00	60.00	38.25	3.75
162	WI	1	1	5815	0.99	3	1	0	1	15.00	0.75	12.40	1.85
163	WI	1	1	5815	0.99	3	.	0	.	24.39	.	12.40	.
164	WI	1	1	5815	0.99	1	116	59	175	50.00	25.00	14.35	10.65
165	WI	1	1	5815	0.99	3	10	2	12	.	.	.	.

APPENDIX D: STATISTICAL ANALYSIS, ALL-BUSINESS MODELS

BUSINESS=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOC_CALL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	79035.60402745	19758.90100686	1.92	0.1394	0.242601	93.8853
ERROR	24	246748.39597255	10281.18316552		ROOT MSE		LOC_CALL MEAN
CORRECTED TOTAL	28	325784.00000000			101.39616938		108.00000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	11385.20098039	1.11	0.3031	1	189.71383292	0.02	0.8931
CS	1	14602.85854342	1.42	0.2450	1	34833.34973401	3.39	0.0781
EAS_L	1	52745.39462146	5.13	0.0328	1	52926.60896168	5.15	0.0325
SCH_DIST	1	302.14988218	0.03	0.8653	1	302.14988218	0.03	0.8653

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	96.41594250	0.77	0.4465	124.57627638
TC	13.33270079	0.14	0.8931	98.14997241
CS	137.81182341	1.84	0.0781	74.87044374
EAS_L	-0.04811629	-2.27	0.0325	0.02120687
SCH_DIST	39.32748274	0.17	0.8653	229.40690340

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	3513.84994347	878.46248587	1.25	0.3168	0.172405	72.1207
ERROR	24	16867.46040135	702.81085006		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	28	20381.31034483			26.51057996		36.75862069

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	2275.90125392	3.24	0.0845	1	503.90102099	0.72	0.4055
CS	1	348.10000000	0.50	0.4883	1	772.27025268	1.10	0.3050
EAS_L	1	889.84789196	1.27	0.2716	1	889.77835906	1.27	0.2716
SCH_DIST	1	0.00079759	0.00	0.9992	1	0.00079759	0.00	0.9992

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	52.21342506	1.61	0.1210	32.47693026
TC	-21.90438511	-0.85	0.4055	25.86888296
CS	20.48930187	1.05	0.3050	19.54617292
EAS_L	-0.00614111	-1.13	0.2716	0.00545789
SCH_DIST	0.06367105	0.00	0.9992	59.76824416

BUSINESS=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOTAL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	91174.47536023	22793.61884006	1.90	0.1441	0.248643	74.7086
ERROR	23	275514.52463977	11978.89237564		ROOT MSE		TOTAL_C MEAN
CORRECTED TOTAL	27	366689.00000000			109.44812641		146.50000000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	1482.39037433	0.12	0.7282	1	310.40068062	0.03	0.8735
CS	1	18373.78711485	1.53	0.2280	1	44401.56841704	3.71	0.0666
EAS_L	1	70703.14365684	5.90	0.0233	1	71012.58309816	5.93	0.0231
SCH_DIST	1	615.15421420	0.05	0.8227	1	615.15421420	0.05	0.8227

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	145.74034938	1.08	0.2897	134.48458599
TC	-17.20206420	-0.16	0.8735	106.86304949
CS	155.62710702	1.93	0.0666	80.83406519
EAS_L	-0.05573483	-2.43	0.0231	0.02289114
SCH_DIST	56.20594536	0.23	0.8227	248.02678659

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: AMT_DUE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	2920.28150547	730.07037637	0.08	0.9875	0.012294	100.2653
ERROR	26	234623.41257195	9023.97740661		ROOT MSE		AMT_DUE MEAN
CORRECTED TOTAL	30	237543.69407742			94.99461778		94.74322581

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	436.66969102	0.05	0.8276	1	877.79194670	0.10	0.7576
CS	1	767.78235099	0.09	0.7728	1	81.62753849	0.01	0.9250
EAS_L	1	1705.38504246	0.19	0.6674	1	1707.39097082	0.19	0.6672
SCH_DIST	1	10.44442101	0.00	0.9731	1	10.44442101	0.00	0.9731

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	97.55720890	0.84	0.4094	116.35859204
TC	-28.65960009	-0.31	0.7576	91.89107445
CS	6.60360816	0.10	0.9250	69.43236288
EAS_L	0.00844130	0.43	0.6672	0.01940626
SCH_DIST	-7.27307470	-0.03	0.9731	213.78383478

BUSINESS=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LTLL_CHG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	1812.32367086	453.08091772	0.24	0.9124	0.038595	113.4460
ERROR	24	45144.60622569	1881.02525940		ROOT MSE		LTLL_CHG MEAN
CORRECTED TOTAL	28	46956.92989655			43.37078809		38.23034483

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	756.24302837	0.40	0.5320	1	12.12532983	0.01	0.9367
CS	1	107.22602500	0.06	0.8133	1	497.46665419	0.26	0.6118
EAS_L	1	387.42688399	0.21	0.6540	1	378.12888857	0.20	0.6579
SCH_DIST	1	561.42773351	0.30	0.5899	1	561.42773351	0.30	0.5899

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	75.47360321	1.42	0.1697	53.31385773
TC	3.76640370	0.08	0.9367	46.91129272
CS	18.61896357	0.51	0.6118	36.20518981
EAS_L	-0.00398234	-0.45	0.6579	0.00888210
SCH_DIST	-53.63882507	-0.55	0.5899	98.18149459

BUSINESS=1

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
TC	31	0.61290323	0.49513765	19.00000000	0.00000000	1.00000000
CS	31	0.51612903	0.50800051	16.00000000	0.00000000	1.00000000
EAS_L	31	2007.77419355	1452.74236554	62241.00000000	218.00000000	5815.00000000
SCH_DIST	31	0.77064516	0.21610083	23.89000000	0.20000000	0.99000000
TELE	31	3.29032258	0.97274691	102.00000000	2.00000000	4.00000000
LOC_CALL	29	108.00000000	107.86631938	3132.00000000	7.00000000	400.00000000
TOLL_C	29	36.75862069	26.97969497	1066.00000000	6.00000000	126.00000000
TOTAL_C	28	146.50000000	116.53786541	4102.00000000	30.00000000	455.00000000
AMT_DUE	31	94.74322581	88.98383637	2937.04000000	18.40000000	484.81000000
NONL_CHG	30	41.63633333	55.24046708	1249.09000000	1.40000000	280.00000000
BAS_CHG	30	17.22400000	7.47040118	516.72000000	7.00000000	38.25000000
LTLL_CHG	29	38.23034483	40.95159595	1108.68000000	-3.33000000	191.16000000

BUSINESS=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=O / NUMBER OF OBSERVATIONS

	TC	CS	EAS_L	SCH_DIST	TELE	LOC_CALL	TOLL_C	TOTAL_C	AMT_DUE	NONL_CHG	BAS_CHG	LTLL_CHG
TC	1.00000 0.0000 31	0.82078 0.0001 31	0.73883 0.0001 31	0.91519 0.0001 31	-0.03572 0.8487 31	0.18694 0.3315 29	-0.33416 0.0764 29	0.06358 0.7479 28	-0.04288 0.8189 31	-0.01137 0.9524 30	0.12152 0.5224 30	-0.12691 0.5118 29
CS	0.82078 0.0001 31	1.00000 0.0000 31	0.76354 0.0001 31	0.83491 0.0001 31	0.09139 0.6249 31	0.27540 0.1482 29	-0.19361 0.3143 29	0.18413 0.3483 28	-0.00271 0.9884 31	-0.01335 0.9442 30	0.17899 0.3440 30	-0.08627 0.6563 29
EAS_L	0.73883 0.0001 31	0.76354 0.0001 31	1.00000 0.0000 31	0.71831 0.0001 31	0.07390 0.6928 31	-0.05439 0.7793 29	-0.33637 0.0744 29	-0.16758 0.3940 28	0.03609 0.8472 31	0.07067 0.7106 30	0.51213 0.0038 30	-0.13871 0.4730 29
SCH_DIST	0.91519 0.0001 31	0.83491 0.0001 31	0.71831 0.0001 31	1.00000 0.0000 31	0.03396 0.8561 31	0.20987 0.2745 29	-0.28535 0.1335 29	0.10340 0.6006 28	-0.03314 0.8595 31	0.02810 0.8828 30	0.04506 0.8131 30	-0.15344 0.4268 29
TELE	-0.03572 0.8487 31	0.09139 0.6249 31	0.07390 0.6928 31	0.03396 0.8561 31	1.00000 0.0000 31	0.22261 0.2458 29	-0.15438 0.4239 29	0.14003 0.4773 28	0.05785 0.7572 31	0.01145 0.9521 30	0.00558 0.9766 30	0.10414 0.5908 29
LOC_CALL	0.18694 0.3315 29	0.27540 0.1482 29	-0.05439 0.7793 29	0.20987 0.2745 29	0.22261 0.2458 29	1.00000 0.0000 29	0.17556 0.3715 28	0.97390 0.0001 28	0.09751 0.6148 29	-0.04499 0.8202 28	-0.34810 0.0695 28	0.31656 0.1077 27
TOLL_C	-0.33416 0.0764 29	-0.19361 0.3143 29	-0.33637 0.0744 29	-0.28535 0.1335 29	-0.15438 0.4239 29	0.17556 0.3715 28	1.00000 0.0000 29	0.39445 0.0378 28	0.72890 0.0001 29	0.61358 0.0005 28	-0.15589 0.4283 28	0.81825 0.0001 27
TOTAL_C	0.06358 0.7479 28	0.18413 0.3483 28	-0.16758 0.3940 28	0.10340 0.6006 28	0.14003 0.4773 28	0.97390 0.0001 28	0.39445 0.0378 28	1.00000 0.0000 28	0.24638 0.2063 28	0.08547 0.6717 27	-0.37748 0.0522 27	0.47685 0.0138 26
AMT_DUE	-0.04288 0.8189 31	-0.00271 0.9884 31	0.03609 0.8472 31	-0.03314 0.8595 31	0.05785 0.7572 31	0.09751 0.6148 29	0.72890 0.0001 29	0.24638 0.2063 28	1.00000 0.0000 31	0.95415 0.0001 30	0.07753 0.6838 30	0.90700 0.0001 29
NONL_CHG	-0.01137 0.9524 30	-0.01335 0.9442 30	0.07067 0.7106 30	0.02810 0.8828 30	0.01145 0.9521 30	-0.04499 0.8202 28	0.61358 0.0005 28	0.08547 0.6717 27	0.95415 0.0001 30	1.00000 0.0000 30	0.01988 0.9185 29	0.75262 0.0001 29
BAS_CHG	0.12152 0.5224 30	0.17899 0.3440 30	0.51213 0.0038 30	0.04506 0.8131 30	0.00558 0.9766 30	-0.34810 0.0695 28	-0.15589 0.4283 28	-0.37748 0.0522 27	0.07753 0.6838 30	0.01988 0.9185 29	1.00000 0.0000 30	-0.05904 0.7610 29
LTLL_CHG	-0.12691 0.5118 29	-0.08627 0.6563 29	-0.13871 0.4730 29	-0.15344 0.4268 29	0.10414 0.5908 29	0.31656 0.1077 27	0.81825 0.0001 27	0.47685 0.0138 26	0.90700 0.0001 29	0.75262 0.0001 29	-0.05904 0.7610 29	1.00000 0.0000 29

APPENDIX E: STATISTICAL ANALYSIS, ALL-RESIDENTIAL MODELS

BUSINESS=0

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOC_CALL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	36778.03411574	9194.50852894	2.45	0.0500	0.082632	93.3157
ERROR	109	408301.58869127	3745.88613478		ROOT MSE		LOC_CALL MEAN
CORRECTED TOTAL	113	445079.62280702			61.20364478		65.58771930

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	22706.25586024	6.06	0.0154	1	7215.64161969	1.93	0.1680
CS	1	6120.16021978	1.63	0.2039	1	11908.03614940	3.18	0.0774
EAS_L	1	3854.73499172	1.03	0.3126	1	3469.62421519	0.93	0.3380
SCH_DIST	1	4096.88304400	1.09	0.2980	1	4096.88304400	1.09	0.2980

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	21.31715128	0.85	0.3954	24.98653175
TC	30.91933836	1.39	0.1680	22.27768200
CS	-40.72210590	-1.78	0.0774	22.83954473
EAS_L	0.00648724	0.96	0.3380	0.00674056
SCH_DIST	41.32390749	1.05	0.2980	39.51408079

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	8146.82572730	2036.70643182	6.34	0.0001	0.172163	116.3462
ERROR	122	39173.69395774	321.09585211		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	126	47320.51968504			17.91914764		15.40157480

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	5541.30414178	17.26	0.0001	1	876.37669912	2.73	0.1011
CS	1	1182.09035379	3.68	0.0574	1	1528.99372647	4.76	0.0310
EAS_L	1	56.11119374	0.17	0.6767	1	27.40410056	0.09	0.7707
SCH_DIST	1	1367.32003798	4.26	0.0412	1	1367.32003798	4.26	0.0412

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	8.88760439	1.26	0.2097	7.04781793
TC	-10.38883710	-1.65	0.1011	6.28838138
CS	-14.20536199	-2.18	0.0310	6.50978734
EAS_L	0.00051402	0.29	0.7707	0.00175950
SCH_DIST	22.60515356	2.06	0.0412	10.95442838

BUSINESS=0

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOTAL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	36472.06448920	9118.01612230	1.89	0.1170	0.065489	84.9322
ERROR	108	520449.97090903	4818.98121212		ROOT MSE		TOTAL_C MEAN
CORRECTED TOTAL	112	556922.03539823			69.41888224		81.73451327

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	7123.31307059	1.48	0.2267	1	2380.13962906	0.49	0.4837
CS	1	11844.08730440	2.46	0.1199	1	21805.61324733	4.52	0.0357
EAS_L	1	5094.04260151	1.06	0.3062	1	4299.05338556	0.89	0.3470
SCH_DIST	1	12410.62151271	2.58	0.1115	1	12410.62151271	2.58	0.1115

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	25.84963792	0.91	0.3637	28.34057259
TC	17.76412996	0.70	0.4837	25.27669806
CS	-55.44273720	-2.13	0.0357	26.06382357
EAS_L	0.00727125	0.94	0.3470	0.00769839
SCH_DIST	71.94774153	1.60	0.1115	44.83302231

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LTLL_CHG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	2033.52077766	508.38019441	2.24	0.0691	0.072850	125.3788
ERROR	114	25880.18356184	227.01915405		ROOT MSE		LTLL_CHG MEAN
CORRECTED TOTAL	118	27913.70433950			15.06715481		12.01731092

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	472.13436489	2.08	0.1520	1	12.42236330	0.05	0.8155
CS	1	616.02071431	2.71	0.1023	1	613.67770574	2.70	0.1029
EAS_L	1	2.18471121	0.01	0.9220	1	11.41274993	0.05	0.8230
SCH_DIST	1	943.18098725	4.15	0.0438	1	943.18098725	4.15	0.0438

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	3.52278206	0.62	0.5393	5.72166736
TC	-1.27088916	-0.23	0.8155	5.43296380
CS	-9.38644021	-1.64	0.1029	5.70902566
EAS_L	-0.00036488	-0.22	0.8230	0.00162735
SCH_DIST	17.93953080	2.04	0.0438	8.80125921

BUSINESS=0

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: AMT_DUE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	9593.58104988	2398.39526247	3.67	0.0073	0.104464	71.7029
ERROR	126	82242.86924020	652.72118445		ROOT MSE		AMT_DUE MEAN
CORRECTED TOTAL	130	91836.45029008			25.54840865		35.63091603

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	1332.50582064	2.04	0.1555	1	27.56813405	0.04	0.8375
CS	1	4964.03383048	7.61	0.0067	1	7290.69346525	11.17	0.0011
EAS_L	1	1308.78860133	2.01	0.1592	1	1126.38300622	1.73	0.1914
SCH_DIST	1	1988.25279743	3.05	0.0834	1	1988.25279743	3.05	0.0834

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	21.47015976	2.24	0.0269	9.59162993
TC	1.82898570	0.21	0.8375	8.89959979
CS	-30.67944610	-3.34	0.0011	9.17966746
EAS_L	0.00333246	1.31	0.1914	0.00253680
SCH_DIST	25.91485398	1.75	0.0834	14.84830293

BUSINESS=0

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
TC	133	0.56390977	0.49777358	75.0000000	0.00000000	1.00000000
CS	133	0.46616541	0.50073994	62.0000000	0.00000000	1.00000000
EAS_L	133	2092.54887218	1649.08927330	278309.0000000	218.00000000	5815.00000000
SCH_DIST	133	0.78706767	0.22487634	104.6800000	0.20000000	0.99000000
TELE	133	2.20300752	0.98287919	293.0000000	1.00000000	3.00000000
LOC_CALL	114	65.58771930	62.75952297	7477.0000000	0.00000000	349.00000000
TOLL_C	127	15.40157480	19.37936222	1956.0000000	0.00000000	140.00000000
TOTAL_C	113	81.73451327	70.51608450	9236.0000000	0.00000000	389.00000000
AMT_DUE	131	35.63091603	26.57883054	4667.6500000	10.04000000	175.00000000
NONL_CHG	120	16.82591667	18.91097327	2019.1100000	0.29000000	130.00000000
BAS_CHG	131	8.44312977	2.82240543	1106.0500000	4.00000000	14.35000000
LTLL_CHG	119	12.01731092	15.38040365	1430.0600000	-2.35000000	130.00000000

BUSINESS=0

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	TC	CS	EAS_L	SCH_DIST	TELE	LOC_CALL	TOLL_C	TOTAL_C	AMT_DUE	NONL_CHG	BAS_CHG	LTLL_CHG
TC	1.00000	0.82177	0.77408	0.72889	0.27523	0.22587	-0.34220	0.11310	-0.12046	-0.04431	0.27746	-0.13005
	0.0000	0.0001	0.0001	0.0001	0.0013	0.0157	0.0001	0.2330	0.1705	0.6308	0.0013	0.1586
	133	133	133	133	133	114	127	113	131	120	131	119
CS	0.82177	1.00000	0.81595	0.68635	0.26804	0.10853	-0.37039	0.00102	-0.23197	-0.12794	0.17423	-0.19196
	0.0001	0.0000	0.0001	0.0001	0.0018	0.2504	0.0001	0.9914	0.0077	0.1638	0.0466	0.0365
	133	133	133	133	133	114	127	113	131	120	131	119
EAS_L	0.77408	0.81595	1.00000	0.63482	0.28584	0.18500	-0.29727	0.08899	-0.10258	-0.01004	0.38021	-0.15430
	0.0001	0.0001	0.0000	0.0001	0.0009	0.0488	0.0007	0.3486	0.2437	0.9133	0.0001	0.0938
	133	133	133	133	133	114	127	113	131	120	131	119
SCH_DIST	0.72889	0.68635	0.63482	1.00000	0.17375	0.21465	-0.16250	0.16107	-0.01991	0.05072	-0.11826	0.01267
	0.0001	0.0001	0.0001	0.0000	0.0455	0.0218	0.0680	0.0883	0.8215	0.5822	0.1785	0.8912
	133	133	133	133	133	114	127	113	131	120	131	119
TELE	0.27523	0.26804	0.28584	0.17375	1.00000	0.00590	-0.29791	-0.06385	-0.14795	-0.13525	0.16814	-0.12291
	0.0013	0.0018	0.0009	0.0455	0.0000	0.9503	0.0007	0.5017	0.0917	0.1408	0.0549	0.1830
	133	133	133	133	133	114	127	113	131	120	131	119
LOC_CALL	0.22587	0.10853	0.18500	0.21465	0.00590	1.00000	0.24677	0.96245	0.31135	0.37862	0.03126	0.08077
	0.0157	0.2504	0.0488	0.0218	0.9503	0.0000	0.0084	0.0001	0.0008	0.0001	0.7424	0.4173
	114	114	114	114	114	114	113	113	112	104	113	103
TOLL_C	-0.34220	-0.37039	-0.29727	-0.16250	-0.29791	0.24677	1.00000	0.50055	0.44059	0.31822	-0.11659	0.36367
	0.0001	0.0001	0.0007	0.0680	0.0007	0.0084	0.0000	0.0001	0.0001	0.0005	0.1936	0.0001
	127	127	127	127	127	113	127	113	125	115	126	114
TOTAL_C	0.11310	0.00102	0.08899	0.16107	-0.06385	0.96245	0.50055	1.00000	0.39962	0.42825	-0.00533	0.16629
	0.2330	0.9914	0.3486	0.0883	0.5017	0.0001	0.0001	0.0000	0.0001	0.0001	0.9555	0.0948
	113	113	113	113	113	113	113	113	111	103	112	102
AMT_DUE	-0.12046	-0.23197	-0.10258	-0.01991	-0.14795	0.31135	0.44059	0.39962	1.00000	0.83890	0.00942	0.72974
	0.1705	0.0077	0.2437	0.8215	0.0917	0.0008	0.0001	0.0001	0.0000	0.0001	0.9153	0.0001
	131	131	131	131	131	112	125	111	131	119	130	119
NONL_CHG	-0.04431	-0.12794	-0.01004	0.05072	-0.13525	0.37862	0.31822	0.42825	0.83890	1.00000	-0.00470	0.25380
	0.6308	0.1638	0.9133	0.5822	0.1408	0.0001	0.0005	0.0001	0.0001	0.0000	0.9593	0.0054
	120	120	120	120	120	104	115	103	119	120	120	119
BAS_CHG	0.27746	0.17423	0.38021	-0.11826	0.16814	0.03126	-0.11659	-0.00533	0.00942	-0.00470	1.00000	-0.11404
	0.0013	0.0466	0.0001	0.1785	0.0549	0.7424	0.1936	0.9555	0.9153	0.9593	0.0000	0.2168
	131	131	131	131	131	113	126	112	130	120	131	119
LTLL_CHG	-0.13005	-0.19196	-0.15430	0.01267	-0.12291	0.08077	0.36367	0.16629	0.72974	0.25380	-0.11404	1.00000
	0.1586	0.0365	0.0938	0.8912	0.1830	0.4173	0.0001	0.0948	0.0001	0.0054	0.2168	0.0000
	119	119	119	119	119	103	114	102	119	119	119	119

APPENDIX F: STATISTICAL ANALYSIS, RURAL RESIDENTIAL MODELS

RES=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOC_CALL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	34912.15766174	8728.03941544	2.41	0.0633	0.179792	92.3285
ERROR	44	159268.53621581	3619.73945945		ROOT MSE		LOC_CALL MEAN
CORRECTED TOTAL	48	194180.69387755			60.16427062		65.16326531

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	23618.03180859	6.52	0.0142	1	3101.07555293	0.86	0.3597
CS	1	749.06666667	0.21	0.6514	1	5295.10034941	1.46	0.2329
EAS_L	1	7420.11029332	2.05	0.1593	1	6555.53362359	1.81	0.1853
SCH_DIST	1	3124.94889317	0.86	0.3579	1	3124.94889317	0.86	0.3579

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	12.13105433	0.41	0.6816	29.37401046
TC	30.22864134	0.93	0.3597	32.65886670
CS	-43.88851422	-1.21	0.2329	36.28711468
EAS_L	0.01539087	1.35	0.1853	0.01143662
SCH_DIST	41.07235343	0.93	0.3579	44.20453078

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	5462.99097987	1365.74774497	2.61	0.0475	0.181585	102.6027
ERROR	47	24622.08594321	523.87416900		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	51	30085.07692308			22.88829764		22.30769231

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	2005.71901217	3.83	0.0563	1	762.63142168	1.46	0.2336
CS	1	635.17202381	1.21	0.2765	1	1530.31646302	2.92	0.0940
EAS_L	1	636.18326118	1.21	0.2761	1	445.93761421	0.85	0.3609
SCH_DIST	1	2185.91668270	4.17	0.0467	1	2185.91668270	4.17	0.0467

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	4.18280845	0.38	0.7068	11.05307472
TC	-14.93014441	-1.21	0.2336	12.37428611
CS	-23.22057837	-1.71	0.0940	13.58613420
EAS_L	0.00397276	0.92	0.3609	0.00430594
SCH_DIST	34.29355953	2.04	0.0467	16.78839797

RES=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOTAL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	38849.52435239	9712.38108810	1.93	0.1224	0.149208	81.6915
ERROR	44	221522.47564761	5034.60171926		ROOT MSE		TOTAL_C MEAN
CORRECTED TOTAL	48	260372.00000000			70.95492738		86.85714286

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	12448.22241379	2.47	0.1230	1	826.38485560	0.16	0.6873
CS	1	2870.41666667	0.57	0.4542	1	12952.86753439	2.57	0.1159
EAS_L	1	12836.35024656	2.55	0.1175	1	10795.19798095	2.14	0.1502
SCH_DIST	1	10694.53502537	2.12	0.1521	1	10694.53502537	2.12	0.1521

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	14.85377604	0.43	0.6702	34.64233435
TC	15.60463551	0.41	0.6873	38.51634020
CS	-68.64307704	-1.60	0.1159	42.79532620
EAS_L	0.01975033	1.46	0.1502	0.01348782
SCH_DIST	75.98171336	1.46	0.1521	52.13275652

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: AMT_DUE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	6181.55808252	1545.38952063	1.66	0.1743	0.121633	75.5163
ERROR	48	44639.62983447	929.99228822		ROOT MSE		AMT_DUE MEAN
CORRECTED TOTAL	52	50821.18791698			30.49577492		40.38301887

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	0.00005582	0.00	0.9998	1	266.77368340	0.29	0.5947
CS	1	3001.91274054	3.23	0.0787	1	4530.17414376	4.87	0.0321
EAS_L	1	945.59704921	1.02	0.3183	1	712.31827685	0.77	0.3858
SCH_DIST	1	2234.04823695	2.40	0.1277	1	2234.04823695	2.40	0.1277

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	16.50188912	1.13	0.2624	14.55138165
TC	8.75707020	0.54	0.5947	16.35034844
CS	-39.93831931	-2.21	0.0321	18.09555927
EAS_L	0.00502008	0.88	0.3858	0.00573606
SCH_DIST	33.62854632	1.55	0.1277	21.69709022

RES=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LTLL_CHG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	888.03899270	222.00974817	1.59	0.1927	0.124005	82.9812
ERROR	45	6273.30140930	139.40669798		ROOT MSE		LTLL_CHG MEAN
CORRECTED TOTAL	49	7161.34040200			11.80706136		14.22860000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	77.90238400	0.56	0.4586	1	6.41827117	0.05	0.8311
CS	1	149.11858316	1.07	0.3065	1	146.37659215	1.05	0.3110
EAS_L	1	0.73536422	0.01	0.9424	1	10.57652137	0.08	0.7842
SCH_DIST	1	660.28266131	4.74	0.0348	1	660.28266131	4.74	0.0348

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	4.33118280	0.76	0.4483	5.66245552
TC	-1.36420593	-0.21	0.8311	6.35788579
CS	-7.44134802	-1.02	0.3110	7.26202300
EAS_L	-0.00062870	-0.28	0.7842	0.00228251
SCH_DIST	18.32156076	2.18	0.0348	8.41858965

TELE=1

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
TC	53	0.39622642	0.49379311	21.00000000	0.00000000	1.00000000
CS	53	0.30188679	0.46346959	16.00000000	0.00000000	1.00000000
EAS_L	53	1515.60377358	1377.19143326	80327.00000000	218.00000000	5815.00000000
SCH_DIST	53	0.73924528	0.25275291	39.18000000	0.20000000	0.99000000
LOC_CALL	49	65.16326531	63.60370368	3193.00000000	1.00000000	320.00000000
TOLL_C	52	22.30769231	24.28792846	1160.00000000	0.00000000	140.00000000
TOTAL_C	49	86.85714286	73.65063928	4256.00000000	3.00000000	386.00000000
AMT_DUE	53	40.38301887	31.26228617	2140.30000000	10.04000000	175.00000000
NONL_CHG	50	19.83960000	23.67717888	991.98000000	1.00000000	130.00000000
BAS_CHG	53	7.86962264	2.71764035	417.09000000	4.00000000	14.35000000
LTLL_CHG	50	14.22860000	12.08924332	711.43000000	-2.11000000	56.75000000

TELE=1

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	TC	CS	EAS_L	SCH_DIST	LOC_CALL	TOLL_C	TOTAL_C	AMT_DUE	NONL_CHG	BAS_CHG	LTLL_CHG
TC	1.00000	0.81175	0.78542	0.62032	0.34875	-0.25820	0.21865	0.00003	0.05296	0.34935	-0.10430
	0.0000	0.0001	0.0001	0.0001	0.0141	0.0646	0.1312	0.9998	0.7149	0.0103	0.4710
	53	53	53	53	49	52	49	53	50	53	50
CS	0.81175	1.00000	0.81710	0.57820	0.24166	-0.29435	0.11186	-0.14191	-0.09024	0.27919	-0.17032
	0.0001	0.0000	0.0001	0.0001	0.0944	0.0342	0.4441	0.3108	0.5331	0.0429	0.2370
	53	53	53	53	49	52	49	53	50	53	50
EAS_L	0.78542	0.81710	1.00000	0.56128	0.35728	-0.16873	0.25662	-0.00141	0.03686	0.43471	-0.13428
	0.0001	0.0001	0.0000	0.0001	0.0117	0.2318	0.0751	0.9920	0.7994	0.0011	0.3525
	53	53	53	53	49	52	49	53	50	53	50
SCH_DIST	0.62032	0.57820	0.56128	1.00000	0.32052	0.02802	0.29320	0.13946	0.16240	-0.15565	0.15798
	0.0001	0.0001	0.0001	0.0000	0.0247	0.8437	0.0409	0.3193	0.2598	0.2657	0.2732
	53	53	53	53	49	52	49	53	50	53	50
LOC_CALL	0.34875	0.24166	0.35728	0.32052	1.00000	0.25331	0.94759	0.41410	0.46896	0.10692	0.12051
	0.0141	0.0944	0.0117	0.0247	0.0000	0.0791	0.0001	0.0031	0.0010	0.4646	0.4250
	49	49	49	49	49	49	49	49	46	49	46
TOLL_C	-0.25820	-0.29435	-0.16873	0.02802	0.25331	1.00000	0.54910	0.38119	0.27869	-0.18053	0.41685
	0.0646	0.0342	0.2318	0.8437	0.0791	0.0000	0.0001	0.0053	0.0525	0.2003	0.0029
	52	52	52	52	49	52	49	52	49	52	49
TOTAL_C	0.21865	0.11186	0.25662	0.29320	0.94759	0.54910	1.00000	0.48567	0.50392	0.03244	0.23759
	0.1312	0.4441	0.0751	0.0409	0.0001	0.0001	0.0000	0.0004	0.0004	0.8249	0.1119
	49	49	49	49	49	49	49	49	46	49	46
AMT_DUE	0.00003	-0.14191	-0.00141	0.13946	0.41410	0.38119	0.48567	1.00000	0.94715	-0.02504	0.75820
	0.9998	0.3108	0.9920	0.3193	0.0031	0.0053	0.0004	0.0000	0.0001	0.8588	0.0001
	53	53	53	53	49	52	49	53	50	53	50
NONL_CHG	0.05296	-0.09024	0.03686	0.16240	0.46896	0.27869	0.50392	0.94715	1.00000	-0.01961	0.52215
	0.7149	0.5331	0.7994	0.2598	0.0010	0.0525	0.0004	0.0001	0.0000	0.8925	0.0001
	50	50	50	50	46	49	46	50	50	50	50
BAS_CHG	0.34935	0.27919	0.43471	-0.15565	0.10692	-0.18053	0.03244	-0.02504	-0.01961	1.00000	-0.17706
	0.0103	0.0429	0.0011	0.2657	0.4646	0.2003	0.8249	0.8588	0.8925	0.0000	0.2187
	53	53	53	53	49	52	49	53	50	53	50
LTLL_CHG	-0.10430	-0.17032	-0.13428	0.15798	0.12051	0.41685	0.23759	0.75820	0.52215	-0.17706	1.00000
	0.4710	0.2370	0.3525	0.2732	0.4250	0.0029	0.1119	0.0001	0.0001	0.2187	0.0000
	50	50	50	50	46	49	46	50	50	50	50

APPENDIX G: STATISTICAL ANALYSIS, TOWN RESIDENTIAL MODELS

RES=3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LOC_CALL

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	11034.92743436	2758.73185859	0.69	0.6017	0.043984	95.9305
ERROR	60	239848.51871949	3997.47531199		ROOT MSE		LOC_CALL MEAN
CORRECTED TOTAL	64	250883.44615385			63.22559064		65.90769231

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	4860.54551960	1.22	0.2746	1	2639.55471763	0.66	0.4197
CS	1	5045.38504983	1.26	0.2657	1	5856.71146019	1.47	0.2309
EAS_L	1	579.67463880	0.15	0.7047	1	552.49844654	0.14	0.7114
SCH_DIST	1	549.32222613	0.14	0.7122	1	549.32222613	0.14	0.7122

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	33.17350240	0.64	0.5248	51.86118976
TC	29.04420833	0.81	0.4197	35.74267924
CS	-37.59203222	-1.21	0.2309	31.05716327
EAS_L	0.00320687	0.37	0.7114	0.00862598
SCH_DIST	32.67533198	0.37	0.7122	88.14533204

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	2107.87195043	526.96798761	3.38	0.0139	0.161699	117.7248
ERROR	70	10927.91471624	156.11306737		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	74	13035.78666667			12.49452149		10.61333333

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	1607.20666667	10.30	0.0020	1	3.64005495	0.02	0.8791
CS	1	438.44023810	2.81	0.0982	1	202.37907067	1.30	0.2588
EAS_L	1	5.13025520	0.03	0.8567	1	3.22306460	0.02	0.8862
SCH_DIST	1	57.09479047	0.37	0.5473	1	57.09479047	0.37	0.5473

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	22.36235738	2.56	0.0126	8.73300005
TC	-0.93227177	-0.15	0.8791	6.10531665
CS	-6.63994534	-1.14	0.2588	5.83178271
EAS_L	-0.00021124	-0.14	0.8862	0.00147014
SCH_DIST	-8.40951093	-0.60	0.5473	13.90567664

RES=3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOTAL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	9856.71173855	2464.17793464	0.51	0.7277	0.033494	89.2292
ERROR	59	284423.03826145	4820.72946206		ROOT MSE		TOTAL_C MEAN
CORRECTED TOTAL	63	294279.75000000			69.43147314		77.81250000

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	1080.08766234	0.22	0.6377	1	1969.63440067	0.41	0.5252
CS	1	7797.25525210	1.62	0.2084	1	7729.71514376	1.60	0.2104
EAS_L	1	369.31367742	0.08	0.7829	1	338.83780519	0.07	0.7918
SCH_DIST	1	610.05514670	0.13	0.7233	1	610.05514670	0.13	0.7233

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	50.91260655	0.89	0.3753	56.98574631
TC	25.08973164	0.64	0.5252	39.25180075
CS	-43.51046297	-1.27	0.2104	34.36120136
EAS_L	0.00254356	0.27	0.7918	0.00959407
SCH_DIST	34.48567186	0.36	0.7233	96.94167594

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: AMT_DUE

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	3730.09054786	932.52263697	1.93	0.1145	0.095631	67.8425
ERROR	73	35275.04146368	483.21974608		ROOT MSE		AMT_DUE MEAN
CORRECTED TOTAL	77	39005.13201154			21.98225980		32.40192308

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	1121.74116923	2.32	0.1319	1	1.54437415	0.00	0.9551
CS	1	1785.12578890	3.69	0.0585	1	2555.77247272	5.29	0.0243
EAS_L	1	784.62842408	1.62	0.2066	1	764.93724771	1.58	0.2123
SCH_DIST	1	38.59516565	0.08	0.7783	1	38.59516565	0.08	0.7783

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	31.94303244	2.31	0.0237	13.83071826
TC	0.60362793	0.06	0.9551	10.67739723
CS	-23.16471422	-2.30	0.0243	10.07252118
EAS_L	0.00327827	1.26	0.2123	0.00260558
SCH_DIST	6.32160414	0.28	0.7783	22.36831028

RES=3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: LTLL_CHG

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	4	877.41894890	219.35473722	0.72	0.5803	0.043157	167.3980
ERROR	64	19453.28837574	303.95763087		ROOT MSE		LTLL_CHG MEAN
CORRECTED TOTAL	68	20330.70732464			17.43438071		10.41492754

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
TC	1	222.27040873	0.73	0.3957	1	0.81479631	0.00	0.9589
CS	1	407.65354834	1.34	0.2511	1	418.81170333	1.38	0.2448
EAS_L	1	0.04829717	0.00	0.9900	1	0.83183250	0.00	0.9584
SCH_DIST	1	247.44669466	0.81	0.3703	1	247.44669466	0.81	0.3703

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	3.32264060	0.30	0.7672	11.17821538
TC	-0.45994817	-0.05	0.9589	8.88363892
CS	-10.01091767	-1.17	0.2448	8.52846773
EAS_L	-0.00011932	-0.05	0.9584	0.00228087
SCH_DIST	16.17498257	0.90	0.3703	17.92707843

TELE=3

VARIABLE	N	MEAN	STD DEV	SUM	MINIMUM	MAXIMUM
TC	80	0.67500000	0.47132993	54.0000000	0.00000000	1.00000000
CS	80	0.57500000	0.49746191	46.0000000	0.00000000	1.00000000
EAS_L	80	2474.77500000	1710.05088365	197982.0000000	218.00000000	5815.00000000
SCH_DIST	80	0.81875000	0.19973638	65.5000000	0.20000000	0.99000000
LOC_CALL	65	65.90769231	62.61033338	4284.0000000	0.00000000	349.00000000
TOLL_C	75	10.61333333	13.27250087	796.0000000	0.00000000	60.00000000
TOTAL_C	64	77.81250000	68.34549834	4980.0000000	0.00000000	389.00000000
AMT_DUE	78	32.40192308	22.50689130	2527.3500000	10.10000000	150.00000000
NONL_CHG	70	14.67328571	14.40060956	1027.1300000	0.29000000	70.00000000
BAS_CHG	78	8.83282051	2.84273871	688.9600000	4.00000000	13.93000000
LTLL_CHG	69	10.41492754	17.29106677	718.6300000	-2.35000000	130.00000000

TELE=3

PEARSON CORRELATION COEFFICIENTS / PROB > |R| UNDER HO:RHO=0 / NUMBER OF OBSERVATIONS

	TC	CS	EAS_L	SCH_DIST	LOC_CALL	TOLL_C	TOTAL_C	AMT_DUE	NONL_CHG	BAS_CHG	LTLL_CHG
TC	1.00000	0.80710	0.74720	0.81180	0.13919	-0.35113	0.06058	-0.16958	-0.08441	0.17489	-0.10456
	0.0000	0.0001	0.0001	0.0001	0.2688	0.0020	0.6344	0.1377	0.4872	0.1256	0.3925
	80	80	80	80	65	75	64	78	70	78	69
CS	0.80710	1.00000	0.79560	0.76278	0.01750	-0.39070	-0.05708	-0.26351	-0.11267	0.05232	-0.16768
	0.0001	0.0000	0.0001	0.0001	0.8900	0.0005	0.6541	0.0198	0.3531	0.6491	0.1684
	80	80	80	80	65	75	64	78	70	78	69
EAS_L	0.74720	0.79560	1.00000	0.68503	0.08028	-0.33696	0.00604	-0.11727	0.01661	0.31032	-0.12656
	0.0001	0.0001	0.0000	0.0001	0.5250	0.0031	0.9622	0.3065	0.8915	0.0057	0.3001
	80	80	80	80	65	75	64	78	70	78	69
SCH_DIST	0.81180	0.76278	0.68503	1.00000	0.11508	-0.35737	0.04243	-0.15451	-0.05283	-0.14814	-0.04395
	0.0001	0.0001	0.0001	0.0000	0.3613	0.0016	0.7392	0.1768	0.6641	0.1955	0.7199
	80	80	80	80	65	75	64	78	70	78	69
LOC_CALL	0.13919	0.01750	0.08028	0.11508	1.00000	0.28557	0.98047	0.21895	0.30041	-0.02947	0.06560
	0.2688	0.8900	0.5250	0.3613	0.0000	0.0222	0.0001	0.0847	0.0220	0.8172	0.6278
	65	65	65	65	65	64	64	63	58	64	57
TOLL_C	-0.35113	-0.39070	-0.33696	-0.35737	0.28557	1.00000	0.46847	0.50000	0.31977	0.04316	0.36484
	0.0020	0.0005	0.0031	0.0016	0.0222	0.0000	0.0001	0.0001	0.0089	0.7150	0.0028
	75	75	75	75	64	75	64	73	66	74	65
TOTAL_C	0.06058	-0.05708	0.00604	0.04243	0.98047	0.46847	1.00000	0.30206	0.33900	-0.01676	0.12729
	0.6344	0.6541	0.9622	0.7392	0.0001	0.0001	0.0000	0.0170	0.0099	0.8963	0.3499
	64	64	64	64	64	64	64	62	57	63	56
AMT_DUE	-0.16958	-0.26351	-0.11727	-0.15451	0.21895	0.50000	0.30206	1.00000	0.66365	0.08923	0.76876
	0.1377	0.0198	0.3065	0.1768	0.0847	0.0001	0.0170	0.0000	0.0001	0.4403	0.0001
	78	78	78	78	63	73	62	78	69	77	69
NONL_CHG	-0.08441	-0.11267	0.01661	-0.05283	0.30041	0.31977	0.33900	0.66365	1.00000	0.05584	0.04790
	0.4872	0.3531	0.8915	0.6641	0.0220	0.0089	0.0099	0.0001	0.0000	0.6461	0.6959
	70	70	70	70	58	66	57	69	70	70	69
BAS_CHG	0.17489	0.05232	0.31032	-0.14814	-0.02947	0.04316	-0.01676	0.08923	0.05584	1.00000	-0.06142
	0.1256	0.6491	0.0057	0.1955	0.8172	0.7150	0.8963	0.4403	0.6461	0.0000	0.6161
	78	78	78	78	64	74	63	77	70	78	69
LTLL_CHG	-0.10456	-0.16768	-0.12656	-0.04395	0.06560	0.36484	0.12729	0.76876	0.04790	-0.06142	1.00000
	0.3925	0.1684	0.3001	0.7199	0.6278	0.0028	0.3499	0.0001	0.6959	0.6161	0.0000
	69	69	69	69	57	65	56	69	69	69	69

APPENDIX H: STATISTICAL ANALYSIS, REVISED TOLL CALL MODELS

BUSINESS=0

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	6491.77080948	6491.77080948	19.87	0.0001	0.137187	117.3445
ERROR	125	40828.74887556	326.62999100		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	126	47320.51968504			18.07290765		15.40157480

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
CS	1	6491.77080948	19.87	0.0001	1	6491.77080948	19.87	0.0001

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	21.95652174	10.09	0.0001	2.17572241
CS	-14.35307346	-4.46	0.0001	3.21952163

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1249.51908087	1249.51908087	3.39	0.0680	0.026405	124.6504
ERROR	125	46071.00060417	368.56800483		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	126	47320.51968504			19.19812503		15.40157480

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
SCH_DIST	1	1249.51908087	3.39	0.0680	1	1249.51908087	3.39	0.0680

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	26.57760977	4.22	0.0001	6.30434040
SCH_DIST	-14.24913604	-1.84	0.0680	7.73884062

BUSINESS=0

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	2	7262.34598689	3631.17299345	11.24	0.0001	0.153471	116.6997
ERROR	124	40058.17369815	323.04978789		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	126	47320.51968504			17.97358584		15.40157480

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
CS	1	6491.77080948	20.10	0.0001	1	6012.82690602	18.61	0.0001
SCH_DIST	1	770.57517742	2.39	0.1250	1	770.57517742	2.39	0.1250

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	11.99820081	1.76	0.0802	6.80120189
CS	-19.04849153	-4.31	0.0001	4.41525680
SCH_DIST	15.43058936	1.54	0.1250	9.99101789

RES=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	2606.66720085	2606.66720085	4.74	0.0342	0.086643	105.0887
ERROR	50	27478.40972222	549.56819444		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	51	30085.07692308			23.44287087		22.30769231

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
CS	1	2606.66720085	4.74	0.0342	1	2606.66720085	4.74	0.0342

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	27.02777778	6.92	0.0001	3.90714514
CS	-15.34027778	-2.18	0.0342	7.04370608

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	23.61702354	23.61702354	0.04	0.8437	0.000785	109.9171
ERROR	50	30061.45989954	601.22919799		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	51	30085.07692308			24.51997549		22.30769231

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
SCH_DIST	1	23.61702354	0.04	0.8437	1	23.61702354	0.04	0.8437

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	20.33392786	1.93	0.0590	10.52320588
SCH_DIST	2.68469138	0.20	0.8437	13.54571140

RES=1

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	2	4532.34526796	2266.17263398	4.35	0.0183	0.150651	102.3684
ERROR	49	25552.73165512	521.48431949		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	51	30085.07692308			22.83603117		22.30769231

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
CS	1	2606.66720085	5.00	0.0300	1	4508.72824442	8.65	0.0050
SCH_DIST	1	1925.67806711	3.69	0.0605	1	1925.67806711	3.69	0.0605

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=O	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	7.85118594	0.74	0.4658	10.68045711
CS	-25.11086866	-2.94	0.0050	8.53995011
SCH_DIST	30.17295919	1.92	0.0605	15.70170055

RES=3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1989.82129870	1989.82129870	13.15	0.0005	0.152643	115.9014
ERROR	73	11045.96536797	151.31459408		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	74	13035.78666667			12.30099972		10.61333333

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
CS	1	1989.82129870	13.15	0.0005	1	1989.82129870	13.15	0.0005

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	16.42424242	7.67	0.0001	2.14132920
CS	-10.37662338	-3.63	0.0005	2.86147150

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	1	1664.81507146	1664.81507146	10.69	0.0016	0.127711	117.5941
ERROR	73	11370.97159520	155.76673418		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	74	13035.78666667			12.48065440		10.61333333

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
SCH_DIST	1	1664.81507146	10.69	0.0016	1	1664.81507146	10.69	0.0016

PARAMETER	ESTIMATE	T FOR HO: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	31.06909516	4.84	0.0001	6.42087494
SCH_DIST	-24.99482139	-3.27	0.0016	7.64547364

RES=3

GENERAL LINEAR MODELS PROCEDURE

DEPENDENT VARIABLE: TOLL_C

SOURCE	DF	SUM OF SQUARES	MEAN SQUARE	F VALUE	PR > F	R-SQUARE	C.V.
MODEL	2	2098.98560499	1049.49280249	6.91	0.0018	0.161017	116.1254
ERROR	72	10936.80106168	151.90001475		ROOT MSE		TOLL_C MEAN
CORRECTED TOTAL	74	13035.78666667			12.32477240		10.61333333

SOURCE	DF	TYPE I SS	F VALUE	PR > F	DF	TYPE III SS	F VALUE	PR > F
CS	1	1989.82129870	13.10	0.0005	1	434.17053352	2.86	0.0952
SCH_DIST	1	109.16430629	0.72	0.3994	1	109.16430629	0.72	0.3994

PARAMETER	ESTIMATE	T FOR H0: PARAMETER=0	PR > |T|	STD ERROR OF ESTIMATE
INTERCEPT	22.92510519	2.88	0.0052	7.96295762
CS	-7.50410424	-1.69	0.0952	4.43861620
SCH_DIST	-9.90893631	-0.85	0.3994	11.68868394