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THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

AN ANALYSIS OF THE DISTRIBUTION NETWORK OF INTRASTATE MOTOR CARRIERS IN OKLAHOMA

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

degree of

DOCTOR OF PHILOSOPHY

BY

THOMAS WILLIAM TERBUSH

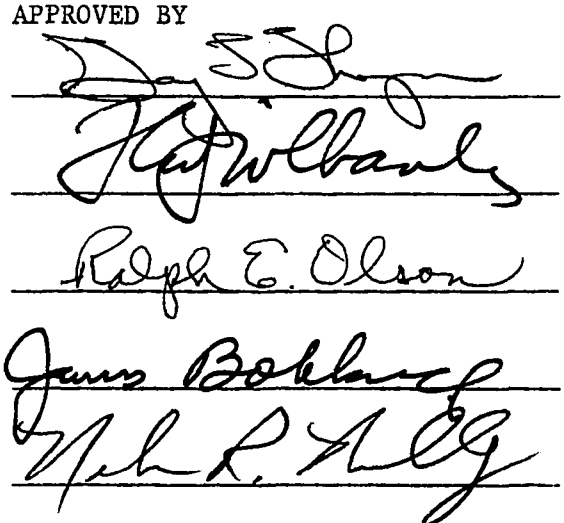
Norman, Oklahoma

1974

AN ANALYSIS OF THE DISTRIBUTION NETWORK OF

INTRASTATE MOTOR CARRIERS IN OKLAHOMA

APPROVED BY



DISSERTATION COMMITTEE

DEDICATION

To an understanding wife and a wonderful mother

JUDITH ANN

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AN ANALYSIS OF THE DISTRIBUTION NETWORK OF INTRASTATE MOTOR CARRIERS IN OKLAHOMA

CHAPTER I

INTRODUCTION

The American trucking industry promotes business by pointing out that the delivery of most consumer products is accomplished by motor carriers. This is particularly true outside the larger metropolitan areas in Oklahoma and similar sparsely settled areas of the United States. This has occurred partially because the railroads have moved away from smaller shipments--the less-than carload traffic that is characteristic of freight moving into smaller communities. As in the past when railroads dominated, the result has been for rural areas to again become dependent upon a single mode of transportation for logistical support.[1] The burden of providing service to rural areas has fallen upon the motor carrier industry, a mode which is well suited to such a demand.

The day-to-day business activity of sparsely settled regions depends primarily upon three types of motor carriers--private, express, and common--to fulfill transportation demand.[2] Although some retail establishments, such as grocery stores, utilize private carriers

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[1]The term logistics is used in this study to describe the total transportation system of an area. A variety of transportation modes may be meshed into a region's logistical support system.

[2]See Appendix A for a description of carrier classification.

almost exclusively, most retail establishments depend upon common carriers, which, combined with express carriers, provide small or emergency shipments. The common carriers which perform most of the services in the rural areas of Oklahoma are the intrastate regular-route common carriers of general commodities. Such carriers are mostly small regional companies operating wholly within the state under authority granted by the Oklahoma Corporation Commission. Most are also registered with the Interstate Commerce Commission enabling them to handle interstate shipments.

The increased dependence upon motor carriers has resulted in a number of problems to the shippers and their receiving customers and to the carriers themselves. On the shipper/receiver side, the three problems of most concern are: (1) claim settlement on lost or damaged shipments; (2) the frequency of service provided by the carriers; and (3) interlining isolation.[3] A problem frequently voiced by the carriers is that small shipments are expensive to handle in relation to their revenue. Small shipments move by common carriers, and, since freight rates are quoted in cents per hundredweight based on weight, value, and density, such shipments may generate less revenue than the costs of handling. Constantin and Smith (1970) found in their study of Oklahoma intrastate common carriers that about forty-six percent of all shipments moved in Oklahoma were minimum weight shipments which accounted for only about fifteen percent of the revenue.

---

[3]Unlike railroads, motor carriers are not required by law to interline shipments, and do so only at their discretion. Interlining isolation results when the larger interregional carriers impose "two line haul" restrictions--i.e., they will not be a party to a joint rate on shipments handled by more than two carriers. This restriction dictates that any freight moving between two communities and handled by three or more carriers must, if it is to move at all, move under the higher combination rate thus economically isolating certain sections of the United States from other sections.

A second major problem facing the carriers has been constantly mounting operating costs and narrowing profit margins. The method used in the past to cope with this problem has been to petition the Corporation Commission for rate increases. While periodic rate increases are justified in an inflationary economy, these increases may possibly mask inefficient and uneconomical operation practices by the carriers as a group. If a rate increase masking inefficient operation is granted, then the people of the area served, in effect, subsidize the carriers. Due to the number of carriers involved and the intricacies of their operations, there are many management practices which may involve uneconomical operations. This study, however, will evaluate only one aspect which seems symptomatic of the industry as a whole--the inefficient areal arrangement of the carriers' operating rights as reflected by the distribution network authorized by the regulatory agencies.

Problem Statement

The research problem is to evaluate the present operating authorities of the intrastate regular-route common carriers in Oklahoma and to suggest structural changes which might provide more economical motor freight transportation for the Oklahoma consumer by reducing the operating costs of the common carriers.[4]

Problems of Spatial Inefficiency

Historically, little attention has been paid to the efficiency of the spatial design of Oklahoma's motor freight distribution system.

---

[4]Operating authorities refers to the operating permit granted to a carrier by a regulatory body to serve a community or number of communities.

Beginning with the state's first regulatory policies in the mid-1920's, the effort seems to have been more concerned with the pieces rather than the puzzle. Most new certificate applications or acquisition proposals have been viewed as separate cases without consequence to the system as a whole. This has resulted in communities being served directly from distant cities rather than from nearby service centers.

An example is the service to five communities in northwestern Oklahoma. The small communities of Gage, Shattuck, Arnett, Harmon and Vici are presently served from Oklahoma City by a carrier as peddle communities.[5] By the shortest routes available to the carrier, each of these small towns is at least one hundred thirty-one miles from Oklahoma City. They all are, however, within thirty-seven miles of Woodward, which is at present being used as a distribution node by a different carrier. Each town is not necessarily served by a separate trip from Oklahoma City, rather they are likely to be served on a single delivery route out of Oklahoma City. Still the minimum length of a single Oklahoma

Table 1

Distance Matrix of Example Towns

From/To	Gage	Shattuck	Arnett	Vici	Harmon	Total
OKC	182	188	173	131	146	820
Woodward	23	31	36	22	37	149
Difference	159	157	137	109	109	671

City delivery route serving all four towns would be three hundred eighty-two miles as compared to an eighty-seven mile delivery route from Woodward.

[5] A peddle community is defined as a community served by a carrier from a terminal located in another community.

Actually, as illustrated in Figure 1, the addition of these communities to the Woodward node would complete a logical distribution loop from Woodward. The freight that originates in Oklahoma City for the towns would simply be added to the freight bound for Woodward each day. The difference between the two delivery routes is two hundred ninety-five miles. This would be eight hundred eighty-five miles per week if, as stated in the firm's schedule, service is provided three days a week. This represents an unnecessary cost of at least $584 a week or $30,373 a year.[6]

The carrier's solution to offering such expensive service to small towns may be to cover costs from more profitable segments of their total systems. It is quite possible that individual carriers have not computed the costs and profits from individual segments. Another possible solution is to apply for a general rate increase, but the most common solution is to decrease service to such communities. If this occurs, freight customers in the affected small towns may realize they are not getting three deliveries each week as promised by the carrier when the route was granted, and may file a complaint with the Corporation Commission. The Corporation Commission then investigates and, if it feels the complaint is valid, admonishes the carrier. In the meantime, merchants of the small communities are quite likely to turn to an alternate form of carrier--the higher priced but more reliable express carrier. This, in turn, diverts more revenue from the common carrier, causing further degeneration of services.

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[6]Based on line haul costs of 66 cents per mile.

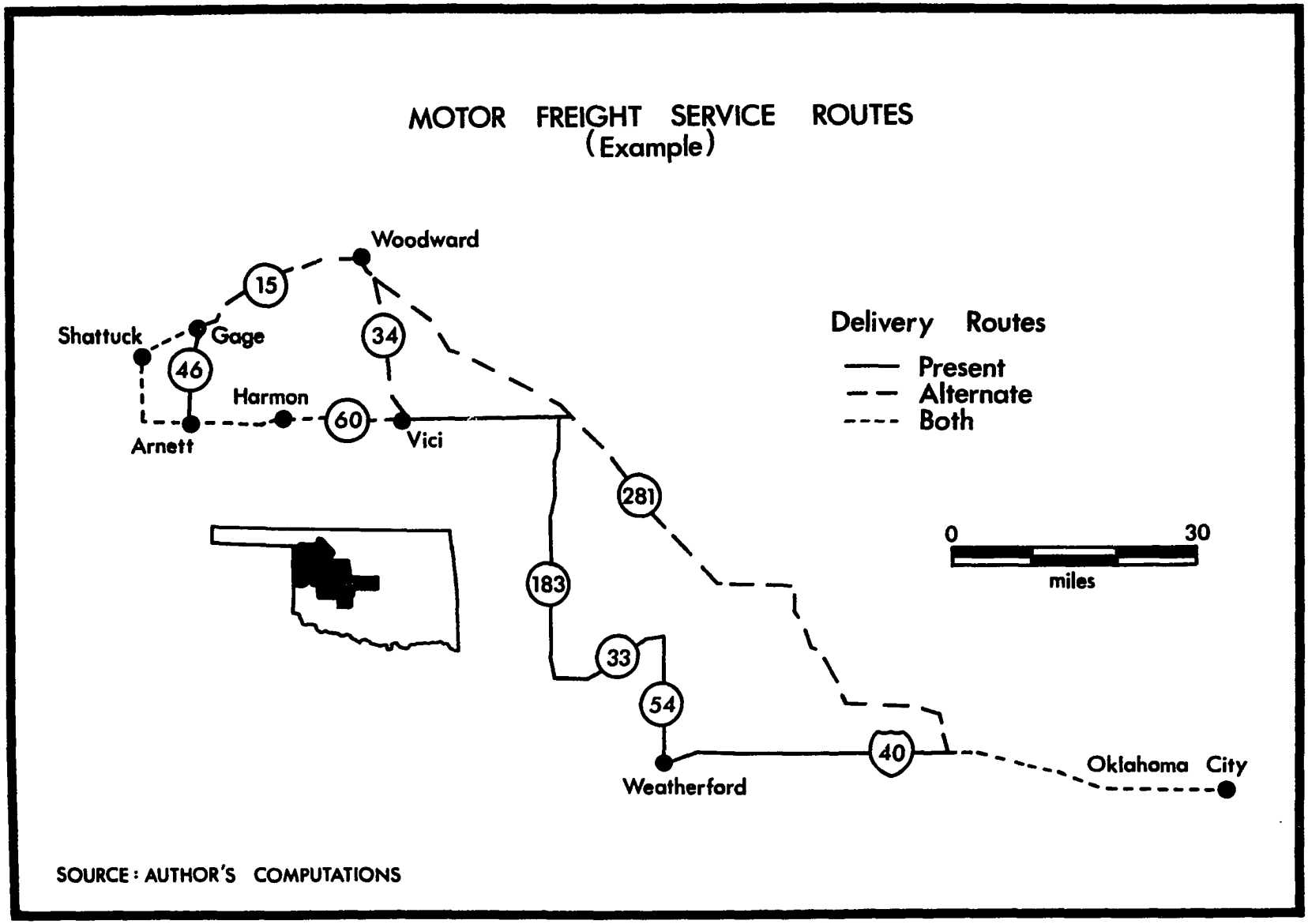

MOTOR FREIGHT SERVICE ROUTES
(Example)
Woodward
15
Shattuck
Gage
34
46
Harmon
60
Arnett
Vici
281
183
33
54
40
Weatherford
Oklahoma City
Delivery Routes
Present
Alternate
Both
0
30
miles
SOURCE : AUTHOR'S COMPUTATIONS

FIGURE 1

Hence, the provision of adequate motor freight service to small towns has deteriorated. Carriers are eager to serve only the larger communities and often make minimal efforts to serve the smaller surrounding communities.[7]

In part, this service problem can be attributed to the present method of granting operating authorities or Certificates of Convenience and Necessity to the Carriers. The present method of granting operating authorities by state and federal regulatory bodies is the "point to point" system. Applications submitted to and granted by a regulatory body are generally for individual communities along a specific highway. This is exemplified by a section of the requirements for petitioning the state regulatory body:

> 7. REGULAR ROUTE, APPLICATION: Attach exhibit "A" describing exact route to be traversed, list of proposed towns to be served, location of proposed terminals, list of towns to be passed through but not proposed to be served, total mileage of route, approximate time of arrival and time of departures from each terminal or way station and all intermediate points to be served. (Attach a map indicating routes already held by applicant and routes sought herein):[8]

When a Certificate is granted, the area of operation is very strictly delineated as indicated by the section of the operationg authority describing the right to serve the five communities used in the previous example:[9]

> 4. Between Oklahoma City, Oklahoma and Erick, Oklahoma serving the off-route points of Durham and Dempsey, and serving all

---

[7]This problem was recognized by Mr. Clyde Moody, Director of the Motor Carrier Division, Oklahoma Corporation Commission in numerous conversations held in August, September, and October of 1972.

[8]Part 7 of the Oklahoma Corporation Commission Form MC F1, titled Application for Common Carrier Certificate of Convenience and Necessity.

[9]The full legal description of the total of the Carrier's Certificate of Convenience and Necessity is in Appendix B and shown in Figure 13.

> intermediate points between Weatherford, Oklahoma and Erick, Oklahoma. From Oklahoma City, Oklahoma via I.H. 40 and U.S. 66 to Weatherford, Oklahoma, thence State Highway 54 to its intersection with State Highway 33, thence State Highway 33 to its intersection with U.S. 183, thence U.S. 183 to its intersection with U.S. 60, thence via U.S. 60 to Seiling, Oklahoma, thence on U.S. Highway 60 to Arnett, Oklahoma, thence north via State Highway 46 to Gage, Oklahoma, thence via State Highway 15 to Shattuck, Oklahoma, thence via U.S. Highway 283 to its intersection with State Highway 33, thence via State Highway 33 to its intersection with State Highway 30, thence via State Highway 30 to Erick, Oklahoma and return over the same route.

The emphasis on the exact location of the route to be travelled in granting operating authorities can be traced to the beginnings of governmental transportation regulation. Railroads, unlike motor carriers, demand exactness of the routeway, for they primarily connect points in linear space along a route that becomes extremely rigid once constructed. The rigidity of the routeway and associated engineering problems in construction were acknowledged by the government and taken into consideration when granting operating authorities. The transference of the concept of a rigid routeway from the railroads to the motor carriers is a result of the motor carrier regulation being, for the most part, based upon the railroad regulation.[10]

The effects of such rigidity on motor carrier operations might be eliminated by shifting the concept of granting authorities from the present linear point to point service concept to one of the regional distribution center with a functional hinterland. Under such a market area philosophy a carrier that requested and was granted rights to serve a specific nodal city would also assume the responsibility of service to hinterland. Evaluating the possibilities of such a new philosophy is the primary objective of this study.

---

[10] A short discussion of the evolution of motor carrier regulation and economic reasons for regulation is the subject of Appendix C.

The goal is to offer a method of reducing the number of road miles necessary to provide adequate freight service to the smaller communities in Oklahoma. It is felt that by using distribution regions, much of the excess line-haul costs of the carriers might be eliminated thus placing the carriers in better financial health and lessening future rate increases.[11] A related benefit would be that of fuel savings. Since fuel consumption is directly proportional to miles travelled, any reduction in total mileage of a distribution system would also have an accompanying reduction in fuel consumption. In the case of the five example communities approximately 10,000 gallons of fuel would be conserved in one year by changing the distribution node. Since this is but one example of many in the state, the amount of fuel saved should be considerable.

Small towns face serious economic problems and a system which withholds motor freight service from them, as the present system does, means that governmental policies are encouraging the continued decline of such places. Perhaps this study can offer a partial solution to the provision of motor freight service to small towns.

A primary consideration of this study is the retention of a free enterprise system--albeit a regulated one--with private ownership of the distribution mechanism. It is felt that competition should be retained where possible to give service incentives and thus protect the shipping public. What is advocated, however, is a planned system, implemented and closely monitored by the regulatory agencies to alleviate or eliminate the inefficient operations and the associated cost to society.

---

[11] Included in line-haul costs are the cost of direct supervision of line drivers; clerical, driver, maintenance, and helper salaries, wages and fringe benefits; fuel and oil; insurance; and depreciation of the life of the vehicle (Constantin and Smith, 1970, 58).

General Outline of the Study

Before the major objective of the study can be attacked, it is necessary to outline the functional organization of the present distribution system and its operating milieu. This is undertaken in Chapter II where the present system is described along with some of its irregularities and inefficiencies. Also, a functional classification of the present distribution system is outlined.

The regionalization model developed in Chapter III utilizes a linear programming solution. Since the standard "transportation problem," a variant of linear programming, could not provide the solution, it was necessary to develop a new approach. The algorithm developed is a departure from those previously used as it selects supply points from a large number of potential points. One of the data inputs into the regionalization model is community demand, for which an easily accessible source does not exist. It, therefore, was necessary to develop a model to provide this data input.

The regional system is outlined and a comparison is made between the costs of the present and the developed system in Chapter IV. Also an example of how the developed system might be implemented is given along with the philosophical changes demanded of regulatory agencies by implementation of such a nodal hinterland system.

Chapter V summarizes and concludes the study. In it, some of the benefits and costs of the adoption of the nodal hinterland concept are discussed. Also possible benefits of the study to areas beyond the scope of the study are mentioned.

This study is intended to make a number of contributions to the field of transportation in an area that has received very little attention--motor

carrier activity in non-metropolitan areas. No previous conceptualization of a hierarchy of towns in a motor freight system has been formulated. The classification system developed for this purpose may be applicable outside the study area of this dissertation. The community demand model developed also marks the first documented effort to ascertain the demand of a community for motor freight transportation. The model used for developing the nodal distribution and collection regions, as previously mentioned, is also a new application of a systematic network design techniques. It is felt that the generated network of nodal regions could result in a substantial savings for the motor carriers and, in turn, for the public. Illustrating the inefficiencies of the present system should, in itself, stimulate the consideration of possible solutions to the problem of providing commodity flow in and out of small towns. It should encourage public officials to assess their actions in granting new authorities or approving transfers in view of the total transportation system within their jurisdiction.

CHAPTER II

THE PRESENT DISTRIBUTION SYSTEM

The Study Area

Oklahoma was selected as the study area for three reasons. One, the state represents a total transportation system when viewed on the intra-state level as the state carriers, with minor exceptions, are restricted by the boundaries of the political unit. Two, the transportation problems encountered are not unlike those found in many other states, as most of the states have similar philosophies of granting operating authorities. And three, personal acquaintance with the problems of motor carriers and their customers in the state has been acquired through six years of personal experience in the Oklahoma motor transportation industry.

Oklahoma's economy is still largely underpinned by primary production—principally agriculture, mineral production, and forest products--which contribute about twenty-nine percent of the state's Gross Product.[1] The state's labor force is only about thirteen percent employed in manufacturing, about half of the national average, and hence the state is a net importer of manufactured goods.[2] With respect to imports of manufactured goods, the state enjoys an advantageous location due to its geographical position with respect to national transportation routeways.

---

[1] Taken from Paul Hagel, et. al., (1973) and Statistical Abstract of Oklahoma, 1972.

[2] Statistical Abstract of Oklahoma, 1972, Table 15.11, p. 223.

Oklahoma is located astride what Becht (1970, 3) calls major routeways (Figure 2).[3] These routeways afford Oklahoma excellent links to other economic regions. The convergence of the routeways has led to the development of Oklahoma City--and to a lesser extent Tulsa—as important consolidation points for transcontinental freight. This function serves the state well as the input of manufactured products from the national economy into the state's distribution system is easily accomplished.

A Functional Classification of Oklahoma's Motor Freight System

The first step in understanding Oklahoma's system of intrastate common carriers is to understand the function of each community in the distribution network. A classification of the communities should assist in the conceptualization of the present system by specifying the nodal connection among communities. Understanding the present system is essential as background to recognizing its inefficiencies.

There are presently thirty-six regular route common motor carriers serving over six hundred Oklahoma communities. Each regular route common carrier operating as an intrastate carrier must file with the Oklahoma Corporation Commission two copies of a detailed Service Schedule for all points which it is authorized to serve. The requirement is set forth in Rule 18, Part B, Paragraphs 1, 2, and 3 of the Rules and Regulations of Motor Carriers (Oklahoma Corporation Commission, 1971, 18) which states:

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[3]He defines routeways as "consisting of two or more (roughtly parallel) routes serving the same two points or terminals."

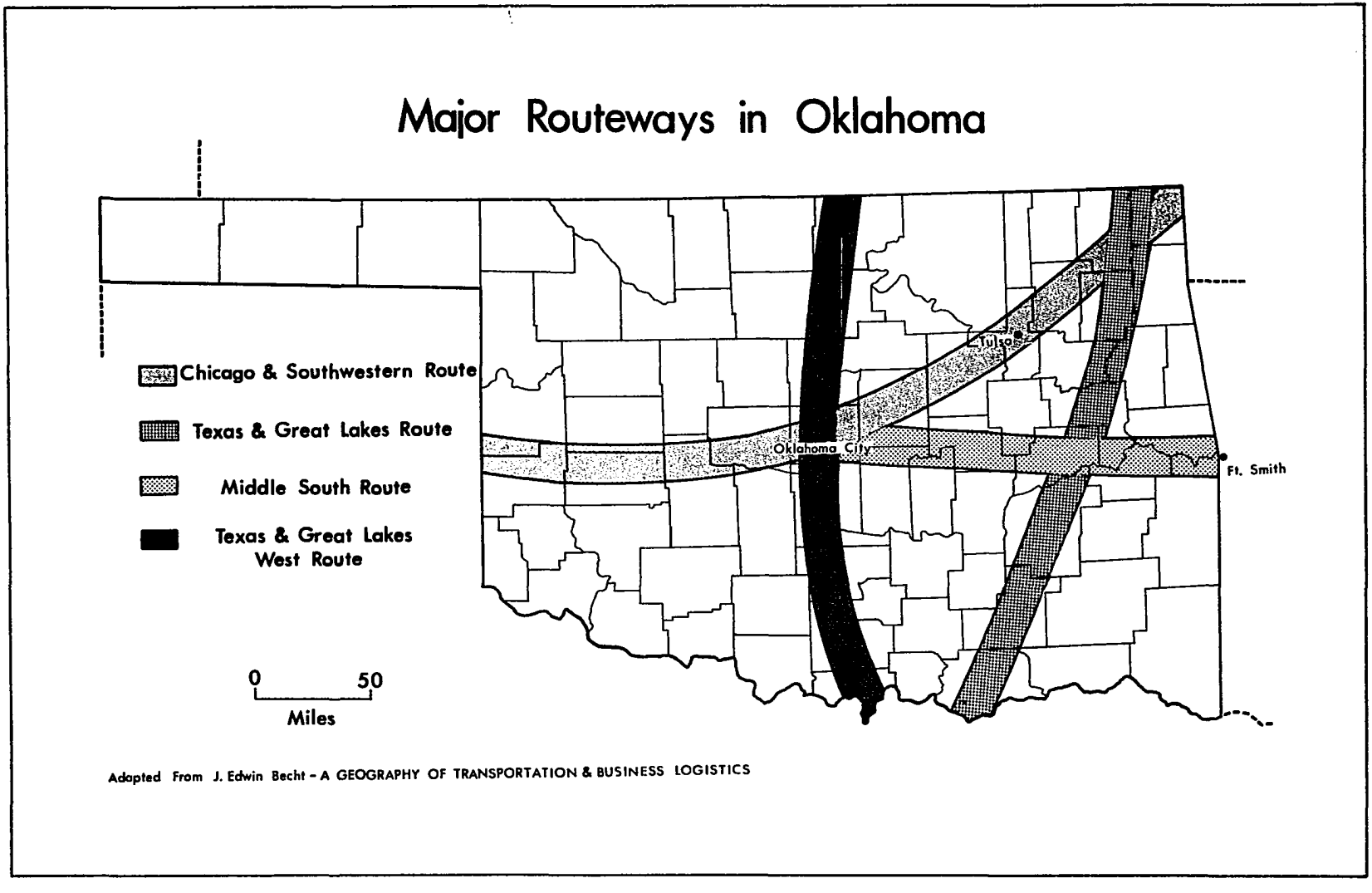

Major Routeways in Oklahoma
Chicago & Southwestern Route
Texas & Great Lakes Route
Middle South Route
Texas & Great Lakes West Route
0
50
Miles
Tulsa
Oklahoma City
Ft. Smith
Adapted From J. Edwin Becht - A GEOGRAPHY OF TRANSPORTATION & BUSINESS LOGISTICS

FIGURE 2

(b) Regular Route Common Carriers of Property:

> (1) Every regular route common carrier of property shall file with the Commission two copies of a detailed service schedule showing every point to be served, and the days of each week upon which service thereto will be performed.
>
> (2) Every change in service schedule shall be filed with the Commission in such fashion that there will be at all times on file, two copies of an accurate and up to date schedule of service actually being performed.
>
> (3) Every regular route common carrier of property shall file with the Motor Carrier Division of the Corporation Commission written notice of intention to discontinue any terminal facility in a town or community at least 15 days prior to effective date thereof. Upon protest or on its own motion, the Commission may order continuation of the operation thereof, pending a hearing upon whether the public will be adversely affected thereby. In such event the cause shall be set for hearing, and such additional notice shall be given as the Commission may direct.

Information available from the service schedule is as follows:[4]

1. Date the schedule was filed.
2. The carrier filing the schedule.
3. Address of the carrier's home office.
4. A listing of the communities served.
5. The days of the week each community is served.
6. How each community is served.
7. The terminal from which each is served.
8. The agent in charge of each terminal.
9. The address and telephone number of each terminal.

From the Service Schedules it is possible to determine: 1) if a community has a transportation facility or terminal, and 2) if a community has a facility, whether it serves other communities. Thus from inspection of the Service Schedules, three different types of communities were identified: 1) communities without terminals,

---

[4]In Appendix D an example of a Service Schedule is given.

2) communities with terminals offering local service only, and 3) communities with terminals that serve the local areas and other communities as well.

How do terminals identified on the Service Schedule receive the freight they distribute? To answer this question interviews, both personal and telephone, were conducted with management personnel. A fourth type of function was identified--terminals that served not only their communities and others but also serve terminals in other communities.

Since it is known from other studies (Constantin, 1965 and Constantin and Smith, 1970) that just over seventy-five percent of all shipments handled by intrastate carriers originate outside of the state, it is necessary to identify the gateway communities where the intrastate system of Oklahoma and the national interstate systems come together in interfaces. This was accomplished by listing the carriers with terminals in each community. Intrastate carriers were then eliminated from this list, thus isolating the interstate carriers.[5]

A sequential order of importance can be used to classify the communities according to their roles in the distribution network according to the transportation function of each. In a hierarchy of towns and cities, different levels of distribution facilities should be found. Six categories were recognizable: 1) peddle communities, 2) local terminals, 3) regional distribution centers (RDC's), 4) minor gateways, 5) intermediate gateways, and 6) major gateways. Since the classification is based upon service considerations and the functions a carrier plays in the community, the classification of a place is determined by its highest order function.

---

[5]The data source for compiling this list was the yellow pages of telephone directories in the state. When uncertainty or question arose, interviews were conducted to settle the issue.

A peddle community has no motor freight terminal. Freight is delivered or, to use a trucking industry term, "peddled" from one or more regional distribution centers. The sizes of the five hundred sixty-three communities in this classification range from over seven thousand to very small rural communities both incorporated and unincorporated.[6]

The criterion for the local terminal classification is the presence of a terminal facility that serves only the community in which it is located. Such a facility receives its freight for intraurban distribution from either an intermediate or major gateway. There are five communities in this classification, ranging in population from 575 to 16,663.

To be classified as a regional distribution center, a community must have a local terminal for intraurban service and also serve at least one peddle community. The thirty-five RDC's have a population range from 1,033 to 52,117.

The minor gateway must have a local terminal and serve as a regional distribution center. It also must have at least one terminal of an interstate carrier with connection to other company terminals outside the state. Stated another way, the community must act as an entry point or gateway into Oklahoma for freight originating in other state. There are ten minor gateways with populations ranging from 3,337 to 74,470.

The intermediate gateways has all the requirements of the minor gateways in addition to serving one or more regional distribution centers.

---

[6]Population figures used are based on the 1970 Census data, the Official Oklahoma Highway map, and the 1972 Rand-McNally Commercial Atlas.

This service consists of sending freight to a Regional Distribution Center for separation and delivery. There are five communities in this classification that range in size from 6,585 to 37,331.

The cities classified as major gateways--Oklahoma City, Tulsa, and Ft. Smith, Arkansas--meet all of the requirements of the intermediate gateways. There are, as seen in Table 2, extreme differences in the number of carriers, both intrastate and interstate, operating facilities in the three cities. The number of these facilities, their size, and their functions in the national interstate system justify the major gateway classification. A summation of the criteria for each classification is given in Table 3.

The connectivity among the various classes is illustrated in Figure 3. There are direct connections among the nodes in the higher levels of the system. Between pairs of all major gateways there are two-way interaction connections. These serve two basic functions: 1) by providing freight movement among businesses in each urban area, and 2) by allowing freight to move from one region of the state to an RDC serving a different region. For the same reason, but on a smaller scale, some connections exist among the intermediate gateways and to the major gateways as shown in Figure 4. The connections of the major and intermediate functions and the RDC and local terminal classifications are given in Figure 5. These connections in some cases, are for more than one carrier. The magnitude of each connection is given in Table 4.

Although two-way connections are present between places of similar rank in the classification system, the freight flow is decidedly down through the system from the gateways to the RDC's, local terminals, and peddle communities. Constantin and Smith (1970, pp. 88-93) found in

Table 2

TYPES OF CARRIERS SERVING LOCAL TERMINALS AND ABOVE

	Type of Carrier			Type of Service						Classification
	Only Intrastate	Both Types	Only Interstate	No. Carriers	RDC'S	No. Carriers	Communities Peddle	Local Term.	Served as a Peddle Community	
Okla. City	21	7	14	18	42	14	138	21		Major Gateway
Tulsa	9	7	15	7	24	7	47	9		" "
Ft. Smith	5	1	9	5	8	2	27	5		" "
McAlester	9	3	1	3	4	6	23	7	2	Intermediate Gateway
Muskogee	6	2	2	2	3	3	38	5	1	" "
Hugo	2		1	1	1	1	8	2		" "
Springfield	1	1	1	1	3	1	6	1		" "
Coffeyville	1	1	2			1	1	1		" "
Liberal	1	1	1			1	27	1		" "
Ada	4		1			2	14	2	2	Minor Gateway
Ardmore	3		4			1	5	1	2	" "
Durant	3	1	2			3	15	3		" "
Enid	5	1	1			5	19	5		" "
Guymon	3	2	1			2	6	3		" "
Lawton	3	2	2			2	20	3		" "
Miami	2	1	2			2	6	2		" "
Ponca City	3	1	1			2	9	2		" "
Tonkawa	3	1				2	14	2	1	" "
Norman	3		1			1	1	1	2	" "
Shawnee	5		1			3	13	3	2	" "
Tahlequah	3	1				2	10	3		" "
Altus	2	1				2	17	2		Regional Distribution
Bartlesville	2	1				1	2	2		Center
Claremore	3	1				1	3	1	2	" "
Cushing	1	1				1	5	1		" "
Henryetta	5	2				1	1	2	3	" "
Nowata	1	1				1	8	1		" "
Okmulgee	3	2				2	5	2	1	" "
Stillwater	2	2				1	4	1	1	" "
Bristow	1	1				1	8	1		" "
Chickasha	1					1	11	1		" "
Clinton	1					1	37	1		" "
Cyril	1					1	8	1		" "
Duncan	1					1	18	1		" "
El Reno	4					2	1	2	2	" "
Fairview	2					1	3	1	1	" "
Hobart	1					1	3	1		" "
Holdenville	4					1	6	2	2	" "
Idabel	1					1	5	1		" "
Lindsey	1					1	19	1		" "
Mangum	1					1	8	1		" "
Okemah	4					1	1	1	3	" "
Pauls Valley	1					1	6	1		" "
Poteau	1					1	23	1		" "
Pryor	2					1	13	1	1	" "
Quinton	1					1	11	1		" "
Seiling	1					1	2	1		" "
Seminole	5					1	1	2	3	" "
Stigler	3					2	9	2	1	" "
Vinita	1					1	4	1		" "
Weatherford	1					1	5	1		" "
Wewoka	5					2	2	2	3	" "
Woodward	1					1	6	1		" "
Boise City	2		2					1	1	Local Terminal
Edmond	2	1						1	1	" "
Guthrie	1							1		" "
McCurtain	1							1		" "
Stilwell	1							1	1	" "

Source: Author's Computations

TABLE 3

CLASSIFICATION CRITERIA

Major Gateway

1. Must have an intrastate carrier terminal for local service.
2. Must serve a minimum of one peddle community.
3. Must serve a minimum of one regional distribution center.
4. Must have a minimum of one interstate carrier terminal.
5. Acts as a national gateway.

Intermediate Gateway

1. Must have an intrastate carrier terminal for local service.
2. Must serve a minimum of one peddle community.
3. Must serve a minimum of one regional distribution center.
4. Must have a minimum of one interstate carrier terminal.
5. Acts as a regional gateway.

Minor Gateway

1. Must have an intrastate carrier terminal for local terminal.
2. Must serve a minimum of one peddle community.
3. Must have a minimum of one interstate carrier terminal.
4. Acts as a regional gateway.

Regional Distribution Center

1. Must have an intrastate carrier terminal for local service.
2. Must serve a minimum of one peddle community.

Local Terminal

1. Must have an intrastate carrier terminal for local service.

Peddle Community

1. Towns served by carriers but without a local terminal.*

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*This does not include such functions that pertain to relay operations, i.e. a place of domicile for road drivers.

Connections Between Community Classifications

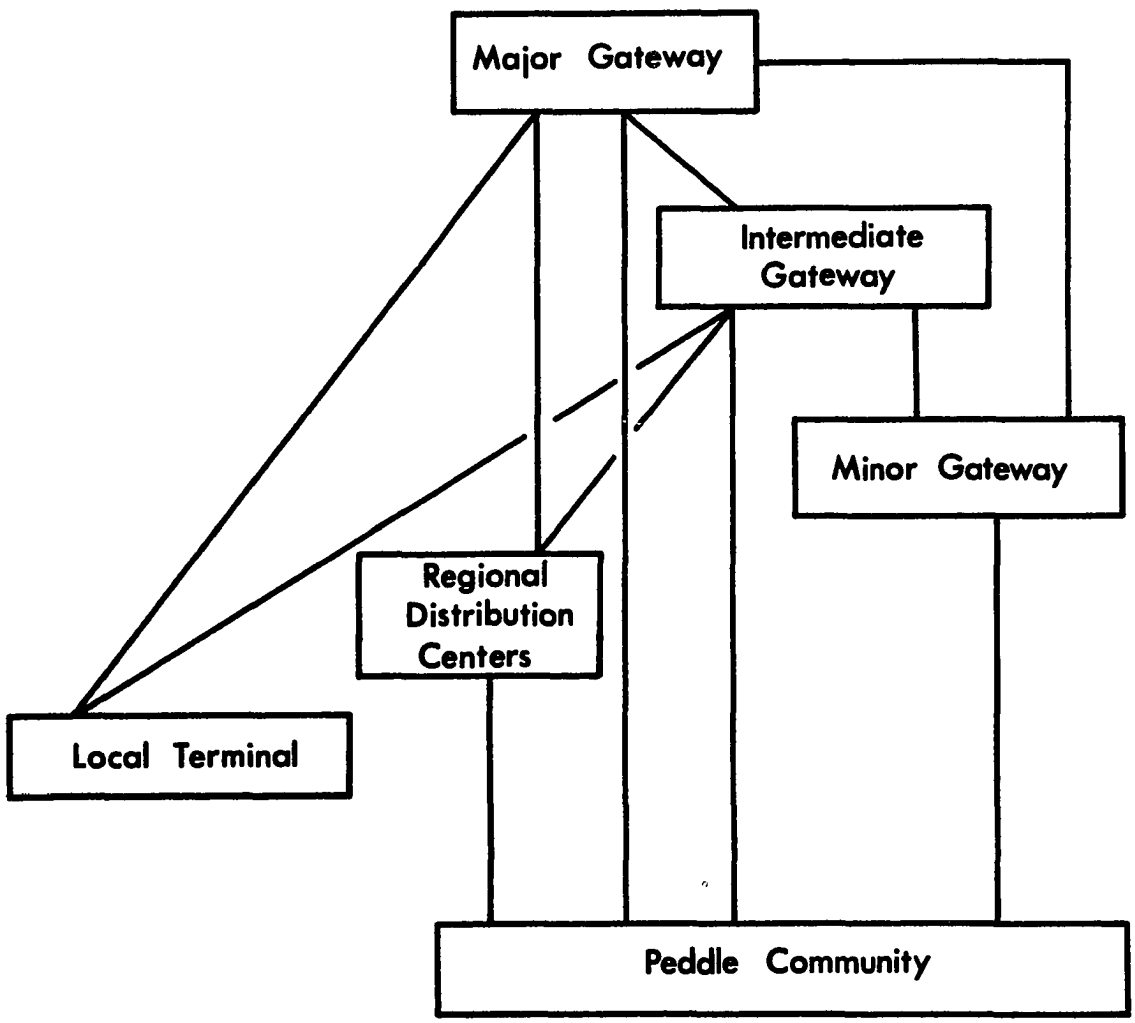


FIGURE 3

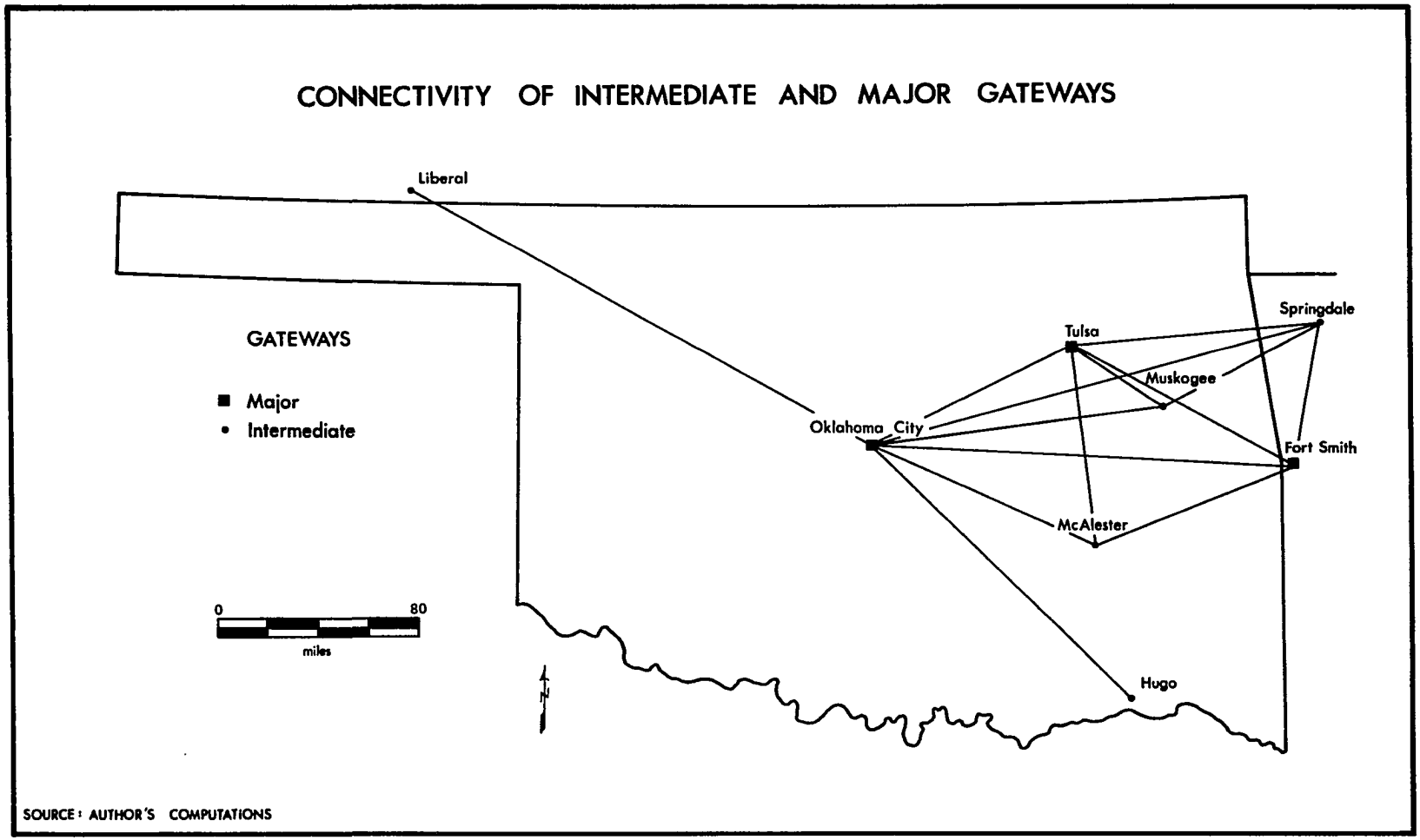
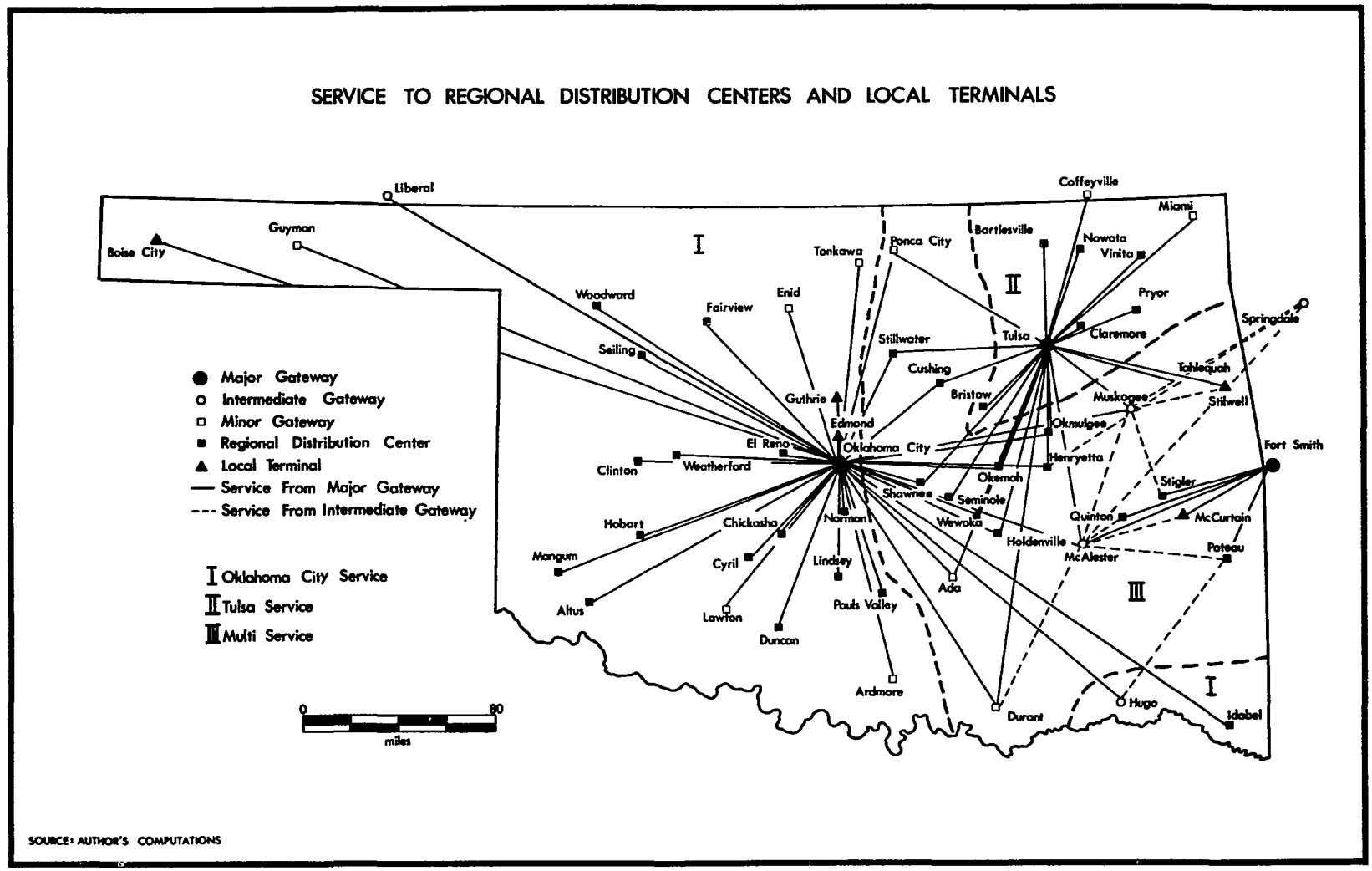

CONNECTIVITY OF INTERMEDIATE AND MAJOR GATEWAYS
Liberal
Springdale
Tulsa
Muskogee
Oklahoma City
Fort Smith
McAlester
Hugo
GATEWAYS
Major
Intermediate
0
80
miles
N
SOURCE : AUTHOR'S COMPUTATIONS

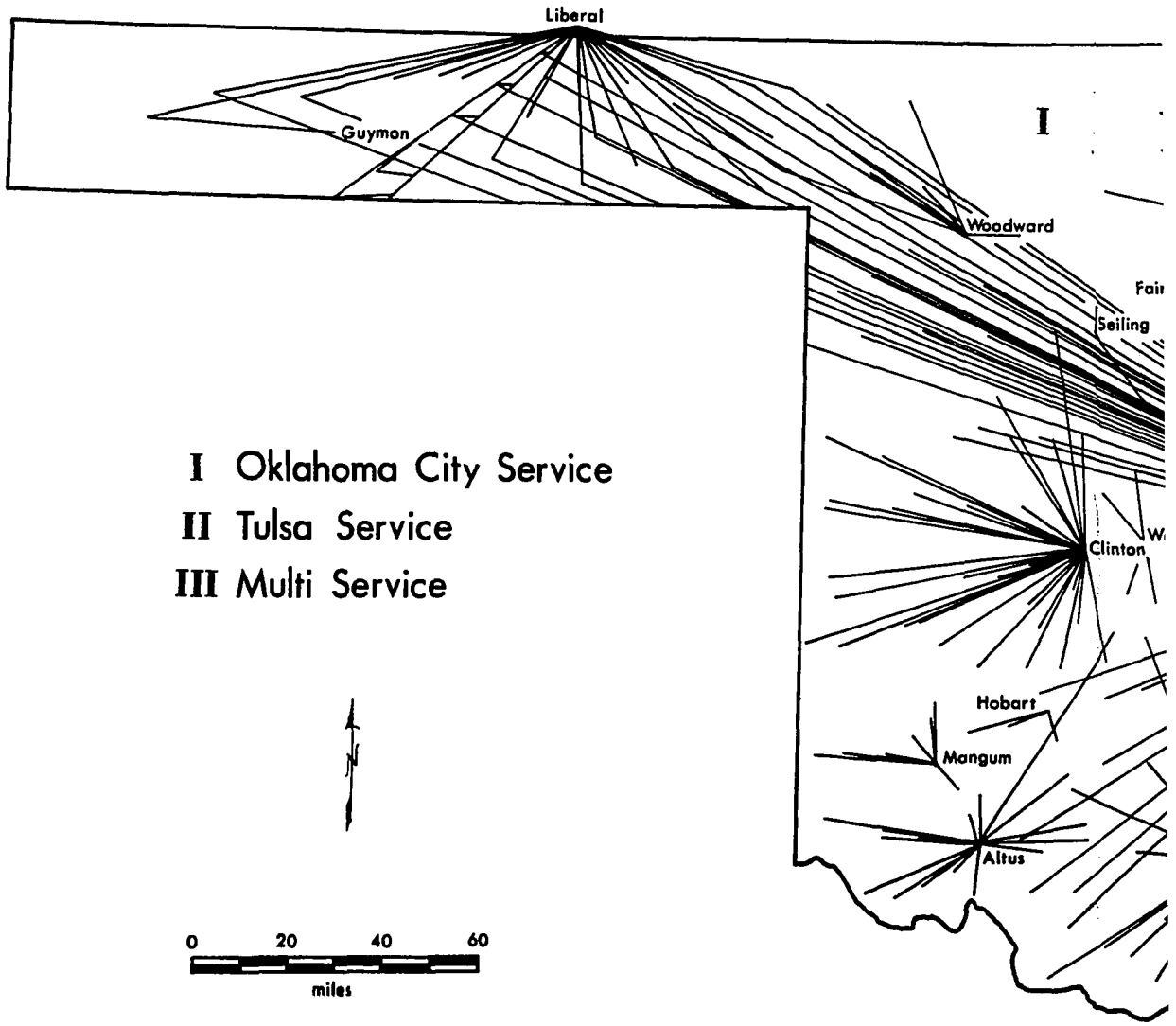
FIGURE 4



SOURCE: AUTHOR'S COMPUTATIONS

FIGURE 5

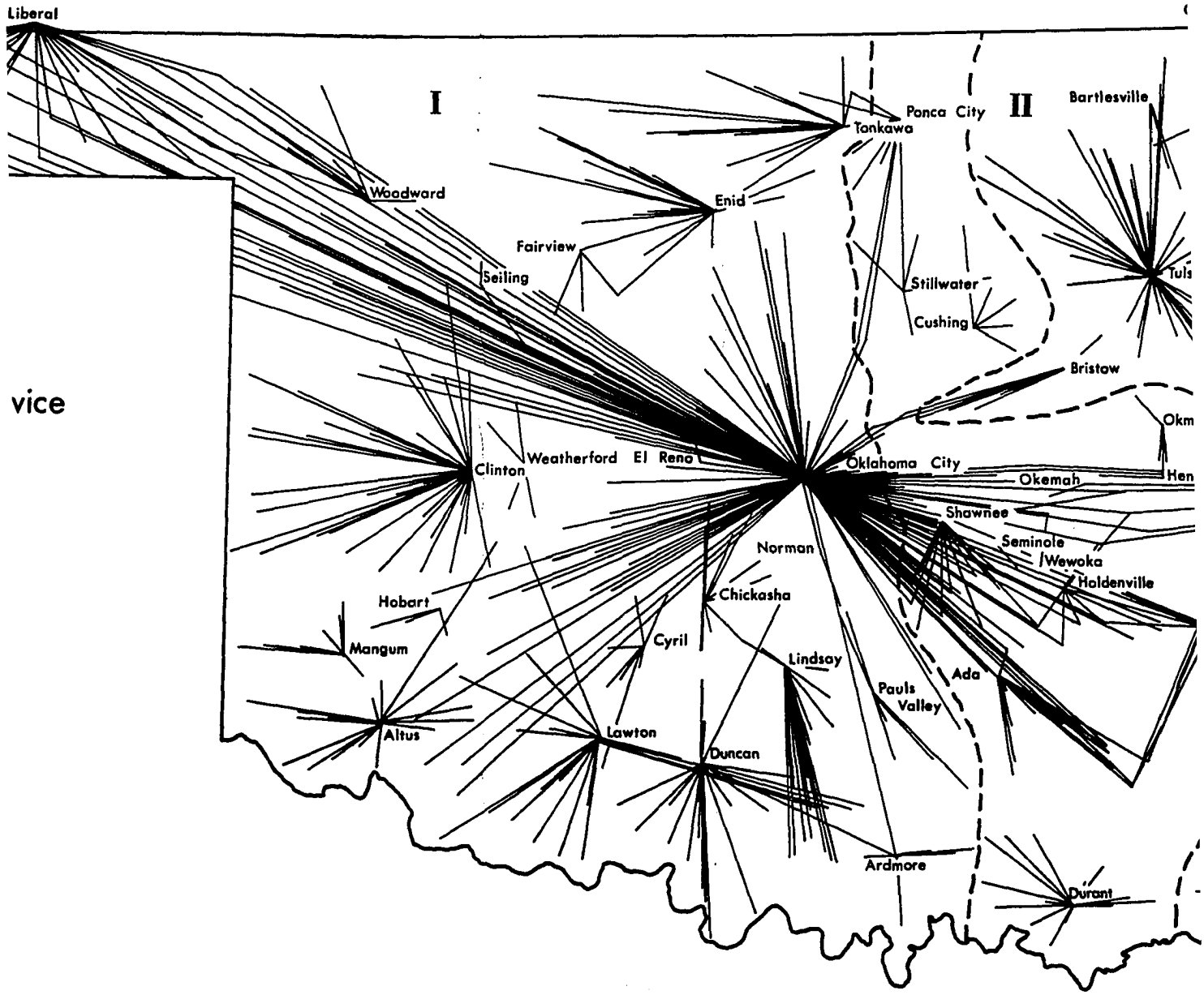
SERVICE TO PED



SOURCE: AUTHOR'S COMPUTATIONS

SERVICE TO PEDDLE COMMUNITIES

vice



E COMMUNITIES

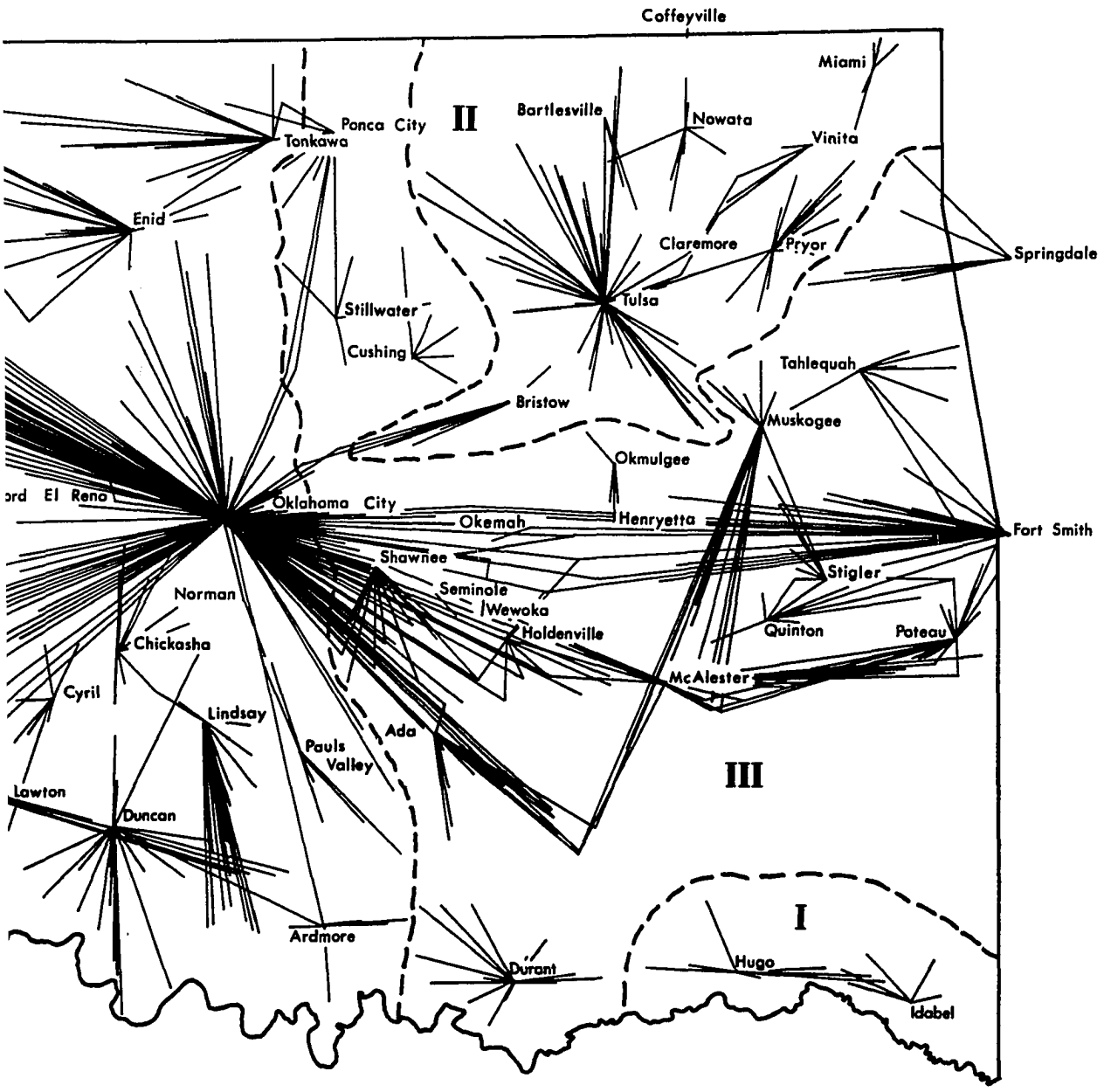


TABLE 4

SERVICE OF REGIONAL DISTRIBUTION CENTERS
(Number of Carriers)

To \ From	Okla. City	Tulsa	Ft. Smith	Muskogee	McAlester	Hugo	Springdale
Coffeyville, Ks.		1					
Liberal, Ks.	1						
Ada	2	1					
Altus	1						
Ardmore	1						
Bartlesville		2					
Boise City	1						
Bristow		1					
Chickasha	1						
Claremore		1					
Clinton	1						
Cushing	1	1					
Cyril	1						
Duncan	1						
Durant	1	1			1		
Edmond	1						
El Reno	2						
Enid	2						
Fairview	1						
Guymon	3						
Guthrie	1						
Henryetta	1	1	1				1
Hobart	1						
Holdenville	2	1					
Hugo	1						
Idabel	1						
Lawton	2						
Lindsey	1						
McAlester	4	2	1	1			1
McCurtain			1		1		
Miami		2					
Mangum	1						
Muskogee	2	3			1		1
Norman	1						
Nowata							
Okemah	1	1					
Okmulgee	1	2					
Pauls Valley	1						
Ponca City	2	1					
Poteau			1		1	1	
Pryor		1					
Quinton			1		1		
Seiling	1						
Seminole	2	1					
Shawnee	3	1					
Stigler			1	1			
Stillwater	1	1					
Stilwell			1	1			
Tahlequah		1	1	1			
Tonkawa	1						
Vinita		1					
Weatherford	1						
Wewoka	2	1					
Woodward	1						

Source: Author's Computations

their study that the backhaul freight moving to the gateways from the small towns is so negligible that it can be ignored. It has been estimated that for the state as a whole the backhaul freight amounts to less than ten percent of the outbound freight in the major gateway terminals.[7]

The Present Distribution Network

The distribution pattern of the Oklahoma intrastate carriers divides the state into three functional regions based on the major sources of freight input to the regional distribution centers. Two of the regions are served entirely by a single major gateway, either Oklahoma City or Tulsa. The third major region is served by all three major gateways and by four intermediate gateways. The regions and service to the regional distribution centers and local terminals have been illustrated in Figure 5.

The Oklahoma City Service Region

The Oklahoma City service region comprises the portion of the state west of a line roughly twenty-five miles west of and paralleling Interstate Highway 35, including the Panhandle, plus the extreme southeastern corner of the state. In this area, additional interstate freight input is distributed through two intermediate and five minor gateways. There are also sixteen communities utilized as regional distribution centers and three local terminals.

The Major Gateway: Oklahoma City

Oklahoma City is important not only in the Oklahoma intrastate network but also in the national interstate system due to its position on

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[7]Personal conversation with carrier personnel.

national routeways. Figure 2 illustrates the point more clearly. The industrial areas of the Northeast and the Great Lakes region are connected to Southern California by the most direct route through Oklahoma City. In addition, the Middle South route joins the Chicago and Southwest routeway at Oklahoma City. The importance of this convergence as a consolidation point for westbound shipments is illustrated by the size of the facilities of three large transcontinental carriers. These facilities serve as major consolidation points for freight moving between the population centers of the Southwest and the manufacturing states of the Great Lakes area and Eastern Seaboard.

A third route of lesser importance but still significant is the Great Lakes and Texas routeway. The branch of the routeway through Oklahoma City is more recent in development, being based on the U.S. Interstate Highway system, and as a result is not as heavily travelled as the shorter but more hazardous route following U.S. Highway 69 in Eastern Oklahoma.

Of the three major gateways, Oklahoma City is the most important to the state's distribution network. There are twenty-one intrastate carriers with facilities in Oklahoma City. Of these twenty-one carriers, nine have their home offices in the city. One of them is among the largest common carriers in the nation. Seven of the carriers also hold interstate authorities with operations ranging from neighboring states to nationwide. In addition to the carriers mentioned above, there are fourteen others in Oklahoma City holding only interstate rights.

The dominance of Oklahoma City in the state system is illustrated by its direct connections with forty-nine of the fifty-five communities

above the peddle community type. Connections exist with all four intermediate gateways, nine of eleven minor gateways, twenty-five of the thirty-five regional distribution centers, and three of the five local terminals. In addition, Oklahoma City serves as a regional distribution center for 138 peddle communities--almost twenty-five percent of the total.

That Oklahoma City dominates its service region is not surprising. It is the largest city of the state and a regional wholesaling center. A majority of the interstate freight enters through its interstate terminals, and it is headquarters for most of the intrastate carriers serving the region. This dominance does, however, create some problems. One problem illustrated on Figure 6, is the tendency for carriers to use Oklahoma City as a large regional distribution center. In many instances, peddle communities could be more economically served from another regional distribution center. This problem occurs mostly in the western part of the state.

A second problem affecting the intrastate carriers of the area is the loss of the interline freight from the interstate carriers that resulted when Oklahoma City and nearby communities expanded their corporate limits. This loss was due to the commercial zone section of the Interstate Commerce Act, Part II, Section 203(B)(9). Although the actual composition of commercial zones are not specifically described in the Act, the ICC in its report and order entitled Commercial Zones and Terminal Areas, (46 MCC 665) (ICC, 1946) established a commercial zone as consisting of:[8]

1. The base municipality.
2. All contiguous municipalities to the base community.

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[8]This section is based on a number of references of which (Kahn, 1958, 29-42) proved to be the most help.

3. All unincorporated areas within:
   a) two miles of the corporate limits of the base municipality when its population is under 2,500.
   b) three miles when the population is between 2,500 and 25,000.
   c) four miles when the population is between 25,000 and 100,000.
   d) five miles when the population is over 100,000, and any incorporated municipality with any part within the limits specified above.
4. All municipalities when wholly surrounded by the base municipality or any other municipality that meet the criteria set forth in parts two and three.

This allows interstate carriers to service shippers in the greater Oklahoma City metropolitan area, thus depriving the intrastate carrier of revenues formerly generated. The interstate carriers interline small shipments of freight to communities without large freight customers, keeping the large shipments for themselves.

The Distribution Region

The distribution region of Oklahoma City consists of about sixty percent of the state's land area and fifty-two percent of the population. The bulk of the region's population is concentrated in four large urban centers--the Oklahoma City metropolitan area, Lawton, Norman, and Enid--with the remainder of the area characterized by small towns separated by great distances. The economy of the region, except that in the extreme southeastern oultier, is supported primarily by wheat, cattle, and petroleum with manufacturing mostly found in the Oklahoma City area.

The nature of the economy of the area causes a very important problem for the carriers operating in the area--an imbalance of the freight flow. Many of the area products exported from the region move through competing modes by railroads, pipelines, private and specialized motor carriers. Thus the typical common carrier has little freight to haul back once the inbound manufactured goods have been delivered.

The settlement pattern causes another problem. The small towns do not generate much inbound freight and since, they are widely separated, they are expensive to serve. The service expense is born almost entirely by the inbound freight due to the lack of signficant outbound freight.

The freight distributed by the regional distribution centers is supplied for the most part by Oklahoma City though some enters the system at the intermediate gateway of Liberal, Kansas and the minor gateways of Guymon, Enid, Lawton, Ardmore, Norman, and Tonkawa. The local terminal at Boise City also has an interface with the interstate system with two interstate carriers having terminals in the community.

Service to southeastern Oklahoma is somewhat anomalous. The region is closer to the other two major gateways and to the intermediate gateways of Muskogee and McAlester than to Oklahoma City. One explanation of its present connection is that the two RDC's, Hugo and Idabel, are part of a carrier's system that operates in a much larger portion of south-central Oklahoma. The area was once isolated from the other RDC serving terminals by lack of good roads across the Ouachita Mountains. Although now there are good roads through the mountains, when the motor carrier routes were initially developed the easiest means of ingress was from the west and hence the extreme southeastern corner of the state was a logical extension of the authority of the carrier operating in south-central Oklahoma.

The economy of the southeastern sector is in part based on the harvesting and processing of the timber in the area. The importance of forest products to the area is illustrated by the fact that over fifty percent of the area's industrial concerns listed in the 1972 Oklahoma Directory of Manufacturers were based upon timber, (Oklahoma Industrial

Development and Parks Department, 1972). Many of the remaining manufacturing plants have moved into the area or were developed to utilize the underemployed female work force of the area.

The Tulsa Service Region

Tulsa, as Oklahoma City, is located on the Chicago and Southwest routeway and as such serves as a national gateway for freight moving into the state from these areas. It is also located on the Great Lakes and Texas routeway, actually just to the west of one of the major routes, U.S. Highway 69. It is, however, close enough to the routeway to have some limited consolidation and rehandle operations of national and multi-state carriers.

From Tulsa, nine intrastate carriers serve twenty-four terminals in other communities and forty-seven peddle communities. Of these nine carriers, six are headquartered in Tulsa and four have interstate rights as well as intrastate. In addition, there are fifteen other carriers with interstate rights only located in Tulsa. As in the case of Oklahoma City, many of these carriers are among the largest in the nation, but their Tulsa-based operations are of a lesser magnitude than those found in Oklahoma City. The Tulsa operation of the interstate carriers are smaller in scale than those in Oklahoma City because Tulsa is located on only two major routeways.

The Tulsa Distribution Region

The area served exclusively by Tulsa is considerably smaller than the Oklahoma City region. It is a compact area with about twelve percent of the state's land area and approximately one-fourth of its population. As in the Oklahoma City region the population is concentrated in the

metropolitan area. In comparison with the Oklahoma City region, however, the area outside the metropolitan area generally has a higher population density.

The economic base differs from that of western Oklahoma with agriculture being less dominate than manufacturing. In addition to the economic functions normally found in a city such as Tulsa, manufacturing is a major contributing factor to freight generation. Many of the smaller communities in the eastern section also have major manufacturing concerns. While petroleum is still the most important extractive industry and is found throughout the area, mining has been important in the eastern section. Most of the interstate freight enters the system at Tulsa with some coming in through the minor gateways of Miami, Oklahoma and Coffeeville, Kansas. In addition to peddle communities served, Tulsa also is the only source of freight for RDC's in the area. The backhaul problem faced by carriers in most parts of the Oklahoma City region is less intense in the Tulsa region with the major problem occurring in the sparsely settled western section. The compactness of the Tulsa area plus the manufacturing specialization have made the region quite attractive for the motor carrier. The carriers of the region are reasonably well organized but in some cases service to a community is offered by more than one carrier. This duplication of service is not harmful if the community can economically support more than one carrier. It can, however, be harmful when neither of two carriers is covering its cost of operation because the demand is insufficient to support more than one.

The Tulsa-Oklahoma City Interface Region

In the north central section of Oklahoma, between the areas served

exclusively by Oklahoma City and Tulsa, there exists a region served by both the major gateways. This area, which has just over four percent of the state's area and population, has its peddle communities served by two RDC's and one minor gateway. The two RDC's, Cushing and Stillwater, are utilized by the same carrier and receive freight from both major gateways. This efficient operation allows the carrier to distribute freight into the area which originates in either major gateway, with minimal major gateway-RDC mileage. The minor gateway, Ponca City, also has connections with both Oklahoma City and Tulsa though by different carriers. It is also served from an intermediate gateway, Tonkawa, as a peddle community.

The Multi-Service Region

Occupying most of the southern two-thirds of eastern Oklahoma, the Multi-Service region contains about eighteen percent of the state's population and almost one-fourth of its area. The region is quite diverse economically. The agricultural economic base was supplemented in the early years of statehood by the development of extractive industries, at first coal and later petroleum. The latter activities tended to draw manufacturing concerns into the area earlier than the other areas discussed. The industrial employment has continued to increase in the larger urban places. The area, however, continues to have a substantial number of persons either unemployed or underemployed.

The region is also the most diverse of all regions in its intrastate distribution system. Crisscrossed by two major routeways--the Texas and Great Lakes Route and the Middle South Route--the region is under the peripheral service influence of all three major gateways--Oklahoma City on the west, Tulsa on the north, and Ft. Smith on the east. All serve

area terminals with RDC functions as do the internal intermediate gateways of Hugo, McAlester, Muskogee, and Springdale, Arkansas. In addition, interstate freight can enter the region at three minor gateways.[9]

Peddle community service is accomplished by all major gateways, the above mentioned intermediate and minor gateways, and eleven regional distribution centers. Some peddle communities are served from several RDC's and by a number of different carriers.

In the area there exists considerable manufacturing activity, which diminishes the backhaul problems of the carriers. However, duplication of service is a definite problem in the region. The carriers, in the eastern section especially, have concentrated their service on major highways, leaving many communities without service.

Analysis of the Present Distribution Pattern

Evolution of the Present Network

The peddle community service vectors (Figure 6) indicate the effect of major highways upon carrier distribution routes. This can be explained by the development of the road network, technological changes in equipment, and expanded operations of carriers.

Travel interaction occurs largely between urban places, and since the railroads have influenced the location of many Oklahoma towns, the earliest vehicle roads followed the railroads. In time, the highways became important as local connectors and regional arterials. Many communities connected by both the railroads and highways have propsered--often at the expense of nearby communities located in the transportation interfluves.

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[9]Appendix E consists of a table giving the magnitude of each link between intermediate and major gateways and terminals with an RDC function.

The second phase of road development was the construction of interconnecting links which facilitated movement between the railroad-highway routes. Finally, high priority links developed that connected different regions or important urban nodes. These high priority linkages were constructed across the earlier grids in such a manner as to provide more direct access to the regions or nodes.[10]

Accompanying the development of the road network were the technological advances of the automobile and truck. These advances effectively increased the traveller's range. He could now, in the same length of time, visit the more distant trade centers which offered specialized services. The convergence of time-space accelerated the decline of many of the interfluve communities and even some communities along the major routeways.

During the same period, technology supplanted the horse-drawn freight wagon and stagecoach with the motor truck, thus giving birth to the motor carrier industry. As previously outlined the early motor carriers were small concerns with limited service areas. Unrestricted before regulation, the improved equipment and better road enabled them to expand their territories wherever there was a market for their services. When regulation arrived in 1935 and authorities delimiting the carrier's operations were required, the carriers were able, under the Grandfather Clause, to receive legal authority for their concurrent operations (Interstate Commerce Act, Part II, 206(A)).[11] This resulted in a large number of small carriers serving local regions. Since expanded

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[10]This section relied heavily upon the works of Taaffe, Morrill, and Gould (1963), Taaffe and Gauthier (1973) and Hurst (1972) to supplement the author's practical knowledge of Oklahoma highway development.

[11]A brief history of transportation regulation is included as Appendix C.

operations required new authorities, the more ambitious carriers began acquiring the operating permits of small carriers to give them acess to new markets. This was usually along the railroad-highway routeways and their connecting links. It is the retention of the service to communities along these major routes that causes highways to stand out so clearly on Figure 6.[12]

The Nodes

The development of most distribution nodes in the network is quite logical. In the change of the Oklahoma cultural landscape from its Army fort and Indian reservation time to today, certain communities evolved into higher central places for reasons beyond the scope of this study. The order of communities in the motor carrier distribution network roughly corresponds to the size and function of the communities. The major gateways are located in large metropolitan centers, intermediate gateways in smaller regionally important cities, and on down the classification. Functions that might be anticipated, however, do not always occur in the lower-order places.

The deviations of regional distribution centers from locations in congruence with the central place system can be explained by one or more of the following: 1) historical inertia, 2) personal preference, or 3) inefficient carrier management. Historical inertia occurs when the carrier's operation changes by addition of operating rights, but the carrier does not move the RDC function to a more efficient location. This could be for a number of reasons--unwillingness to take chances on capital losses

[12]Based upon conversations with a number of motor freight industry personnel and Hudson and Constantin (1958).

which could result in selling and repurchasing terminal properties, unwillingness of owner to move his family to another town, or the fact that the carrier may not recognize changing population patterns.

The second personal preference, occurs mostly with small lines. The owner upon acquisition of a carrier may decide to make his hometown the major RDC for the line with the judgment made on the basis of personal values.

Another departure from the expected can be explained by a type of carrier operation. To operate a RDC away from the home terminal, some carriers utilize what is known as a commission agent. The carrier contracts with an individual to deliver and pickup the carrier's freight for a commission. This can be quite rewarding financially if the RDC is located in a "good freight town" with a limited hinterland. In some instances, however, this is not the case and the carrier is faced with finding someone to do the job in the community or a nearby town. One example is an RDC which has changed from one community to another about twenty miles apart every few months for a period of about three years.

Irregularities of the Present Distribution System

Certain facets of the present system appear discordant with a more carefully planned system. Some of the irregularities are: 1) service by one RDC to a peddle community nearer to a second RDC, 2) duplication of service, 3) lack of any intrastate service to a community, and 4) the closed door effect.

One of the most striking irregularities is service to peddle communities beyond an intervening regional distribution center. This problem is readily apparent when viewing Figure 6. Many of the RDC's

serve at least one peddle community within the sphere of a second RDC. This most frequently occurs with service from Oklahoma City, especially in the northwest and southwest areas of the state, and in the eastern section of the Multiple Service region. This is partially explained by the general lack of appreciation of the spatial aspect and planning by the Corporation Commission when granting or approving the transfer of operating authorities. The present emphasis is on the actual route to be travelled and not on the total distribution system or even the total system of the carrier.

This emphasis has also resulted in the second irregularity found in the present distribution system. Along the regional connector highways it is not uncommon to find communities, even the smallest, served by a number of carriers. On the other hand, a carrier not wanting to deliver the small amount of freight demanded by a small community, may decide to let the others perform the service. This results in poor, or non-existent service to such communities.

The reverse happens if the community has a freight generating activity. In this case, the carriers want the business and compete for it. In such an instance, it is possible for higher not lower transport costs to result from the competition as each carrier handles but a portion of the total shipments. Often such portions are not enough to produce the return necessary for continued operation, however, and a rate increase is sought and granted on the basis of high operating costs.

A prominent irregularity of the present distribution system is the lack of any service by intrastate carriers to many of state communities. The populations of most of the communities lacking service are small as indicated by Table 5 and Figure 7.

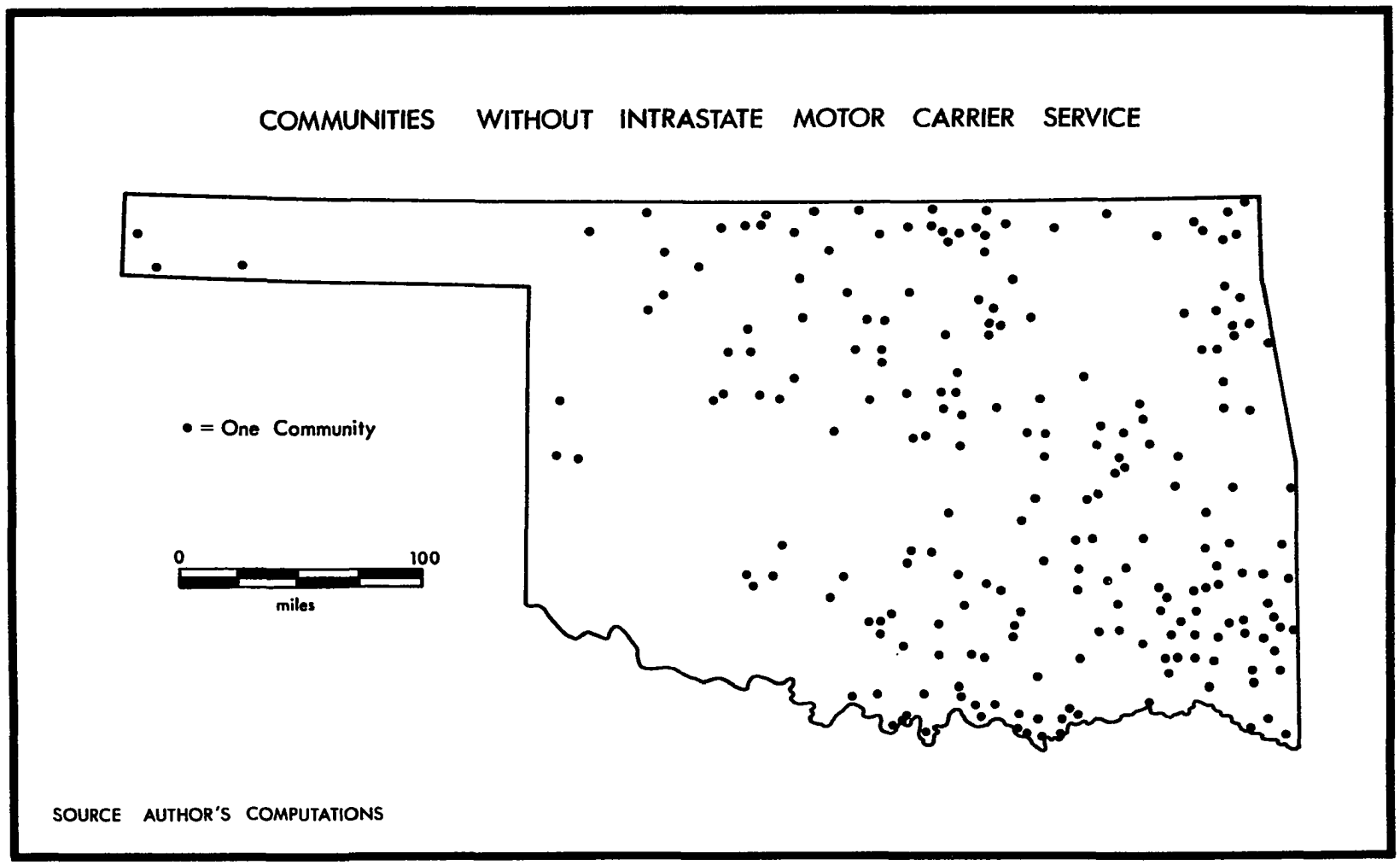

COMMUNITIES WITHOUT INTRASTATE MOTOR CARRIER SERVICE
• = One Community
0
100
miles
SOURCE AUTHOR'S COMPUTATIONS

FIGURE 7

TABLE 5

COMMUNITIES WITHOUT INTRASTATE CARRIER SERVICE

Population Range	Number of Communities
Rural	7
0 - 50	50
51 - 100	51
101 - 200	59
201 - 300	22
301 - 400	13
401 - 500	7
501 - 600	2
601 - 700	2
Above 700	4
TOTAL	217

Source: Author's Computations

Many of the communities without service are located away from major highways. When a community is quite small, usually its retail establishments are also small, with low freight demand, and hence carriers usually do not seek authority to serve the community unless it is located on a route between two larger freight-producing communities. From a carrier's viewpoint this is understandable, as to meet costs in delivering a single shipment to a community ten miles away from a highway requires the carrier to handle a seven hundred fifty pound shipment of Class 100 goods.[13] The probability of a small town receiving a shipment that size is quite small. Constantin and Smith (1970) found that only about seventeen percent of the total shipments moving in Oklahoma are over seven hundred fifty pounds.

While the lack of service to small off-route communities can be understood in light of the above explanation, it is difficult to understand

[13]This is using cost data developed by Constantin and Smith (1970) that has been inflated by fifteen percent to approximate current cost and is probably an underestimate. Class 100 goods include most general merchandise.

why the larger communities are not served. This is especially true for Newkirk (population 2,173) within thirteen miles of Ponca City on a major highway and Morris (1,119) seven miles from Okmulgee.

The last irregularity, the closed door effect, is exemplified by the operation of a carrier operating out of Ft. Smith, Arkansas. Frieght destined to communities served by the carrier can only be delivered from Ft. Smith. This is reasonable for freight generated in Ft. Smith but when freight is picked up in Oklahoma City, hauled to Ft. Smith, then returned to communities within seventy miles of Oklahoma City the system becomes somewhat less than economically efficient.

Effects of Present Irregularities

Since the motor carrier industry is privately owned and operated to produce a return on investment, any excess cost due to inefficient operation is passed on to the users fo the system and ultimately to the consumers. The inefficient operation of any one carrier or the industry as a whole resulting in unnecessary costs presently affects the public in two ways.

For the industry as a whole, the basic tariffs, or rates, are uniform. For example, it costs the same amount to ship two hundred pounds of shoes to any point that is equidistant from the origin point no matter which carrier is used. When rate increases are granted, they are for the industry as a whole, not just for one carrier. Thus it is possible for the excess costs of a few carriers to be born by all citizens of the state.

The second way the public is affected is by unreliable service. This can result from the problems discussed above, or extended operations

by a carrier as in the example in Chapter I, or by deliberate design of a carrier wishing to concentrate only on the "good freight towns." Regardless of the contributing cause, merchants in a community affected must find an alternate source of transportation. This may necessitate travel by the merchant to his source of supply in his own vehicle, reliance upon wholesaling firms owning their own delivery fleet, or turning to an alternate public carrier. Although the first two alternatives find some use, it is the last one that is often considered and the carrier engaged is the common carrier engaged in express service.

Such express carriers operate under a separate tariff schedule that is more costly, and they specialize in smaller shipments. They are, in Oklahoma, quite well organized and offer reliable service. For small shipments the express carrier is less expensive than the common carrier (Table 6). As an example, using the rates on shoes or other Class 100 freight between Guymon and Oklahoma City, it is seen that the cost advantage of the epxress carrier disappears for shipments over ninety-nine pounds.

The rate of the express carrier is constant regardless of volume--$5.20 per cwt. In contrast, the rate of the common carrier is reduced with increased weight of the shipment. The rate on shipments of less than 1,500 pounds is $3.62 per cwt. The charge is reduced to $3.36 for shipments of between 1,500 and 2,500 pounds, and there is another reduction at 2,500 pounds to $3.23. In addition there is a volume rate for shipments of over 20,000 pounds.

From Table 6 it is apparent that it becomes more expensive for the merchants of a community if they have to rely upon the express carrier. This, in turn, is passed to the people of the community.

TABLE 6

RATES TO GUYMON, OKLAHOMA FROM OKLAHOMA CITY FOR COMMON CARRIER AND EXPRESS CARRIER
(Class 100 goods)

Weight	Common Carrier		Express Carrier		Difference
	Rate	Cost	Rate	Cost	EC-CC
1	5.15*	5.15	1.28*	1.28	-3.87
50	5.15	5.15	5.20	2.60	-2.55
99	5.15	5.15	5.20	5.15	0
100	5.15	5.15	5.20	5.20	.05
142	3.62	5.15	5.20	7.38	1.35
150	3.62	5.43	5.20	7.80	2.23
175	3.62	6.34	5.20	9.10	2.76
200	3.62	7.24	5.20	10.40	3.16
300	3.62	10.86	5.20	15.60	4.74
400	3.62	14.48	5.20	20.80	6.32
500	3.62	18.10	5.20	26.00	7.90
1,000	3.62	36.20	5.20	52.00	15.80
1,500	3.36	50.40	5.20	78.00	27.60
2,500	3.23	80.75	5.20	130.00	49.25
20,000	2.02	404.00	5.20	1,040.00	636.00

*Minimum rate
Source: for Express Carrier, Mistletoe Express; Common Carrier, Mr. T. J. Blaylock of T.I.M.E.-DC, Inc.

In summary, the excess cost resulting from inefficient operation can and does inhibit growth and damages the economic health of communities and, at times, entire regions. It is the contention of this study that the main contributing factor causing illogical and uneconomical operation in the distribution system of the intrastate carriers is the present outdated method of granting operating authorities, a situation which might be corrected by the methods advocated in the following chapters.

CHAPTER III

THE REGIONAL TRANSPORTATION MODEL

Introduction

The solution to the problem of developing a motor freight system based on distribution nodes and surrounding functional hinterlands is best accomplished by the use of linear programming. Since the "transportation problem" was first formulated by Hitchcock (1941) and Koopmans (1951), it has found a large number of applications, primarily in business and engineering. In geography, the transportation problem has been used to arrive at solutions to a number of problems. Both Scott (1971) and Massam (1972) have written Resource Papers in the Association of American Geographer's Commission on College Geography Series presenting overviews of the technique as applied to spatial problems.

Structure of the Model

The classical transportation problem is used to solve problems in cases with a series of demand points being satisfied from a series of supply points, the objective being to minimize travel distance, hence costs. It has the general form:

Minimize:

$$C = \sum_{i=1}^{n} \sum_{j=1}^{m} t_{ij} x_{ij} \qquad (1)$$

With the objective function being subject to the following constraints:

$$\sum_{j=1}^{m} x_{ij} \leq S_i \qquad (2)$$

$$\sum_{i=1}^{n} x_{ij} = D_j \tag{3}$$

$$x_{ij} \geq 0 \tag{4}$$

Where:

C = Total costs

n = number of supply points designated

i = 1, 2, ..., n

m = number of demand points designated

j = 1, 2, ..., m

t_{ij} = unit cost of moving from i to j

x_{ij} = flow of goods from i to j

S_i = supply capacity at the i^{th} supply point

D_j = total demand of j^{th} point

Thus, it is the function of the transportation problem to minimize the transport costs of supplying "m" demand nodes from "n" supply points. The objective function (1) is subject to the constraint that the flow from any supply point must be equal to or less than the capacity of that supply point (2) and the total shipments equal the total demand at any one demand point (3) where all flows must be positive numbers (4).

The study problem is not precisely similar to the now classical transportation problem expressed above. Where the above model requires known supply points, the study problem requires a method of selecting the supply points. Where the classical transportation problem has supply points with limited capacity, the study problem has supply points where supply increases as demand increases. These two differences necessitated finding an alternate method for solving the problem.

The algorithm developed is of the form:

Minimize:

$$TC = \sum_{i=1}^{n} \sum_{j=1}^{m} d_{ij} C_{ij} \tag{5}$$

Constrained by:

$$D_k \geq MDL \tag{6}$$

where:

$$D_k = D_i + \sum_{j=1}^{m} D_{ij}$$

$$d_{ij} > 0 \tag{7}$$

$$S_i = D_k \tag{8}$$

and with

TC = total costs

n = number of Regional Distribution Centers from

$i = 1, 2, \ldots, n$

m = number of Peddle Communities from $j = 1, 2, \ldots, m$

d_{ij} = distance to i^{th} RDC from j^{th} PC

C_{ij} = cost of moving to i^{th} RDC from j^{th} PC

D_k = demand of i^{th} RDC Region

D_i = demand of i^{th} RDC

D_{ij} = demand of j^{th} PC assigned to i^{th} RDC

MDL = minimum of demand level

S_i = capacity of i^{th} RDC

The Operational Model

The solution of the problem is achieved by the development of an operational model of the type outlined in Figure 8. Before the model can be operationalized, four steps are required: 1) the selection of an initial group of communities as possible regional distribution points; 2) construction of a cost matrix; 3) weighting of major gateways; and 4) a demand for each community in the study area.[1]

Selection of Potential Regional Distribution Points

The list of potential regional distribution points was compiled by selecting all Oklahoma towns of more than two thousand persons in addition to those towns in the present distribution system functioning as regional distribution centers (or higher). Each county seat was also included. The list was then edited to omit those communities which were part of a contiguous metropolitan zone as defined by the ICC.[2] The resultant list of RDC's was composed of 111 Oklahoma communities plus Liberal and Coffeeville, Kansas and Ft. Smith and Springdale, Arkansas for a total of 115. This preselection limits the solution to being only a least cost solution for the communities selected. It does not necessarily represent a global solution.

The Cost Matrix

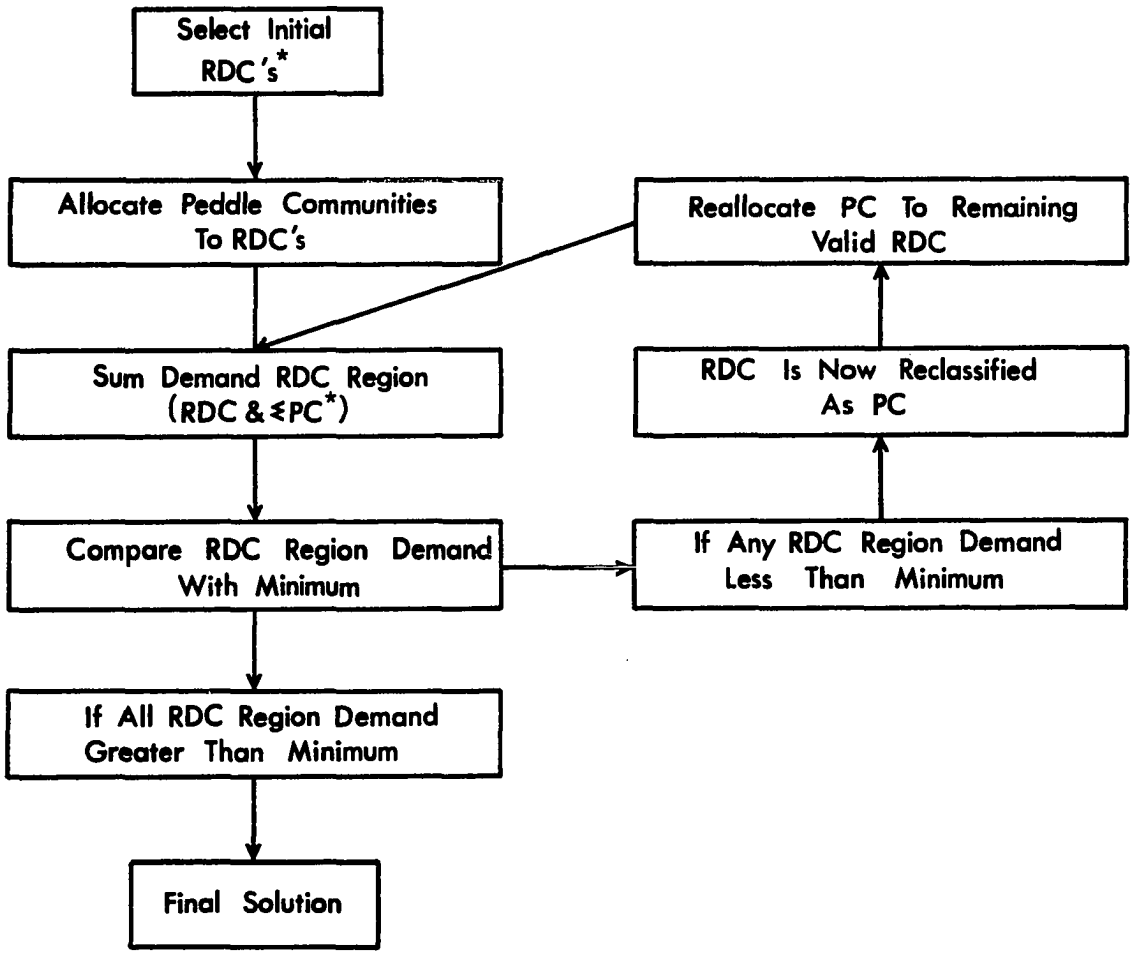
The cost matrix constructed was of the size (115 x 813) where the columns were the potential RDC's and the rows were the potential RDC's

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[1] A discussion of the computer program and the program itself is the subject of Appendix G.

[2] See page 28 for definition of the contiguous metropolitan zone.

REGIONAL TRANSPORTATION MODEL



*Regional Distribution Center

*Peddle Communities

FIGURE 8

plus the remaining communities. It was necessary to include the potential RDC's as possible peddle communities in the matrix because many would not qualify as RDC's due to low demand levels in the local areas. The cost matrix was constructed by using a computer program based upon the Dijkstra algorithm for finding the shortest path through a network.[3] The network used was the highway system of Oklahoma. Since the line haul costs were essentially linear (Constantin and Smith, 1970, p. 78) distance was not translated into cost at this point, as it was preferable to wait to perform these computations until after the matrix was reduced from a [115 x 813] matrix to a [1 x n] matrix of the final system.

Weighting of Major Gateways

The third step before program implementation was the weighting of three potential RDC's--Oklahoma City, Tulsa, and Ft. Smith--to provide an advantage in being assigned peddle communities over other potential RDC's. Being the major interface with the interstate system it was necessary to increase the attraction of peddle communities to these major gateways to offset handling charges incurred at the RDC's. This was accomplished by displacing the division point between the weighted RDC toward the unweighted RDC by ten percent of the distance between the two RDC's.

Community Demand

Before one can adequately develop an optimum route solution to a transportation problem, he must have some idea of the magnitude for movement at each demand node in the system. Ideally, the demand is ascertained

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[3] SPA, written by Lawrence M. Ostresh at the University of Iowa.

by a waybill sample. Due to financial and time limitations, however, waybill sampling was not feasible for this study, hence, a predictive model utilizing associated demand characteristics was developed.

In geography and transportation engineering, most studies of transportation demand have focused on demand for urban passenger transportation. One of the few to focus upon freight demand, Perle (1949) attempted to analyze the demand for freight services on a national level. His study was concerned with the demand for freight transportation during the years of 1956 to 1960 as exemplified by motor carrier and railroad behavior during the time. Specifically, it examined the relationships between the consumption of freight services and the price system. The model used for his analysis was a linear regression type.

A similar regression model was also chosen to predict community demand in this study. Such a model could be well suited for planning, as changes in the transportation environment could be reflected in the data input. The procedure chosen was stepwise multiple regression for two reasons. First, since no community demand models for motor freight transportation appear in the literature, it was imperative to know the contribution of each variable towards predicting community demand. Two, due to the lack of precedent, it was not known which variables would be significant in predicting demand. The stepwise procedure eliminates statistically insignificant variables (Draper and Smith, 1960).

The Community Demand Model

A sample of one hundred forty-nine Oklahoma communities was utilized to develop the predictive equation using a multiple linear regression model of the form:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + e$$

Where:

Y = the dependent variable expressed in pounds of freight per day per community

a = intercept

b = slope

X_1 = selected community sales tax receipts

X_2 = population of the community

X_3 = manufacturing employment in the community

X_4 = per capita sales tax of the community

e = error term or residual

Dependent Variables. The dependent variable was the freight demand expressed in pounds for each community. The data for this variable was obtained from a waybill sample conducted by Constantin and Smith for use in a study of Oklahoma intrastate carriers for the Ozarks Regional Commission (Constantin and Smith, 1970). Their study was conducted using ICC methodology for waybill sampling and can be considered a five percent sample.

Selected Community Sales Tax Receipts (X_1). Community sales tax receipts were selected to reflect the demand for transportation by the retail establishments of each community. Sales tax can be considered as a reliable measure of retail volume of almost all businesses in a community because of the structure of the tax in Oklahoma. The state of Oklahoma levies a two percent tax on all retail sales of consumer items except gasoline, 3.2 percent beer, tobacco products, farm machinery, and farmer purchases of feed and fertilizer.[4] Included in sales tax data are such

[4]Motor vehicles, gasoline, 3.2 beer, and tobacco products are all taxed by the state but the revenue from the taxation is not considered sales tax and is reported as a different category by the Tax Commission.

non-retail items as business machines, business services, lodging, public utilities, oil field equipment, and other commercial products.[5]

Since the tax is collected from businesses which do not utilize common motor freight carriers, it was necessary to edit the total sales tax receipts of each community to reflect only the volume of those businesses using the common carrier.[6] The data entered into the regression model were the edited total for each sample community for the first quarter of 1973. Total collections for the quarter were selected because each business files a report with the State Tax Commission at least once a quarter.

Community Population (X_2). The population of each community was selected as a variable in the belief that the size of a community might have an effect on freight demand not evidenced by the adjusted sales tax. The population entered is that reported in the 1970 Census of Population with populations of small unincorporated communities taken from the 1972 Rand-McNally Commercial Atlas and Marketing Guide.

Community Manufacturing Employment (X_3). Community manufacturing employment was included to reflect the demand of manufacturing activity in the community for services of the intrastate carriers. The source of the data was the 1972 Oklahoma Directory of Manufacturers and Products compiled by the Oklahoma Industrial Development and Parks Department. This source was selected over data available from the Census of Population for three reasons. It is more specific as to type of manufacturing

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[5] Personal communication with Oklahoma Tax Commission personnel.

[6] A complete list of the Oklahoma Tax Commission's classification of community business types is in Appendix F with the businesses included in and deleted from the study properly identified. The inclusion of business types that use the common carrier was made on the basis of personal knowledge acquired through experience in the motor carrier industry and by a survey conducted by personal interview in all businesses in eleven Oklahoma communities.

activity which is necessary when editing those that do not use common carriers. It includes persons employed in a town but who may live in another town or outside the city limits. Also, information concerning manufacturing activity is available for all towns regardless of size.

As with sales tax, it was necessary to edit the data to exclude those manufacturing establishments that do not utilize common carriers. Activities excluded were food processing plants, mining activities, timber processing firms, and ice manufacturers.

Community Per Capita Sales Tax (X_4). The per capita sales tax was included to reflect the influence of a community's trade territory. It was felt that the variable would give a measure of the population of the area served by the community, i.e., a high per capita tax would indicate the community serves a large rural population and some surrounding communities while an inverse would be true for communities with low per capita tax.

Data Analysis and Demand Estimations

When the equation was solved using a stepwise regression procedure, it was found that an analysis of the raw data produced a multiple correlation coefficient of +.8195, explaining 67.17 percent (R^2) of the variation in community freight demand as estimated from 1970 waybill samples. The sales tax variable proved to be highly intercorrelated with other variables, the highest, 0.939, with population.

TABLE 7

INTERCORRELATION MATRIX

	Y	Sales Tax	Per Capita Tax	Mfg. Employment	Population
1	1.000	0.767	0.158	0.662	0.672
2		1.000	0.145	0.592	0.939
3			1.000	0.023	0.047
4				1.000	0.543
5					1.000

Source: Author's Computations

Since the use of the regression equation is for prediction rather than hypothesis testing multi-collinearity is not a problem. As ". . . if the purpose of the regression analysis is only to predict the value of Y corresponding to a set of x_i values, then multi-collinearity is not a serious problem, provided that the intercorrelations continue unchanged into the future" (Poole and O'Farrell, 1970, 155). Multi-collinearity is also discussed by Massy (In Aaker, 1971, 35) who states: "While it is desirable to use independent variables that together contribute a maximum of information, the correlation between them does not matter, per se."

TABLE 8

MULTIPLE CORRELATION SUMMARY TABLE

Step Entered	Variable	R	R^2	Increase in R^2
1	Community Sales Tax	0.7667	0.5878	0.5878
2	Community Mfg. Employment	0.8090	0.6545	0.0667
3	Community Population	0.8188	0.6704	0.0159
4	Community Per Capita Sales Tax	0.8195	0.6717	0.0013

Table 8 gives the step each variable entered into the regression and its contribution to the explanation of the demand variance. The resultant regression equation was:

$$Y_i = 477.3 + (.17726)X_{1_i} + (8.45284)X_{2_i} + (-.38969)X_{3_i} + (47.54755)X_{4_i} + e_i$$

Where:

Y_i = the computed freight demand of a community

And:

X_{1_i} = community sales tax

X_{2_i} = manufacturing employment for the community

X_{3_i} = the population of a community

X_{4_i} = per capita sales tax for a community

e_i = unexplained community demand

Community sales tax was the most important variable explaining 58.78 percent of the variation in community freight demand. Even though the remaining three variables contributed only an additional 8.39 percent, they all contribute a maximum of information in predicting Y values and all are significant to the equation with an F level for deletion of 0.005.

Analysis of Model

Residuals. The residuals, when plotted, appear to be spatially random in nature (Figure 9). Communities served by the same carrier and located in the same area are both over and under-predicted. The only noticeable pattern of the residuals is non-spatial and is associated with error in the initial demand values.[7]

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[7]The sampling technique used by Constantin and Smith causes an over-prediction for communities with a small demand and under-prediction for communities with a large demand. This occurs when waybills are sampled without regard to communities. When sampling waybills to all communities served by a carrier and arranged in no specific order, the actual percentage of waybills sampled for communities with a small number of waybills will be higher than the desired sample percentage while the actual percentage of the waybills sampled for communities with a large number of waybills will be smaller than the desired sample percentage. (In conversation with Dr. Antti Talvatie, Professor of Civil Engineering, University of Oklahoma.)

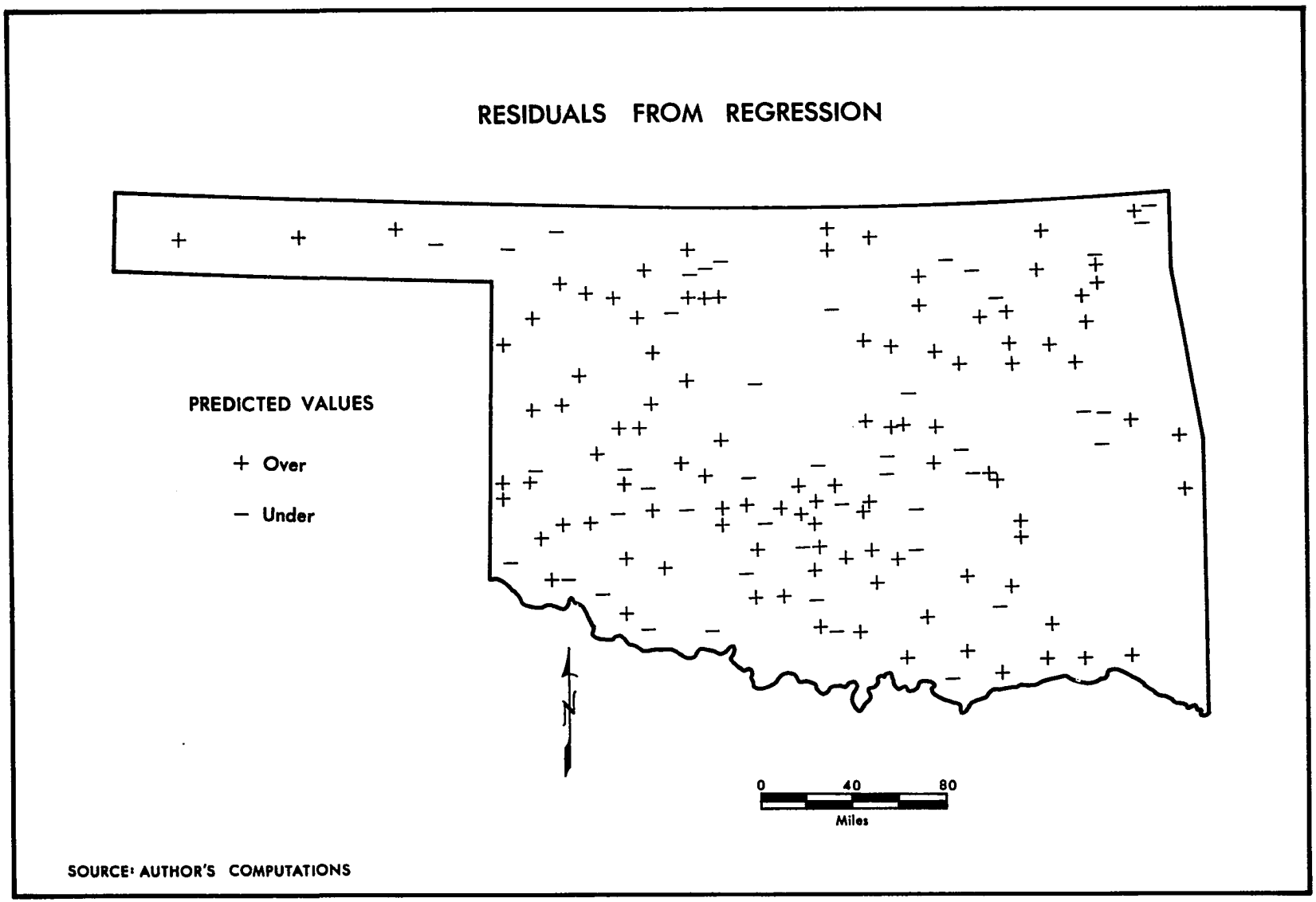

RESIDUALS FROM REGRESSION
PREDICTED VALUES
+ Over
– Under
0
40
80
Miles
SOURCE: AUTHOR'S COMPUTATIONS

FIGURE 9

Unexplained Variance. The model employed has, as do most models which attempt prediction of man's behavior, some limitations and unexplained variance. Some of the unexplained variance is the result of the scope of the study, and some stems from the nature of the intrastate carriers' inefficiencies previously discussed. One of the primary limitations inherent in the scope of the study is the selection of only one transportation mode, the intrastate motor carrier, for examination. There are other modes by which transportation demand of a community can be satisfied. The total demand of a community is met by the combined efforts on the part of all or some of the options, by rail, by interstate common motor carrier, by carriers engaged in express service, by parcel carriers--the bus express, private parcel carriers, and the United States Postal Service--by private carriers, or by any number of the specialized motor carriers. Unfortunately, no study has ever attempted to explain the proportionate shares of the different carriers in the service of a community. Thus, it is necessary to work with what is available when trying to explain community freight demand.

Even if one were able to ascertain the "normal" mix of the modes it would still be necessary to contend with deviations from the norm caused by a great variety of unknown characteristics. Intermodal demand shifts in a community can be the result of irrational decisions rather than rational economic behavior. It is entirely possible that traffic which should move by intrastate common carriers is not available due to poor customer-carrier relations. If delivery personnel antagonize the receivers, or claim settlement is not prompt, or delivery schedules are not maintained, the intrastate carrier's share could be less than normal. The converse could also be true.

In addition to the above contributions to error variance, the sampling error in the waybill sample of Constantin and Smith also contributed to the error variance. However, it is not possible to separate the error variance into the different causes. Also, some error is no doubt attributable to the fact that the variables were not all collected from the same time frame.

Model Implementation

Using the regression equation developed, the demand of the remaining communities for which all data were available but not included in the Constantin and Smith waybill sample were computed. In addition a number of communities served by the carriers but not separately identified by the State Tax Commission were assigned a demand. Since most of the communities were quite small, the arbitrary assignment was one hundred pounds per community. This was done in order that these communities could be entered into the regional model along with those with demand determined by the community demand model.

Once a demand was known for all communities it was possible to proceed to the next step, the solution of the transportation problem to develop a more efficient carrier distribution network. A discussion of the developed system is undertaken in the following chapter.

CHAPTER IV

THE NODAL HINTERLAND DISTRIBUTION SYSTEM

The Nodal Regions

The regional transportation model collapsed the one hundred fifteen possible distribution nodes to thirty-five final nodes. The total length of the service vectors for the generated network was 21,319 miles.[1] This compared quite favorably with the present system's total service vector length of 34,780 miles, a reduction of 38.7 percent. The difference would have been considerably greater had not the two hundred and seven communities not served in the present system been included in the generated system. Even with the addition of almost one third more communities, using the generated nodal system the savings to the carriers--and hopefully the users--would amount to $22,200 a week or almost $1,455,000 per year.[2]

The figures are the sums of one measurement of the distance between an i^{th} RDC and a j^{th} peddle community. Since line-haul costs are linear over distance, any additional movement over an i-j link would be the cost of movement times the frequency of movement and the cost relationship between the present and the developed network remaining constant. Thus,

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[1] The length of one service vector is the distance from one RDC to one peddle community served by that RDC. The distance measured is that of the shortest path through the existing highway network from the RDC to the peddle community.

[2] The savings are computed on line-haul costs $.66 per mile for 13,361 miles then divided by two. This division by two is to convert vector distance to delivery route distance. It was found that the delivery route distance for a nodal region was approximately one-half the vector distance.

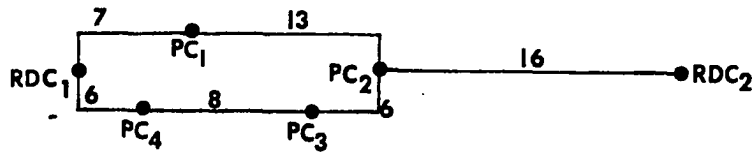
since multiple movements were not considered in either system, the savings could be considerably higher where the demand of a community is sufficient for multiple daily movements.

The developed RDC regions shown on Figure 10 have retained many of the communities of the present network classified as RDC's or higher as nodal points of the region. Some, however, have been replaced, either by communities not included in the present network or by assigning present RDC's to peddle community status. In addition, new regions have been developed about two communities (Frederick and Pawhuska) previously having only peddle community functions.

Those communities that lost their RDC function and are included in another region are given in Table 9. In addition, the out-of-state RDC's of Coffeeville, Kansas and Springdale, Arkansas were eliminated entirely.

The Distribution System[3]

Before the generated network can be operationalized it is necessary to make some minor adjustments in the boundaries of the RDC regions. These adjustments result from the use of service vectors to develop the regions rather than delivery routes from the RDC's. Thus, it is possible for a peddle community located on an intersection to be assigned to one RDC but be in a logical delivery route from a second RDC. This is illustrated in Figure 11.



[3]This section is an example of how the nodal system could be implemented. The author realizes that actual implementation would involve much work by many individuals from industry, government, and academia.

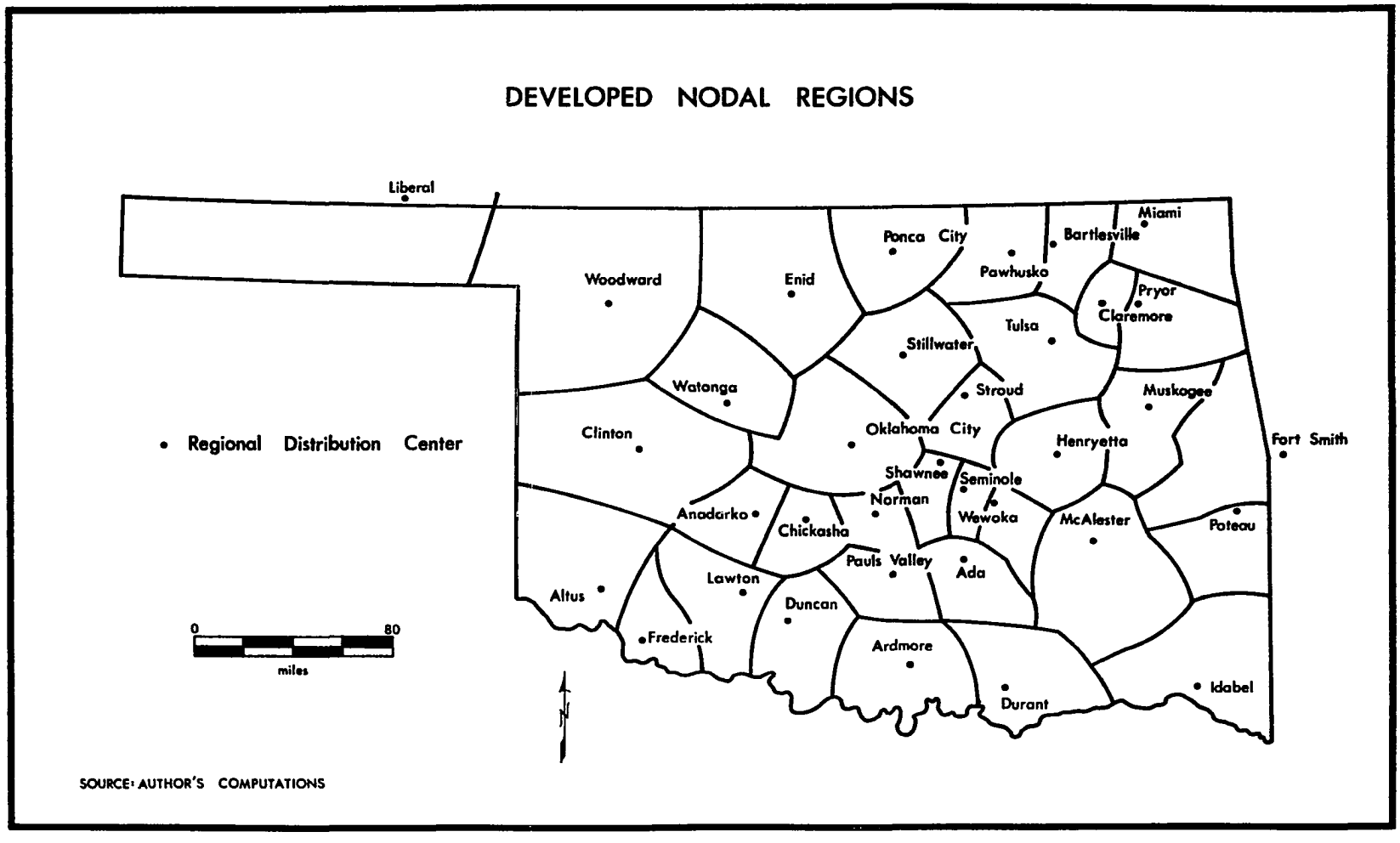

DEVELOPED NODAL REGIONS
Liberal
Woodward
Enid
Ponca City
Bartlesville
Miami
Pawhuska
Pryor
Claremore
Tulsa
Stillwater
Watonga
Stroud
Muskogee
Clinton
Oklahoma City
Henryetta
Fort Smith
Shawnee
Seminole
Norman
Anadarko
Chickasha
Wewoka
McAlester
Poteau
Pauls Valley
Ada
Lawton
Altus
Duncan
Frederick
Ardmore
Durant
Idabel
• Regional Distribution Center
0
80
miles
N
SOURCE: AUTHOR'S COMPUTATIONS

FIGURE 10

TABLE 9

COMMUNITIES LOSING THE RDC FUNCTION

Communities Losing the RDC Functions	Present RDC Region
Guymon	Liberal
Seiling	Woodward
Weatherford	Clinton
Hobart	Altus
Mangum	Altus
Cyril	Anadarko*
Fairview	Watonga*
El Reno	Oklahoma City
Lindsey	Pauls Valley
Wewoka	Holdenville
Bristow	Stroud*
Cushing	Stroud*
Tonkawa	Ponca City
Nowata	Bartlesville
Vinita	Miami
Tahlequah	Muskogee
Okmulgee	Henryetta
Okemah	Henryetta
Stigler	Ft. Smith
Quinton	McAlester
Hugo	Idabel

*New RDC
Source: Author's Computations

where the distance to PC_2 from RDC_1 is 20 miles and RDC_2 it is 16 miles, thus PC_2 would be assigned to RDC_2. However, when considering a delivery route developed out of RDC_1 it is necessary to pass through PC_2 to complete the route. Fortunately, this situation does not occur often in the generated network and the corrections made added only 103 miles to the distance/cost of the generated network.

Functional Structure of the Nodal System

As was the case in the discussion of the present distribution system, it was necessary to first identify the functional hierarchy of communities in the nodal system. All of the six classifications found in the present system were also found in the nodal system except one--the intermediate gateway. This level was eliminated because of the small percentage of the intrastate freight it originated and supplied to the RDC's in relation to the major gateways. Much of the intrastate and interstate freight supplied to the RDC's by an intermediate gateway first originated in the major gateway. Thus, with the elimination of the intermediate gateways the cost of transferring the freight in these centers was eliminated.

The redirection of the interstate freight interlined in the intermediate gateways and sent to RDC's was easily accomplished. Although the nodal system did not alter the routes of the interstate carriers, the abolition of the intermediate gateway--RDC connections altered the operations of the interstate carriers by forcing them to change their loading patterns.[4]

[4]The loading pattern of a carrier refers to the consolidation of shipments to a number of destinations into one movement to a breakbulk point (gateway) for final delivery. For example, a carrier with terminals in Oklahoma City, Denver, St. Louis and Chicago would load its Oklahoma freight in Chicago on a vehicle moving to Oklahoma City, its Colorado freight to Denver, and its Missouri freight to St. Louis. When the freight reaches Oklahoma City, the freight destined to Enid is interlined with a carrier serving Enid, etc. while the Oklahoma City freight is delivered.

Freight destined for a RDC formally served from an intermediate gateway would now have to be interlined at the major gateway serving the RDC.

Since the nodal system does not alter the interstate operating rights, the intermediate gateways would still have interstate connections but would operate as minor gateways. The freight moving through the interface between the interstate and intrastate systems would be for the community itself and the peddle communities it serves.

All communities with interstate connections that serve only peddle communities are classed as minor gateways. There are two types of minor gateways, those on the perimeter of the state and those in the interior. The perimeter gateways intercept freight moving into the state. They are: Liberal, Kansas; Lawton, Ardmore, Miami, Ponca City, and Enid. The interior gateways are either on major routeways--McAlester and Muskogee-or have enough demand so the interstate carriers want to serve them--Ada.

Freight delivery in a nodal distribution system would ideally be undertaken by one carrier. In the case where a RDC is served from one gateway, this would be easily accomplished as the carrier would move its freight from its gateway terminal to the RDC for final delivery. If the RDC is served by two gateways and located on or near the route between the gateways, it quite logically could be served by the same carrier from each gateway on a "sitout and pickup" basis.[5] If an RDC is logically served by several carriers from different gateways, the delivery functions

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[5]The term "sitout and pickup" is used to describe a motor carrier operation in which a truck driver enroute from Community A to Community B, delivers a trailer at an intermediate point, Community C, and takes a trailer destined to point B on to the final destination.

in the nodal region could be handled by a pooling arrangement by the carriers involved.[6]

A number of communities could logically be local terminals due to their demand function. These communities, however, are not identified as their selection should be made by the carrier serving the RDC region in which they are located. It may be that the carrier prefers to serve a community with a large demand as a peddle community on a direct delivery route by detailing one driver and vehicle to deliver and pick up freight in the one community only.

Freight Flows in the Nodal System

As mentioned previously, all RDC's in the nodal system are served only by the major gateways (Figure 12). Oklahoma City again dominates the system serving the largest number of the RDC's. It exclusively serves nineteen of the thirty-two communities functioning as regional distribution centers. Fourteen of the RDC's are in the western one-half of the state which is in the Capitol City's exclusive area in the present system. Idabel in the far southeast is also still served exclusively by Oklahoma City.

Since Oklahoma City can intercept freight from all regions of the United States due to its national routeway location, Idabel was assigned to it because of the Idabel region's limited demand of 60,341 lbs/day (Table 10). If the region were served from either Tulsa or Ft. Smith, it would mean an indirect movement of freight demand to the region moving

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[6]Pooling is the joint operation by a number of carriers where one carrier handles the pickup and delivery function for all carriers involved for joint communities served.

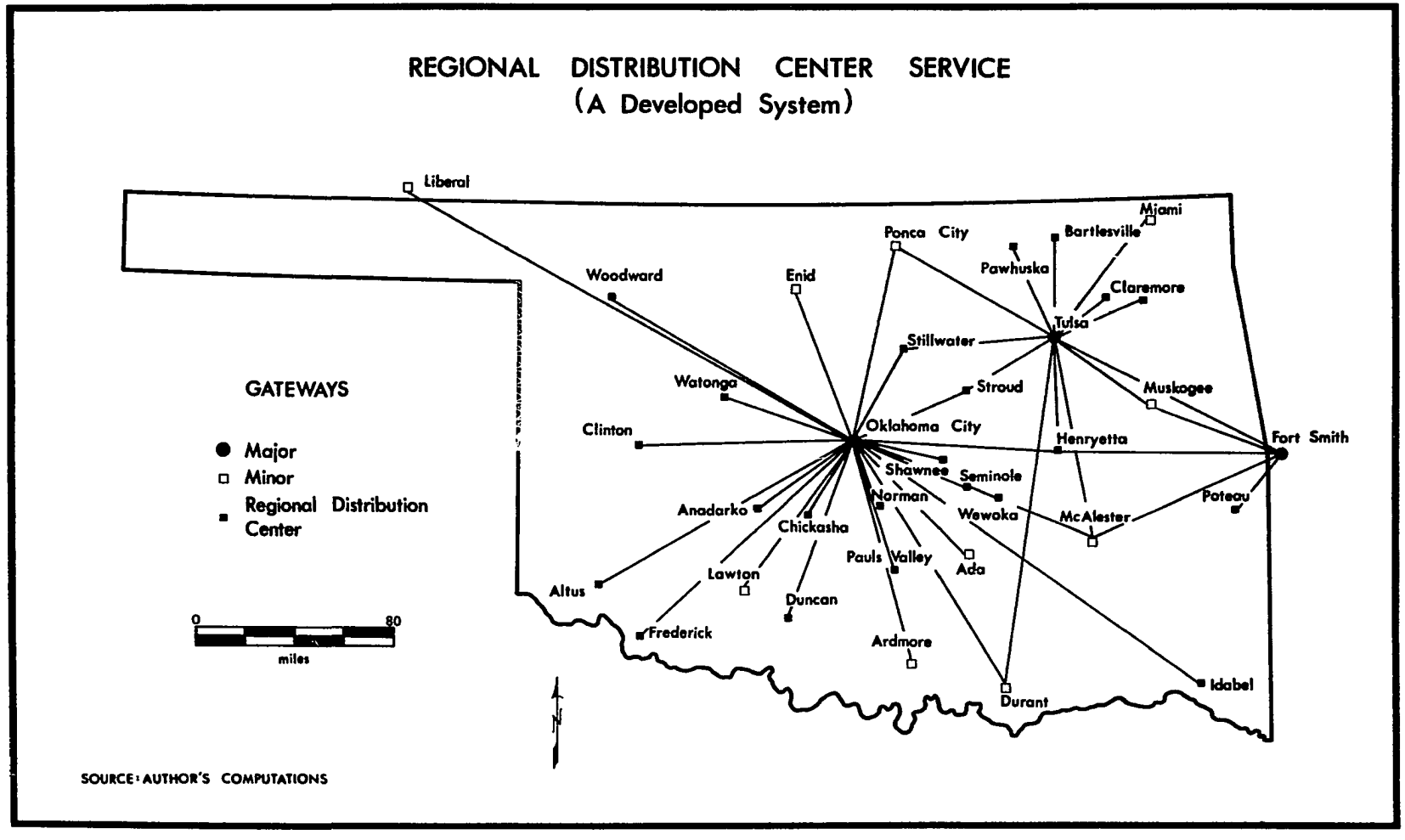

REGIONAL DISTRIBUTION CENTER SERVICE
(A Developed System)
Liberal
Woodward
Enid
Ponca City
Miami
Bartlesville
Pawhuska
Claremore
Tulsa
Stillwater
Watonga
Stroud
Muskogee
Clinton
Oklahoma City
Henryetta
Fort Smith
Shawnee
Seminole
Norman
Poteau
Anadarko
Chickasha
Wewoka
McAlester
Pauls Valley
Ada
Lawton
Altus
Duncan
Frederick
Ardmore
Durant
Idabel
GATEWAYS
Major
Minor
Regional Distribution Center
0
80
miles
SOURCE: AUTHOR'S COMPUTATIONS

FIGURE 12

TABLE 10

DAILY DEMANDS OF THE NODAL REGIONS
(In pounds)

	RDC Demand	Units*	Regional Demand	Units	Total Demand	Units
Ada	69,606	3.48	32,664	1.63	102,270	5.11
Altus	28,197	1.41	35,864	1.79	64,061	3.20
Anadarko	38,411	1.92	12.834	.64	51,245	2.56
Ardmore	94,655	4.73	60,355	3.02	155,010	7.75
Bartlesville	48,492	2.44	72,818	3.64	121,610	6.08
Chickasha	49,129	2.46	24,238	1.21	73,367	3.67
Claremore	41.659	2.08	4,359	.22	46,018	2.30
Clinton	31.446	1.57	51,152	2.76	86,598	4.33
Duncan	44,834	2.24	35,396	1.77	80,230	4.01
Durant	49,724	2.49	45,971	2.29	95,695	4.78
Enid	41,329	2.07	37,056	1.85	78,385	3.92
Frederick	36,320	1.82	10,711	.54	47,031	2.35
Henryetta	61,872	3.09	100,348	5.02	162,220	8.11
Idabel	30,748	1.54	29,793	1.49	60,541	3.02
Lawton	51,193	2.56	6,056	.30	57,249	2.86
McAlester	101,577	5.08	42,223	2.11	143,800	7.19
Miami	60,004	3.00	72,105	3.61	132,109	6.61
Muskogee	56,609	2.83	38,020	1.90	94,629	4.73
Okla. City	NA	NA	264,550	13.23	264,550	13.23
Norman	62,108	3.11	12,905	.65	75,013	3.76
Pauls Valley	15,019	.75	70.009	3.50	85,028	4.25
Pawhuska	26,155	1.31	21,763	1.09	47,918	2.40
Ponca City	51,898	2.59	43,950	2.20	95,848	4.79
Poteau	32,989	1.65	11,759	.59	44,748	2.24
Pryor	43,501	2.18	44,962	2.25	88,463	4.43
Seminole	50,799	2.54	2,264	.11	53,063	2.65
Shawnee	71,698	3.58	4,753	.24	76,451	3.82
Stillwater	49,190	2.46	46,900	2.35	96,090	4.81
Stroud	10,953	.55	84,515	4.23	95,468	4.78
Tulsa	NA	NA	117,130	5.86	117,130	5.86
Watonga	18,397	.92	29,505	1.48	47,902	2.40
Wewoka	65,401	3.27	31,040	1.55	96,441	4.82
Woodward	46,939	2.35	29,832	1.49	76,771	3.84
Ft. Smith, Ark.	NA	NA	61,286	3.06	61,286	3.06
Liberal, Ks.	NA	NA	33,695	2.68	33,695	2.68

*One unit is equal to one "pup" trailer, 20,000 pounds, and one-half of a forty foot trailer or 40,000 pounds.

Source: Author's Computations

on a routeway not passing through the city--the Middle South in the case of Tulsa and all but the Middle South in the case of Ft. Smith. If the region were served by more than one gateway, the freight would likely not be enough to fully utilize the equipment moving from either gateway.

In the nodal system, four communities now served by Oklahoma City only were previously in the multi-service region. The communities of Ada, Seminole, Shawnee, and Wewoka were assigned to Oklahoma City because of their proximity to the gateway. The contributions of Tulsa and Ft. Smith to the total freight flow into the four regions likely are less than those of Oklahoma City, which would cause one of two things--either equipment moving at less than capacity or reduction in the level of service in order to fully utilize equipment.

Tulsa, as before, exclusively serves only a limited area in the northern corner of the state which has five RDC's. It does, however, continue to jointly serve three RDC's in the Oklahoma City-Tulsa interface region. Two of the RDCs, Stroud and Stillwater, could be served as a "sitout" by "pups" trailers on runs between the two gate ways.[8] The third, Ponca City, with a daily demand of 95,848 pounds has enough for service by forty foot trailers from both gateways.

In the Multi-Service region all three gateways, as before, serve RDC's. Ft. Smith alone serves Poteau because of its proximity and because the majority of freight now moving into the region moves through Ft. Smith. Three of the RDC's--McAlester, Muskogee, and

---

[8]The term "pup" refers to one-half a tandem trailer unit pulled by one tractor. These trailers are usually 25 to 27 feet long and give high degree of flexibility to the motor carrier industry. One trailer is called a "pup" while the two trailers together with the converter axle are called a "set of pups."

Henryetta--are served by all gateways. Henryetta, located at the junction of Interstate Highway 40 and U.S. Highways 75 and 62, is logically served by all three on a "sitout, pickup basis." The remainding two nodal communities have enough freight demand from all major gateways to warrant the service. Durant, at the far southern border of Oklahoma is served by Tulsa and Oklahoma City, with Tulsa serving the freight moving from the northeastern United States and Oklahoma City that from the east and west coasts.

In Table 10, the total demand for each nodal region is given along with the demand of the city and the hinterland. All demands are expressed in pounds per day and units of truck capacity, where one unit is equal to 20,000 pounds or one "pup" trailer. The total demand for the Liberal, Kansas nodal region is less than the required 40,000 pounds per day (33,695). Liberal, however, is a special case. It is the center for a larger region than the Oklahoma Panhandle with influence in part of the Texas Panhandle as well as in southwestern Kansas. This illustrates one of the problems when considering a state as a unit for developing a transportation network--political subdivisions are not necessarily the best planning units.

Many communities along political borders have trade areas that cross state boundaries, a fact which must be considered by the planner in the development of logical plans for a state. The planning might often be better if political boundaries could be ignored. At this time, however, it is impractical, except in the case of border cities, because of the state's prerogative to regulate its own internal systems.

Policy Implications of the Nodal Hinterland Concept

The acceptance of the nodal hinterland concept by agencies charged with regulating motor carrier operations would require some basic philosophical changes in the granting or transfer of Certificates of Public Convenience and Necessity. One such change would be the definition of the authority itself. The restriction of motor carriers to certain rigidly defined routes would not be necessary. Instead, the authority would require definition of the node and its associated hinterland communities. Such an authority might be defined as:

> Service between Oklahoma City and Woodward, Oklahoma and its hinterland communities of (list of communities).

This would eliminate route definition and allow the carrier to organize his delivery routes within the region and movement between the gateway and the node in any manner he so desired.

Another philosophical change necessitated would be the concept of intramodal competition acting as a regulator of rates. This concept was first advanced in Section 5 of the 1887 Act to Regulate Commerce which prohibited pooling (Locklin, 1966, 212). Though not stated policy today, this concept has continued to influence the granting of authorities. The idea of any company holding a monopoly on service to an area seems abhorrent to the average American. Public utilities, however, commonly hold the right to exclusive service to an area which is in effect a monopoly franchise. If exclusive rights were granted, as proposed, to an intrastate common carrier for a nodal region, it would not be inconsistent to regulate the carrier in the same manner as public utilities. This is especially applicable to rates with the basic rate structure subject to approval by the regulatory agencies. This is not

unlike the present system under which general rate changes must be approved by the regulatory agencies.

If the methodology proposed for development of nodal regions were to be utilized by a regulatory agency, the agency could conduct a new waybill sample for input into the demand model as the dependent variable. The agency could conduct such a sample by requesting the appropriate data from carriers under its regulation. An ideal situation would be periodic sampling on a continuing basis. The agency could select a representative sample of communities and collect the total waybills on freight destined to them on a regular basis. Such a sample should be constructed to take into consideration the periodic fluctuations in the freight flow encountered.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The goal of this study has been to evaluate the present spatial patterns of the intrastate regular-route common carriers in Oklahoma and to develop an alternate distribution system that provides more economical freight transportation for the general public. The present distribution system was examined and evaluated for uneconomical operations caused by the present method of granting Certificates of Public Convenience and Necessity.

A more economical intrastate common carrier distribution network was developed based on a concept of a distribution node and adaptation of the transportation problem developed specifically for the study. As an input to the regional transportation model developed, community demand was predicted for each community in the state by a model developed for this study using the stepwise multiple regression procedure. One possible implementation of the generated nodal hinterland distribution system was demonstrated. An evaluation was also made of the philosophical and policy changes required of a regulatory agency upon adoption of a nodal hinterland distribution system.

Conclusions

Effects of the Proposed Distribution System

The most visible effect or benefit of the proposed distribution system is the reduction in the carriers' line haul costs. As noted previously, this could amount to at least seven hundred thousand dollars

a year. This recovery by the carriers would be an on-going process with a like amount being recovered in each succeeding year. If this savings were passed on to the users, either by a rate reduction or by forestalling rate increases, it could stimulate economic growth in some areas.

Although less dramatic, the elimination of the uneconomical irregularities could also be of great importance. If the proposed system increases dependability of the carrier's service, the merchants that now utilize the higher priced express carrier could again use the common carrier for a majority of their shipments. Thus, an additional savings could be realized by consumers, one not considered in tabulation of the carrier savings. Greater reliability of the common carrier service might well result in establishment of income producing business in areas previously not considered because of poor transportation services.

Another possible indirect benefit that would have a better chance of occurring from the proposed system is joint operation of pickup and delivery functions by the intrastate carriers in the major gateways. Presently, each intrastate carrier operates its own terminal and fleet of pickup and delivery vehicles in the major gateways. This means that, in the case of Oklahoma City, twenty-one different carriers' vehicles stop at each interstate carrier to pickup interlined interstate shipments, and at each warehouse and at each wholesaler to pickup intrastate shipments for the communities they serve. While figures are not readily available, the reduction to only one vehicle calling on each interstate carrier or business would result in a large savings to the carriers, not to mention the terminal costs saved.

Thus, adoption of the proposed system would not only result in the direct reduction in line haul cost to the carriers but would have a multiplier effect resulting in possible indirect cost reductions in other phases of carrier operation, in the users business, and utimately to the consumer. The proposed system would not be without its costs, however. One of the visible costs of implementing the proposed system would be a reduction in earnings by the express carrier. It could, however, survive by its competitive advantage in handling small shipments. Another cost would be the one-time administrative cost incurred by the public through the regulatory agencies in carrying out the transition from the present to the proposed system. Over all, though, it is felt that the benefits far outweight the costs.

Concluding Remarks

Although the primary purpose of this study was to develop a more efficient intrastate common carrier distribution system, certain elements of the study have a wider application. The use of sales tax data as an indication of the economic well being of a community has promise. This readily available data has many potential uses. It could easily be used in regional studies as a measure for cash flow in a community economy.

Another possible use of sales tax data is in central place studies. Since the data collected are identified by function, i.e., grocery stores, hardware stores, etc., and by establishment, it could be used to determine the number of establishments of each function found in each community. In addition, the sales tax data would give the relative importance of each establishment based upon its volume--something that is usually not measured in central place studies where importance of each establishment is considered to be the same.

Another element of the study which has potential of wider applications is the regionalization model. It could be used by business enterprises wishing to locate facilities having a minimum product demand for support. It might be used to locate warehouses, assembly plants, branch manufacturing plants, and retail establishments.

Another possible application of the technique is in locating public services. The health care system is one that would be quite appropriate, since a minimum population is necessary to provide support for doctors, dentists, clinics and hospitals. Other governmental services to the population might also be located using the model. The model would be quite appropriate for locating these services as the people they serve usually travel on individual trips through the existing road networks. By using the model the distances travelled by such users could be minimized.

The study also brings to attention certain areas that should be the subject of future studies. One finding of the study was the general absence of knowledge about the transportation distribution picture outside metropolitan areas. There is almost a complete absence in the literature of studies on the modal mix. Little is known about the type of carriers which serve various economic establishments, the percentage of community logistical support provided by each carrier, and whether the modal mix varies with the size of the establishment, the size of the community, or the distance from the community of the gateways.

With few exceptions, the literature is also void on the demand for transportation. This is true not only for communities as pointed out previously, but also for regions, or if demand differs significantly from community to community or region to region.

This study represents a modest contribution towards understanding the complex patterns of an industry critical to regional economic dynamics. Perhaps its major value is to raise the question of re-designing outdated, inefficient patterns by governmental process, while preserving at the same time a free enterprise economic system.

A P P E N D I X A

CLASSIFICATION OF CARRIERS[1]

The motor carriers are classified by the I.C.C. by: 1) types of carriers; 2) types of routes; and 3) types of commodities hauled. There are two general types of carriers, the "for-hire" and the private.

Classification by Types of Carriers

The Private Carrier

The private carriers are those owning the goods that they are transporting in their own vehicles or vehicles they have control over through long term lease. These carriers are exempt from regulations other than regulations designed to protect the public and the highways.

The For-Hire Carrier

The for-hire carriers have three divisions. They are:

1. Common Carrier

   > The common carrier is defined as any person who undertakes to transport passengers or property for the general public in interstate or foreign commerce by motor vehicle for compensation whether by regular or irregular routes.

2. Contract Carrier

   > The contract carrier is defined as any person who engaged in transportation by motor vehicle, of passengers or property in interstate or foreign commerce for compensation under continuing contracts with a person or a limited number of persons either (a) for the furnishing of transportation services through the assignments of motor vehicles for a continuing period of time to the exclusive use of each person served, or (b) for the furnishing of transportation services designed to meet the distinct need of each individual customer.

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[1]This section is a composite that has been taken from a number of sources; the most important of which are Kahn (1958) and Hudson and Constantin (1958).

3. Exempt Carriers

There are a number of carriers that are classified as exempt. They are:

a) Motor vehicles employed solely in transportation of teachers or children to and from school.

b) Taxicabs with a capacity of not more than six passengers and not operating on a regular route or between fixed terminals.

c) Motor vehicles owned or operated by or on the behalf of hotels and used exclusively for transportation of hotel patrons between hotels and local railroad or other common carriers.

d) Motor vehicles controlled and operated, under authorization, regulation, and control of the Secretary of the Interior principally for the purpose of transporting persons in and about the national parks and national monuments.

e) Motor vehicles controlled and operated by any farmer, when used in the transportation of his agriculture commodities and products thereof, or in the transportation of supplies to the farm.

f) Motor vehicles controlled and operated by a cooperative association as defined by the Agricultural Marketing Act, approved June 15, 1929, as amended.

g) Motor vehicles used exclusively in carrying livestock, fish (including shell fish), or agricultural commodities (not including manufactured products thereof), if such motor vehicles are not used in carrying any other property, or passengers, for compensation.

h) Motor vehicles used exclusively in the distribution of newspapers.

i) The transportation of persons or property by motor vehicle when incidental to transportation by air craft.

j) The transportation of passengers or property in interstate or foreign commerce wholly within a municipality or between contiguous municipalities or within a zone adjacent to and commercially a part of any such municipality or municipalities, except when such transportation is under a common control, management, or arrangement for a continuous carriage or shipment to or from a point without such municipality, municipalities, or zone, and provided that the motor carrier engaged in such transportation of passengers over regular or irregular route or routes in interstate commerce is also lawfully engaged in the intrastate transportation of passengers over the entire length of such interstate route or routes in accordance with the laws of each State having jurisdiction.

k) The casual, occasional, or reciprocal transportation of passengers or property in interstate or foreign commerce for compensation by any person not engaged in transportation by motor vehicle as a regular occupation or business.

The common and contract carriers are subject to economic regulation--regulation of rates and charges, areas of operation, routes, and commodities carrier--in addition to public and highway safety regulation. The exempt carriers are subject only to public and highway safety where applicable.

Classification by Type of Route

There are five different classifications of routes as defined by the I.C.C. They are:

1. Regular Route Schedule Service

   Any person who undertakes to transport any class or classes of property in interstate or foreign commerce by motor vehicle for compensation between fixed termini and over regular route or routes upon established or fixed schedules.

2. Regular Route Nonscheduled Service

   The same conditions as above with the exception of operating over the routes at intermittent intervals and not upon fixed or established schedules.

3. Irregular Route Radial Service

   A carrier which operates over irregular routes from a fixed base point or points to other points within a radial area which is fixed and authorized by the I.C.C. in a certificate or permit or from those points back to the base point or points.

4. Irregular Route Nonradial Service

   A carrier who operates over irregular routes between points within a general territory as defined and authorized by the I.C.C. in a certificate or permit and any other point in the same general territory without regard to a base point.

5. Local-Cartage Motor Carrier

   A carrier who operates wholly within a municipality or between contiguous municipalities or within a zone adjacent to and commercially a part of any such municipality or municipalities.

Classification by Type of Commodity Carried

There are seventeen classifications by type of commodity carried. The only classification pertinent to the study is the carrier of general freight. This is the broadest classification with the only restrictions being commodities that require special equipment or special handling. The other classifications are:

1) Household Goods
2) Heavy Machinery
3) Liquid Petroleum Products
4) Refrigerated Liquid Products
5) Refrigerated Solid Products
6) Dump Trucking
7) Agricultural Products
8) Armored Truck Service
9) Motor Vehicles
10) Building Materials
11) Films and Associated Commodities
12) Forest Products
13) Mine Ores, Not Including Coal
14) Retail Store Delivery
15) Explosives or Dangerous Articles
16) Specific Commodities Not Subgrouped

APPENDIX B

AN EXAMPLE OF A CARRIER'S ROUTE AUTHORITY

The following is an example of a carrier's route authority that has been excerpted from the official order of the Oklahoma Corporation Commission granting the operating rights:

> Between Oklahoma City, Oklahoma, and the Oklahoma-Texas State line approximately one (1) mile west of Texola, Oklahoma, serving all intermediate points except Bethany, Yukon, and El Reno, Oklahoma, and serving the off-route point of Hydro, Oklahoma.
>
> From Oklahoma City, Oklahoma via U.S. 66 and I.H. 40 to the Oklahoma-Texas State line, and return over the same route.
>
> 2. Between Oklahoma City, Oklahoma and Sayre, Oklahoma serving all intermediate points between Clinton, Oklahoma and Sayre Oklahoma, and the off-route points of Stafford, Oklahoma, Hammon, Oklahoma, and Herring, Oklahoma.
>
> From Oklahoma City, Oklahoma via I.H. 40 and U.S. 66 to Clinton, Oklahoma, thence via State Highway 73 to its junction with State Highway 34, thence to its junction with State Highway 33, thence via State Highway 33 to its junction with U.S. 283, thence U.S. 283 to Sayre, Oklahoma and return over the same route.
>
> 3. Between Oklahoma City, Oklahoma and intersection of State Highway 34 and State Highway 33, serving all intermediate points between Clinton, Oklahoma and the intersection of State Highway 34 and State Highway 33.
>
> From Oklahoma, City, Oklahoma via U.S. 66 and I.H. 40 to Clinton, Oklahoma, thence U.S. 183 to its intersection with State Highway 32, thence State Highway 33 to its intersection with State Highway 34, and return over the same route.
>
> 4. Between Oklahoma City, Oklahoma and Erick, Oklahoma serving the off-route points of Durham and Dempsey, and serving all intermediate points between Weatherford, Oklahoma and Erick, Oklahoma.
>
> From Oklahoma City, Oklahoma via I.H. 40 and U.S. 66 to Weatherford, Oklahoma, thence State Highway 54 to its intersection with State Highway 33, thence State Highway 33 to its intersection with U.S. 183, thence U.S. 183 to its intersection with U.S. 60, thence via U.S. 60 to Seiling, Oklahoma, Thence on U.S. Highway 60

to Arnett, Oklahoma, thence north via State Highway 46 to Gage, Oklahoma, thence via State Highway 15 to Shattuck, Oklahoma, thence via U.S. Highway 283 to its intersection with State Highway 33, thence via State Highway 33 to its intersection with State Highway 30, thence via State Highway 30 to Erick, Oklahoma and return over the same route.

5. Between Oklahoma City, Oklahoma and Sayre, Oklahoma, serving all intermediate points between Clinton, Oklahoma and Sayre, Oklahoma.

From Oklahoma City, Oklahoma via I.H. 40 and U.S. 66 to Clinton, Oklahoma, thence via U.S. 183 to itsintersection with State Highway 47, thence via State Highway 47 to its intersection with U.S. 283 thence via U.S. 283 to Sayre, Oklahoma, and return over the same route.

6. Between Oklahoma City, Oklahoma and Vici, Oklahoma serving all intermediate points between Elk City, Oklahoma and Vici, Oklahoma, and the off-route point of Trail, Oklahoma, and return over the same route.

From Oklahoma City, Oklahoma to Elk City, Oklahoma via I.H. 40 and U.S. 66, thence via State Highway 34 to Vici, Oklahoma, and return over the same route.

7. Between Oklahoma City, Oklahoma and the intersection of State Highway 33 and U.S. 283 approximately one (1) mile north of Roll, Oklahoma serving all intermediate points between Elk City, Oklahoma and the intersection of State Highway33 and U.S. 283.

From Oklahoma City, Oklahoma to Elk City, Oklahoma via I.H. 40 and U.S. 66, thence via State Highway 66 to its intersection with U.S. 283, thence U.S. 283 to its intersection with State Highway 33 and U.S.283, and return over the same route.

8. Between Oklahoma City, Oklahoma and the Oklahoma-Texas State line approximately five (5) miles west of Sweetwater, Oklahoma, servingall intermediate points between the intersection of State Highway 152 and State Highway 54 and the Oklahoma-Texas State line approximately five (5) miles west of Sweetwater, Oklahoma.

From Oklahoma City, Oklahoma via State Highway 152 to the Oklahoma-Texas State line approximately five (5) miles west of Sweetwater, Oklahoma, and return over the same route.

9. Between Oklahoma City, Oklahoma and Weatherford, Oklahoma, serving the off-route points of Corn, Oklahoma and Colony, Oklahoma.

From Oklahoma City, Oklahoma to Weatherford Oklahoma via I.H. 40 and U.S. 66, thence via State Highway 54 to its intersection with State Highway 152, and return over the same route.

10. Between Oklahoma City, Oklahoma and Sayre, Oklahoma, serving allintermediate points between Cordell, Oklahoma and Sayre, Oklahoma, includingCordell, Oklahoma.

From Oklahoma City, Oklahoma via State Highway 152 to Cordell, Oklahoma thence via U.S. 183 to Rocky, Oklahoma, thence via State Highway 55 to its intersection with state Highway 152, thence via State Highway 152 to Sayre, Oklahoma, and return over the same route.

11. Between Oklahoma City, Oklahoma and Butler, Oklahoma serving all intermediate points between Sentinel, Oklahoma, and Butler, Oklahoma and theoff-route point of Clinton Sherman Air Force Base.

From Oklahoma city, Oklahoma via I.H. 40 and U. S. 66 to Clinton, Oklahoma, thence via State Highway 183 to Rocky, Oklahoma, thence via State Highway 55 to Sentinel, Oklahoma, thence via State Highway 44 to Butler, Oklahoma, andreturn over the same route.

12. Between Elk City, Oklahoma and Retrop, Oklahoma, serving all intermediate points.

From Elk City, Oklahoma via State Highway 6 to Retrop, Oklahoma and return over the same route.

13. Between Elk City, Oklahoma and the intersection of State Highway 34 and State Highway 152.

From Elk City, Oklahoma via I.H. 40 and U.S. 66 to its intersection with State Highway 34, thence via State Highway 34, thence via State Highway 34 to its intersection with State Highway 152, and return over the same route.

14. Between Oklahoma City, Oklahoma and the intersection of U.S. Highway 183 and State Highway 47 serving all intermediate points between Thomas, Oklahoma and the intersection of U.S. 183.

From Oklahoma City, Oklahoma via I.H. 40 and U.S. 66 Weatherford, Oklahoma, thence State Highway 54 to Thomas, Oklahoma, thence State Highway 47 to its intersection with U.S. 183, and return over the same route.

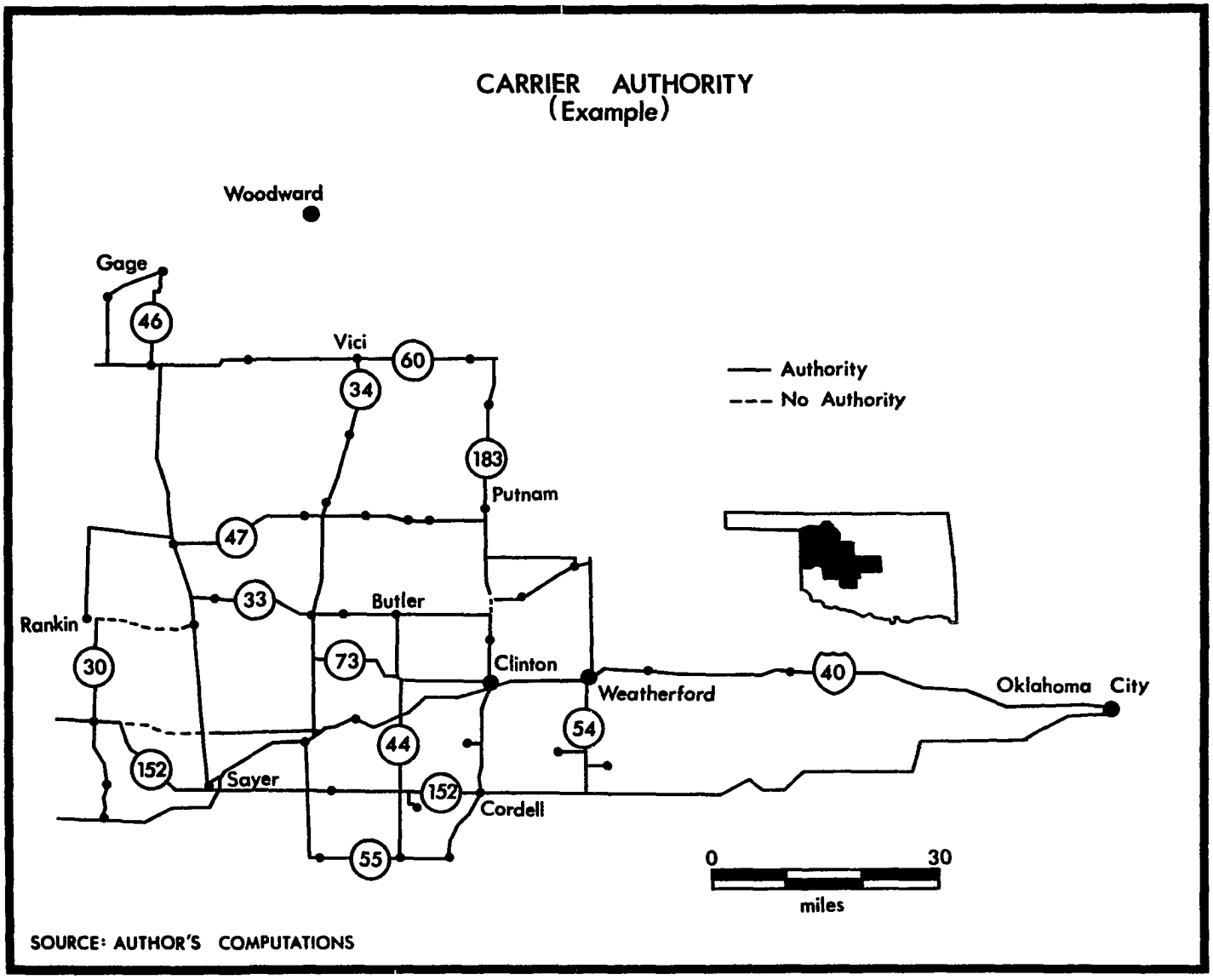

CARRIER AUTHORITY
(Example)
Woodward
Gage
46
Vici
60
34
183
Putnam
47
33
Butler
Rankin
30
73
Clinton
40
Oklahoma City
Weatherford
54
44
152
Sayer
152
Cordell
55
Authority
No Authority
0
30
miles
SOURCE: AUTHOR'S COMPUTATIONS

FIGURE 13

A P P E N D I X C

APPENDIX C

EVOLUTION OF REGULATION

Government regulation of common carriers had its beginnings with the attempts by several states to regulate railroads in the 1970's. Although strong antirailroad feelings had developed earlier, the movement in the 1870's was a result of a general agricultural depression and there were feelings that the railroads were responsible for a large part of the problem. The farmers, particularly in the Midwest, felt that freight rates were too high, that they had been tricked by railroad promoters--probably true for the most part--and that they were at the mercy of the eastern "Robber Barons." The various states enacted numerous laws, known collectively as the Granger Laws, during this period that generally attempted to do four things: (1) establish maximum rates, (2) prohibit local discrimination, (3) prohibit the dispersing of free passes to public officials, and (4) prohibit the merging of competing lines. While the Courts upheld the rights of the states to regular common carriers within their own legal jurisdiction the legality of interstate regulation by the states was not upheld.

This action then brought pressure on the federal government to provide interstate regulation and this movement, again backed primarily by agrarian elements of the Midwest, culminated in the passage of the Act to Regulate Commerce in 1887. Various actions by the federal judiciary and counteractions by the Congress to enforce the 1887 Act lead to the enactment of several additional laws. These were

consolidated and other shortcomings of the 1887 Act were eliminated by the passage of the Transportation Act of 1920. The only mode regulated under these acts was the railroads. This was due to the poor state of economic health enjoyed by the water carriers, which had yet to recover from the competition of the railroads, and the infantile state of the trucking industry.

Regulation of the motor carrier industry had its beginnings, like the railroads, on the state level. At first, when the commercial activity was largely restricted to urban areas there were no differences between the regulation of commercial carriers and privately owned vehicles. As the commercial activity increased, however, the states began to impose regulations specific to commercial carriers. The first laws were enacted by Pennsylvania in 1914 with most of the remaining states enacting regulatory laws in the next decade.

The heavy demand upon the railroads during World War I and their problem in coping with it caused the motor carrier operation to expand to fill the need. Though still functioning as auxillaries to the railroads, the carriers began short intercity movements, cutting into what was at that time a very lucrative portion of the railroads' traffic--high-value less-than-carload freight.

Expansion of the motor carrier industry gained further impetus from the period of economic boom following the war. The large amount of capital available made it easy for ex-soldiers, who had during the war become acquainted with the motor truck and its capabilities, to enter the industry. It was during this period that the motor carrier industry moved from infancy to adolescence--from the intra-urban to the interurban to the interstate.

The states responded to industry growth by increasing regulations in three different aspects of the industry: (1) safety--speed limits; length, height, and width of vehicles; brakes; lights; and other factors that affected the safe operation of the vehicles, (2) roadway protection--maximum weights, wheel spacing, axle weights, and other such requirements, and (3) economic regulation--minimum insurance requirements of cargo and liability, licensing, taxes, and issuance of Certificates or Permits of Public Convenience and Necessity, both interstate and intrastate. In 1925, the Supreme Court eliminated the state's control over interstate carrier operations by decisions handed down in three cases: Michigan Public Utilities Commission vs. Duke, 266 U.S. 573 (1925); Buck vs. Kuykendall, 267 U.S. 307 (1925); and George W. Bush and Sons vs. Malory, 267 U.S. 317 (1925).

The Court found the states' efforts to limit competition by denial of operating certificates or permits on the interstate level was not consistent with the commerce clause of the Constitution. The right of the states to exercise public power for the protection of its population and highways was not challenged nor was its right to elicit payments from interstate carriers for use of its highways through use of taxes and licenses.

After the Supreme Court decisions, the only entry control over interstate carriers was gone and unrestricted expansion resulted. No longer having any governmental requirements to satisfy, any person who could scrape together enough money for a downpayment on a truck and a tankfull of gasoline could become an interstate carrier. The economic euphoria of the period and the low capital requirement for entry caused the industry to overexpand which in turn caused fierce competition and the financial collapse of numerous carriers.

The condition of the industry lead to efforts to gain federal regulations with the first bill being introduced into Congress in 1925.

Efforts for federal regulation were intensified following the financial crisis in 1929 when the demand for transportation was greatly reduced due to a decline in industrial production. Competition for the available business grew, not only within the motor carrier industry but between the motor carrier and the railroads. It was the increased intermodal competition which gave the added impetus necessary for federal regulation of the motor carriers with the groups already striving for regulation--labor unions, railroads, state regulatory agencies, and the larger, more established motor carriers--being joined by segments of the federal government.

Under the National Industrial Recovery Act the motor carriers had, as all industries, adopted a code of voluntary regulation. The federal government, however, was faced with preventing financial collapse of the railroads, a task made more difficult by the non-regulated motor carriers competition with the regulated railroads. The Federal Coordinator of Transportation, Joseph B. Eastman, recommended in 1933 that all modes which competed with the railroads be regulated. This action became fact for the motor carriers when the Motor Carrier Act was passed on August 9, 1935 and became law on October 1, 1935.

Elements of the 1935 Motor Carrier Act

The Motor Carrier Act of 1935, which became Part II of the Inter-State Commerce Act in 1940, has served as a basis to which additions

have been made. There are five main sections of the Act: Carrier classification, entry controls, consolidation and merger regulations, rate controols, and accounts and securities supervision.*

There are three methods by which a company can become either a common or contract carrier: the grandfather clause, approval of applications for new operating authorities, and by merger or acquisition. The grandfather clause made allowances for those carriers operating prior to enactment of the 1935 Act. A common carrier could secure a Certificate of Public Convenience and Necessity--or in the case of contract carriers, a permit--if they made application to the Interstate Commerce Commission and could offer evidence they were actually in bona fide operation before June 1, 1935--contract carriers before July 1, 1935.

The second method, still in use, is to apply to the ICC for new operating authority. To secure a new certificate as a common carrier it must be proved to the satisfaction of the ICC that the proposed carrier is "fit, willing, and able" to perform the new service and that such new service is required to meet present and future public convenience and necessity. The application must give the type of service, the route, and a description of the commodities to be moved. The contract carrier must also, to secure a new permit, prove that it is "fit, willing, and able" and that the new operation is in line with public interest and national transportation policy. These requirements have, in effect acted to limit the number of carriers because of the difficulty of

*Carrier classification is the subject of Appendix I.

proving the need for additional service. The difficulty occurs due to the existence of certificates for almost every conceivable route and the need to prove the necessity of another carrier to adequately serve the route which is, in essence, necessary to prove the present carriers serving the route cannot handle the existing business. This almost invariably brings forth vigorous protest on the part of the existing carrier.

The third method in which a company can enter the motor carrier industry is to expand present operations through the purchase of existing operating right or merger with another carrier. This is covered by the third section of the Act. Most transfer of operating authorities, either by acquisition or merger, are subject to ICC approval. The exceptions are the very small firms where the total vehicles involved were less than twenty--later changed in 1965 to an aggregate gross income of less than $300,000. This section of the Act serves to preserve a measure of competition while the entry controls tend to limit competition.

Just as the 1920 Railroad Act, the 1935 Act established rate controls for motor carriers. It provided that all rates must be published and strictly observed and that adequate public notice of proposed rate changes must be given. Also, undue and unreasonable preference or prejudice toward persons, places, or commodities are prohibited. The ICC has the power, if a rate upon examination is found to be "unjust or unreasonable, or prejudicial" to "determine and prescribe the lawful rate, fare, or charge or the maximum or minimum, or maximum and minimum rate, fare, or charge thereafter to be observed."

The last major section gave the ICC authority to require periodic or special reports, proscribe a uniform system of accounts, and oversee the issuance of securities by the motor carriers. This section also allows exemption of the smaller carriers from its provisions.

A major omission of the 1935 Motor Act is the lack of a provision for the requirement for through routes and joint rates. It was thought that the large number of motor carriers would give the shippers a wide enough range of choices that such regulation would be unnecessary. The structure of the industry has changed since 1935 when it contained a large number of small carriers and very few interregional with dependence upon the railroad as a regional connector to a large number of interregional and even transcontinental lines connecting the regions with the smaller lines serving as feeder lines. This condition of the railroads no longer being important for much freight as regional connectors has resulted in some cases of regional isolationalism when the larger carriers legally restrict their establishment of through routes and joint rates. The provision for discrimination against intermediate points was also excluded. This means a motor carrier can charge an intermediate point a higher rate than the rate on freight moving through the point to another point. Again the philosophy was that the large number of carriers would effectively eliminate the problem.

State Regulation

The intent of Congress in the writing of the Motor Carrier Act of 1935 was not to assume the complete regulation of motor carriers

as expressed in section 202(c) of the Act which reads:

> Nothing in this part shall be construed to affect the powers of taxation of the several states or to authorize a motor carrier to do an intrastate business on the highways of any state, or to interfere with the exclusive exercise by each state of the power of regulation of interstate commerce by motor carriers on the highways thereof.

Thus, the state retained the right to control intrastate carriers in all aspects of economic regulations. It also retained the right to subject interstate carriers as well as intrastate to regulations for the protection of its highways and citizens and to impose taxes and licensing requirements upon interstate carriers. The rules and regulations of the states generally follow those of the federal government in the area of economic regulation with minor variation from state to state.

This appendix is a presentation of general nature and the contents represent a condensation, hopefully accurate, of a subject that can, and has been the main theme of a number of books. The quotations are from the original Motor Carrier Act as approved by the Congress while the thoughts, dates and court cases are common to most transportation studies. Some of the more helpful sources were: Pegrum (1968), Constantin and Hudson (1959), Locklin (1966), Sampson and Farris (1971), Taff (1953 and 1961), and Kahn (1958).

A P P E N D I X D

MC No. 23503

Service Report on Oklahoma Intrastate Traffic Date: April 3, 1973

Graves Truck Line, Inc. P. O. Drawer 838, 2130 So. Ohio, Salina, Ks. 67401 Dan H. Dalrymple

(Carrier) (Address) (Authorized Officer or Manager's Signature)
Dan H. Dalrymple, Traffic Mgr.

Note 1. Name all points authorized in certificate (if no service being furnished, state "None").
Note 2. After initial report is made, carriers will report subsequent changes only, within fifteen (15) days of change.
Note 3. Motor carrier must notify Commission, in writing, of his intention to discontinue any terminal facilities at least fifteen (15) days prior to effective date thereof.

Town	Days of Week Now Served	How Served (See Note 1)	Terminal Location	Agent	Address and Telephone	Remarks
Adams	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Baker	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Balko	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Beaver	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Billings	Mon - Wed - Fri	E	Enid, Okla.	Glen Holloway	229 E. Elm 405-234-2040	
Blackwell	Monday through Friday	K	Tonkawa, Okla.	Gerald Reames	2001 N. Public 405-628-2977	
Boise City	Monday through Friday	T	Boise City, Okla.	Wanda L. Jones	303 N. Cimarron 405-544-2982	
Boyd	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Braman	Monday through Friday	K	Tonkawa, Okla.	Gerald Reames	2001 N. Public 405-628-2977	
Clear Lake	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Elmwood	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Enid	Monday through Friday	T	Enid, Okla.	Glen Holloway	229 E. Elm 405-234-2040	
Eva	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Floris	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Forgan	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Ft. Sill	Monday through Friday	R	Lawton, Okla.	Bill R. Anderson	205 East D 405-353-0137	
Garber	Mon - Wed - Fri	E	Enid, Okla.	Glen Holloway	229 E. Elm 405-234-2040	
Gate	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Gray	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Goodwell	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Guymon	Monday through Friday	T	Guymon, Okla.	Wayne Jones	W. Hiway 54 405-338-6991	
Hardesty	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Hitchcock	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Hooker	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Hough	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Knowles	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Lawton	Monday through Friday	T	Lawton, Okla.	Bill R. Anderson	205 E. D 405-353-0137	
Logan	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Mocane	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Mouser	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Oklahoma City	Monday through Friday	T	Oklahoma City	Dean Sellers	1901 S.E. Skyline Dr. 405-672-2331	
Optima	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Ponca City	Monday through Friday	K	Tonkawa, Okla.	Gerald Reames	2001 N. Public 405-628-2977	
Randlett	Monday through Friday	R	Lawton, Okla.	Bill R. Anderson	205 East D 405-353-0137	
Slapout	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Straight	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Texhoma	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Tonkawa	Monday through Friday	T	Tonkawa, Okla.	Gerald Reames	2001 N. Public 405-628-2977	
Tulsa	Monday through Friday	T	Tulsa, Okla.	Frank Reeves	4310 S. Jackson 918-446-5403	
Turpin	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	
Tyrone	Monday through Friday	L	Liberal, Ks.	Dennis Haynes	568 Airport 316-624-1691	

NOTE 1: T - Full Terminal Service
L - Delivered from Liberal
K - Delivered from Tonkawa
E - Delivered from Enid

RECEIVED MOTOR CARRIER DIV. APR 5 1973

RECEIVED MOTOR CARRIER DIV. APR 5 1973

CORPORATION COMMISSION OF OKLAHOMA

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APPENDIX E

CARRIER CONNECTIONS IN THE MULTIPLE SERVICE REGION

SERVICE OF REGIONAL DISTRIBUTION CENTERS AND LOCAL TERMINALS

	OKC	TUL	FTS	HUGO	MUS	MAC	SPG
Ft. Smith							JRTL
McAlester	DAY	JRTL	JRTL				JRTL
	LEEW	ROCK					
	RIMT						
	ROCK						
Muskogee	JRTL	COFD					JRTL
	ROCK	JRTL					
		ROCK					
Springfield	JRTL	JRTL					
Hugo	RYAN						
Ada	COX	COX					
	RYAN						
Durant	RYAN	COFD				ROCK	
Ponca City	LEEW	ROCK					
	ROCK						
Cushing	B&B	B&B					
Henryetta	COX	JRTL	JRTL				JRTL
Holdenville	COX	COX					
	DAY						
Okemah	COX	COX					
Okmulgee	B&B	B&B					
		OKXP					
Poteau			ROBT	ROBT		ROBT	
Quinton			WILS			WILS	
Seminole	COX	COX					
	DAY						
Shawnee	COX	COX					
	DAY						
	TRIA						
Stigler			PRTL		CAMP		
Stillwater	B&B	B&B					
Tahlequah		OKEX	DAVS		DAVS		
Wewoka	COX	COX					
	DAY						
McCurtain			WILS			WILS	
Stillwell			DAVS			DAVS	

Source: Author's Computations

APPENDIX F

CLASSIFICATION OF BUSINESSES USED

BY

THE OKLAHOMA STATE TAX COMMISSION

FOOD GROUP

- Grocery Stores and Meat Markets
- Bakeries, Dairies, Delicatessens
- Confectioneries & Candy Stores*
- Fruit Stands & Vegetable Markets
- Restaurants, Cafes, Lunch Rooms
- Other Food & Beverage Concerns
- Taverns (excluding beer sales)

APPAREL GROUP

- Men's Clothing*
- Women's Apparel*
- Shoe Stores*
- Other Apparel Stores*

GENERAL MERCHANDISE GROUP

- Department & General Stores*
- Dry Goods Stores*
- Drug Stores, Pat. Med. Dealers*
- Variety Stores, Toy Shops*
- Hardware, Imp. & Farm Mach.*
- Household Appl. & Elec. Stores*
- Jewelry Stores & Watchmakers*
- Leather Goods Dealers*
- Sporting Goods Dealers*
- Cigar & News Stands (excluding tobacco)
- Books, Office & School Supplies*
- Second Hand Stores, Pawn Shops*

FURNITURE, FIXTURES & EQUIPMENT GROUP

- Furniture & Home Furnishings*
- Radio & Music Stores*
- Office & Commercial Furn. & Equip.*
- Office·Mach. & Cash Registers*

MOTOR VEHICLE GROUP

- Dealers (excluding Vehicle Sales)*
- Service Stations (excluding gas) Parking*
- Garages & Auto Repair Shops*
- Accessories, Bodies, Parts, Etc.*
- Auto Salvage, Misc. Auto Stores

LUMBER AND MATERIALS GROUP

- Lumber, Brick, Tile, Stone*
- Paint, Wall Paper & Glass*
- Metals*
- Heating & Plumbing Supplies*
- Other Materials & Bldg. Supplies*

SERVICE GROUP

- Hotels & Lodging Houses
- Theaters & Tent Shows
- Athletic Events & Misc. Amusement
- Printing & Advertising
- Barber & Beauty Shops
- Opticians
- Undertakers & Funeral Homes
- Photo & Blue Print Shops
- Shoe Repair Shops
- Other Services & Allied Supplies

PUBLIC UTILITY & TRANS. GROUP

- Railroads, Trolleys, Interurbans
- Telephone & Telegraphs Cos.
- Electric Gas & Water Utilities
- Motor Transportation
- Air Transportation
- Pipe Lines
- Other Utilities & Trans.

MISCELLANEOUS GROUP

- Fuel & Ice
- Feed, Seed, Grain, Fertilizer, etc.*
- Flowers & Nursery Stock*
- Tombstones & Monuments*
- Hatcheries
- Cotton Gins & Cotton Oil Mills
- Industrial Mach., Parts & Equipment*
- Oil Field Equipment*
- Explosives, Chemicals & Gases*
- Blacksmiths & Machine Shops*
- Commercial Supplies & Devices*
- Scientific Equipment & Supplies*
- Junk & Waste Dealers
- Misc. Retail & Commercial Firms*
- Auction & Casual Sales
- Business not Stated
- Schools
- Retail Liquor Stores
- Coin Operated Devices

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*Business types included in edited Community Sales Tax

A P P E N D I X G

STRUCTURE OF THE REGIONAL MODEL COMPUTER PROGRAM

The first step of the regional model computer program is to edit the imput cost matrix and identify nodes that are potential supply points (s_i) and the demand points (d_j). It then builds a second cost matrix composed of the preselected supply points and all points of the porblem as demand points. The original matrix intered was [141 x 816] which reduced to the cost matrix for the problem [115 x 816]. The program is structured to allow any subset matrix of the original cost matrix to be selected for use.

The second step in the program is to allocate the demand points to the nearest supply points. This is accomplished by scanning each row of the matrix for the minimum s_i-d_j cost. If the demand point is also a supply point, that row is passed over and the next is scanned. The determination of the minimum cost is accomplished by comparison of the s_1-d_j cost with all other $s_{2,n}$ for that particular d_j. When a lower cost is encountered, it then becomes the basis for comparison. In addition, some supply points are weighted to become more attractive due to their roles as transhipment points and the cost associated with transhipment. After all demand are assigned the result is a number of matrices equal to the number of initial preselected supply points of the form [3 x M] where the three columns are: 1, the demand point; 2, the s_i-d_j cost; and 3, the demand for each point.

The third step is the summation of the cost and demand columns. The sum of the demand column is added to the demand of the supply point

then compared with a minimum demand level—in the study problem this is 40,000 lbs/day. If the summed demand is greater than the minimum, the supply point is retained, if it is less then the supply point becomes a demand point. When any supply point has been deleted, the program then constructs a new cost matrix [(N-X) x M] where X is the number of deleted supply points. The program then repeats steps two and three until the summed demand for all supply points is greater than the minimum demand level specified. In the case of the study problem, this resulted in a final cost matrix of]35 x 816] or 35 supply points and 781 demand points (816 total points less the 35 supply points). The computer progam itself is given on the following pages.

```
STMT LEVEL NEST
                    /* TERMINAL AND RECEIVING POINTS PROBLEM FOR TERBUSH */
  1                 OUTER  PROC OPTIONS(MAIN)
  2     1           EXECUTION STEP PROC(N1,N2)
  3     2           OUT PUT ROUTINE PROC(N1,N2,D P,R P)
  4     3             DCL (N1,N2,D P(*,*)) FIXED BIN(15)
  5     3             DCL R P(*,*) FIXED BIN(31,7)
  6     3             PUT SKIP FILE(SYSPRINT) EDIT('PROBLEM COMPLETED','DISTRIBUTION POINT'
                                                  ,'S WILL BE LISTED WITH ASSOSIATED RECE'
                                                 ,'IVING POINTS')
                                                   (X(45),A,SKIP,A,A,A)
  7     3             DO J=1 TO N1
  8     3     1         IF D P(1,J) 0 THEN DO
 10     3     2           PUT SKIP(2) FILE(SYSPRINT) EDIT('DISTRIBUTION POINT',D P(1,J))
                                                      (A,X(2),F(5))
 11     3     2           PUT SKIP LIST('ASSOSIATED RECEIVING POINTS ARE   ')
 12     3     2           DO I=1 TO N2
 13     3     3             IF (R P(2,I)=J & R P(1,I) 0) THEN
 14     3     3     PUT SKIP FILE(SYSPRINT) EDIT(R P(1,I),R P(2,I),R P(3,I))
                                             (X(4),F(4),X(4),F(4),X(4),F(12))
 15     3     3           END
 16     3     2     PUT SKIP LIST('TOTAL POUNDAGE IS   ')
 17     3     2     PUT FILE(SYSPRINT) EDIT(TOTAL POUNDAGE(J))   (X(4),F(12))
 18     3     2     PUT SKIP LIST('TOTAL DISTANCE IS  ')
 19     3     2     PUT FILE(SYSPRINT) EDIT(TOTAL DISTANCE(J))   (X(4),F(12))
 20     3     2       END
 21     3     1     END
 22     3             PUT FILE(SYSPRINT) SKIP(2) LIST(REPEAT('*',25),'END PART ONE',
                                                 REPEAT('*',25))
 23     3           RETURN
 24     3           END OUT PUT ROUTINE
 25     2           POINT SET PROC(DISTRIBUTION POINT,RECEIVING POINT,J)
 26     3             DCL (DISTRIBUTION POINT(*,*),J) FIXED BIN(15)
 27     3             DCL RECEIVING POINT(*,*) FIXED BIN(31,7)
 28     3             DCL M FIXED BIN(15)
 29     3             DCL I FIXED BIN(30)
 30     3             IF RECEIVING POINT(1,J) 0 THEN DO
 32     3     1       M=1
 33     3     1       BACK5  IF( DISTRIBUTION POINT(1,M) 0   DISTANCE(J,M)=0)
 34     3     1       THEN DO
 35     3     2         M=M+1
 36     3     2         GO TO BACK5
 37     3     2       END
 38     3     1     OUT3  ST1=DISTANCE(J,K)*DISTRIBUTION POINT(3,M)
 39     3     1       DO I=M+1 TO N1
 40     3     2         IF (DISTRIBUTION POINT(1,I) 0 & DISTANCE(J,I) =0) THEN DO
 42     3     3           IF DISTRIBUTION POINT(3,I)*DISTANCE(J,I) ST1 THEN DO
 44     3     4             M=I
 45     3     4             GO TO OUT3
 46     3     4           END
 47     3     3         END
```

```
STMT LEVEL NEST
   48    3  2        END
   49    3  1        RECEIVING POINT(2,J)=M
   50    3  1      END
   51    3          RETURN
   52    3        END POINT SET
   53    2        INPUT PROC
   54    3        DCL (((D,N,(T)(1540)),JR(856),NODE,I,J) FIXED BIN(31),
                       (SYSIN,SYSPRINT) FILE, NODES LEFT BIT(1) INIT('1'B)
   55    3        DCL STR CHAR(108)
   56    3        DCL (NRJT,NRJP) FIXED BIN(31)
   57    3        GET FILE(SYSIN) LIST(NRJT)
   58    3        NRJP=N2
   59    3        ON ENDFILE(FIL1) BEGIN
   61    4        NODES LEFT='0'B
   62    4        END
   63    3        IT=-1B
   64    3          GET SKIP FILE(SYSIN) EDIT((RECEIVING POINT(1,I),RECEIVING POINT(3,I)
                           DO I=1B TO N2))((N2) (X(4),F(4),X(4),F(10,2),SKIP))
   65    3        GET SKIP FILE(SYSIN) LIST((DISTRIBUTION_POINT(1,J) DO J=1 TO N1))
   66    3        DO I=1B TO N2
   67    3  1     IF(RECEIVING POINT(1,I))=0
   68    3  1     END
   69    3        DO I=1B TO N1
   70    3  1     IT(DISTRIBUTION POINT(1,I))=1B
   71    3  1     END
   72    3        OPEN FILE(FIL1) INPUT
   73    3        OPEN FILE(FIL2) OUTPUT
   74    3        DO WHILE (NODES LEFT)
   75    3  1     GET FILE(FIL1) EDIT(NODE,(N(I),D(I) DO I=1B TO NRJT),STR)
                  (F(4),(NRJT*2) F(4),A(108))
   76    3  1     IF IT(NODE) = 1B THEN DO
   78    3  2     JR=0B
   79    3  2     I=1B
   80    3  2     DO J=1B TO NRJT
   81    3  3     IF IT(N(J))  =0B THEN DO
   83    3  4     JR(I)=D(J)
   84    3  4     I=I+1B
   85    3  4     END
   86    3  3     END
   87    3  2     PUT FILE(FIL2) EDIT(      (JR(I) DO I=1B TO NRJP))((NRJP  ) F(4))
   88    3  2     END
   89    3  1     END
   90    3        CLOSE FILE(FIL1)
   91    3        CLOSE FILE(FIL2)
   92    3        RETURN
   93    3        END INPUT
   94    2        DCL DISTRIBUTION POINT(3,N1) FIXED BIN(15)
   95    2        DCL DISTANCE(N2,N1) FIXED BIN(15) CONTROLLED UNALIGNED
   96    2        DCL (N1,N2,I,J,L,M,REG DIST PT(15),LOAD FACTOR,CONSTANT)
```

```
STMT LEVEL NEST

                        FIXED BIN(15)
 97     2          DCL (TOTAL DISTANCE(N1),TOTAL POUNDAGE(N1), MINIMUM POUNDAGE,ST1)
                        FIXED BIN(31)
 98     2            DCL RECEIVING POINT(3,N2) FIXED BIN(31,7)
 99     2          DCL (FIL1,FIL2) FILE
100     2            DCL OUTPUT ROUTINE ENTRY
101     2            DCL POINT SET ENTRY
102     2          GET FILE(SYSIN) LIST(LOAD FACTOR,CONSTANT,MINIMUM POUNDAGE)
103     2          CALL INPUT
104     2          DO I=1 TO N1
105     2  1         DISTRIBUTION POINT(3,I)=CONSTANT
106     2  1       END
107     2          GET SKIP FILE(SYSIN) EDIT(N OF RDP,(REG DIST PT(I) DO I=1 TO N OF RDP)
                                    )(F(4),(N OF RDP) F(4))
108     2          OPEN FILE(FIL2) INPUT
109     2          ALLOCATE DISTANCE
110     2          DO J=18 TO N1
111     2  1       GET FILE(FIL2) EDIT((DISTANCE(L,J) DO L=18 TO N2))((N2) F(4))
112     2  1       END
113     2          CLOSE FILE(FIL2)
114     2          L=1
115     2            DO J=1 TO N1
116     2  1         IF DISTRIBUTION POINT(1,J)=REG DIST PT(L) THEN DO
118     2  2           DISTRIBUTION POINT(3,J)=DISTRIBUTION POINT(3,J) - LOAD FACTOR
119     2  2           L=L+1
120     2  2         END
121     2  1       END
122     2          IF (L-1)  = N OF RDP THEN DO
124     2  1         PUT SKIP FILE(SYSPRINT) LIST('A REGIONAL DIST IS NOT LIST A DIST'
                    ,'POINT')
125     2  1         RETURN
126     2  1       END
127     2          BACK4 DO J=1 TO N2
128     2  1       CALL POINT SET(DISTRIBUTION POINT,RECEIVING POINT,J)
129     2  1       END
130     2            DO J=1 TO N1
131     2  1         DO I=1 TO N2
132     2  2           IF DISTRIBUTION POINT(1,J)=RECEIVING POINT(1,I) THEN DO
134     2  3             DISTRIBUTION POINT(2,J)=I
135     2  3             RECEIVING POINT(1,I)=-RECEIVING POINT(1,I)
136     2  3             GO TO OUT1
137     2  3           END
138     2  2         END
139     2  1         PUT FILE(SYSPRINT) LIST('DIST-POINT',DISTRIBUTION POINT(1,J),
                                    'IS NOT LISTED AS RECEIVING POINT')
140     2  1       RETURN
141     2  1     OUT1 END
142     2          BACK6 DO J=1 TO N1
143     2  1       TOTAL DISTANCE(J)=0
```

```
STMT LEVEL NEST
  144     2    1   TOTAL POUNDAGE(J)=RECEIVING POINT(3,DISTRIBUTION POINT(2,J))
  145     2    1     IF DISTRIBUTION POINT(1,J) 0 THEN DO
  147     2    2       DO I=1 TO N2
  148     2    3       IF RECEIVING POINT(1,I) 0 & RECEIVING POINT(2,I)=J THEN DO
  150     2    4   TOTAL POUNDAGE(J)=TOTAL POUNDAGE(J) + RECEIVING POINT(3,I)
  151     2    4   TOTAL DISTANCE(J)=TOTAL DISTANCE(J) + DISTANCE(I,J)
  152     2    4       END
  153     2    3     END
  154     2    2   IF (TOTAL POUNDAGE(J) MINIMUM POUNDAGE & DISTRIBUTION POINT(3,J)=
  155     2    2         CONSTANT) THEN DO
  156     2    3           L=DISTRIBUTION POINT(2,J)
  157     2    3           RECEIVING POINT(1,L)=-RECEIVING POINT(1,L)
  158     2    3           DISTRIBUTION POINT(1,J)=-DISTRIBUTION POINT(1,J)
  159     2    3           I=RECEIVING POINT(2,L)
  160     2    3           IF DISTRIBUTION POINT(1,I)   0 THEN
  161     2    3   CALL POINT SET(DISTRIBUTION POINT,RECEIVING POINT,L)
  162     2    3       DO I=1 TO N2
  163     2    4       IF RECEIVING POINT(2,I)=J THEN
  164     2    4   CALL POINT SET(DISTRIBUTION POINT,RECEIVING POINT,I)
  165     2    4       END
  166     2    3     END
  167     2    2   END
  168     2    1   END
  169     2          CALL OUT PUT ROUTINE(N1,N2,DISTRIBUTION POINT,RECEIVING POINT)
  170     2        FREE DISTANCE
  171     2        END EXECUTION STEP
  172     1          DCL (NUMBER OF DP,NUMBER OF RP) FIXED  BIN(15)
  173     1          DCL EXECUTION STEP ENTRY
  174     1          GET FILE(SYSIN) LIST(NUMBER OF DP,NUMBER OF RP)
  175     1          CALL EXECUTION STEP(NUMBER OF DP,NUMBER OF RP)
  176     1          STOP
  177     1        END OUTER
```

BIBLIOGRAPHY

Public Documents

Oklahoma Corporation Commission. Rules and Regulations of Motor Carriers (Effective December 1, 1971). Oklahoma City: Oklahoma Corporation Commission, 1971.

Oklahoma Industrial Development and Parks Department. Oklahoma Directory of Manufactures and Products, 1972 Oklahoma City: State of Oklahoma, 1972.

Oklahoma State Highway Commission. Official Oklahoma State Highway Map, 1973. Oklahoma City: State Highway Department, 1973.

Statistical Abstract of Oklahoma, 1972. Norman, Oklahoma: Bureau for Business and Economic Research, University of Oklahoma, 1973.

U.S. Bureau of the Census. Census of Population: 1970, General Population Characteristics, Final Report PC(1)-B38 Oklahoma. Washington, D.C.: U.S. Government Printing Office, 1971.

Books

Aaker, David A. Multivariate Analysis in Marketing: Theory and Application. Belmont, California: Wadsworth Publishing Company, Inc., 1971.

Becht, J. Edwin. A Geography of Transportation and Business Logistics(The Brown Foundations of Geography Series). Dubuque,Iowa: Wm. C. Brown Company Publishers, 1970.

Constantin, James A. The Characteristics of Motor Freight Movements by General Commodity Carriers in Oklahoma (Small Business Management Reports, Funded by the Small Business administration through the Oklahoma Department of Commerce and Industry). Norman, Oklahoma: 1963.

Constantin, James A. and Smith, Raymond L. Oklahoma Rate-Making Practice and Structure Analysis and Recommendations for Economically More Effective Rate and Service Schedules (Ozarks Regional Commission Contract TA68-10(NEG)0-3). Norman, Oklahoma: 1970.

Commercial Atlas and Marketing Guide. Chicago: Rand McNally and Co., 1972.

Draper, N. R. and Smith, H. Applied Regression Analysis (Wiley Series in Probability and Mathematical Statistics). New York: John Wiley and Sons, Inc., 1966.

Hagle, Paul, et al. Basic Data and Projections for the Oklahoma Economy by Planning District. Stillwater, Oklahoma: Oklahoma State University Research Foundation, 1973.

Hudson, William J. and Constantin, James A. Motor Transportation: Principle and Practice. New York: The Ronald Press Company, 1958.

Hurst, Michael E. Eliot. A Geography of Economic Behavior: An Introduction. North Scituate, Mass.: Durbury Press, 1972.

Kahn, Fritz R. Principles of Motor Carrier Regulation. Dubuque, Iowa: Wm. C. Brown Company Publishers, 1958.

Locklin, Philip D. Economics of Transportation. 6th ed. Homewood, Illinois: Richard D. Irwin, Inc. 1966.

Massam, Bryan H. The Spatial Structure of Administrative Systems(Commission on College Geography Resource Paper No. 12). Washington, D.C.: Association of American Geographers, 1972.

Pegrum, Dudley F. Transportation: Economics and Public Policy 2nd ed. (The Irwin Series in Economics). Homewood, Illinois: Richard D. Irwin, Inc., 1968.

Sampson, Roy J. and Farris, Martin T. Domestic Transportation: Practice, Theory, and Policy. 2nd ed. Boston: Houghton-Mifflin Co., 1971.

Scott, Allen J. An Introduction to Spatial Allocation Analysis (Commission on College Geography Resources Paper No. 9). Washington, D.C.: Association of American Geographers, 1971.

Taaffe, Edward J. and Gauthier, Howard L. Geography of Transportation(Foundations of Economic Geography Series). Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1973.

Taff, Charles. Commercial Motor Transportation. 4th ed. Homewood, Illinois: Richard D. Irwin, Inc., 1969.

Taff, Charles A. Operating Rights of Motor Carriers. Dubuque, Iowa: Wm. C. Brown Company Publishers, 1953.

Articles

Alao, Nurudeen. "Two Classes of Distance Minimization Problems: A Review, Some New Interpretations, and Extensions," Geographical Analysis, Vol. 3, No. 4 (October, 1971), 299-319.

Bellman, Richard. "Notes on the Theory of Dynamic Programming--Transportation Models," Management Science, Vol. 4 No. 2 (January, 1958), 191-195.

Berry, Brian J. L. "Recent Studies Concerning the Role of Transportation in the Space Economy," Annals of the Association of American Geographers, Vol. 49, No. 3 (September, 1959), 328-342.

Beuthe, Michael V. "A Predictive Model of Regional Demands for Freight Transportation," Journal of Regional Science, Vol. 12, No. 1(1972),85-93.

Charnes, A. and Cooper, W.W. "The Stepping Stone Method of Explaining Linear Programming Calculations in Transportation Problems," Management Science, Vol. 1, No. 1(October, 1954),49-69.

Cooper, Leon. "Solutions of Generalized Locational Equilibrium Models," Journal of Regional Science, Vol 7, No. 1, (1967),1-18.

Cox, Kevin R. "The Application of Linear Programming to Geographic Problems," Tijdschrift voor Economische en Sociale Geografie, Vol. 56 (1965), 228-236.

Dantzig, George B. "Application of the Simplex Method to a Transportation Problem," Chapter XXIII, Activity Analysis of Production and Allocation. T.C. Koopmans ed. New York: John Wiley and Sons,Inc., 1951.

Dantzig, G.B. and Ferguson, A. R. "The Problem of Routing Aircraft," Aeronautical Engineering Review, Vol. 14 (April, 1965), 51-55.

_____. "The Allocation of Aircraft to Routes -- An Example of Linear Programming under Uncertain Demand," Management Science, Vol. 3, No. 1(October, 1956), 45-73.

Ford, L. R., Jr. and Fulkerson, D.C. "Solving the Transportation Problem," Management Science, Vol. 3, No. 24(October, 1956), 24-32.

Gardner, Marilyn Tschanner. "The Basic Geometric Approach to Network Optimization Applied to Systems Design," Proceedings of the American Association Geographers, Vol. 3(1971), 52-55.

Garrison, W.L. and Marble, D.F. "Factor-Analytic Study of the Connectivity of a Transportation Network," Papers, Regional Science Association: European Congress, 1963, Vol. 12(Lund Congress, 1964), 231-238.

Gifford, Gilbert L. "The Small Shipment Problem," Transportation Journal, Fall(1970), 17-27.

Hitchcock, F.L. "The Distribution of a Product from Several Sources to Numerous Localities," Journal of Mathematics and Physics, Vol. 20(1941), 224-230.

Koopmans, T.C. "A Model of Transportation," Chapter XIV, Activity Analysis of Production and Allocation. T.C. Koopmans ed. New York: John Wiley and Sons, Inc., 1951.

Kriebel, Charles H. "Warehousing with Transhipment Under Seasonal Demand," Journal of Regional Science, Vol 3, No. 1(1961), 57-69.

Nordbeck, Stig. "Computing Distances in Road Nets," Papers, Regional Science Association: European Congress, 1963, Vol. 12(Lund Congress, 1964), 207-220.

Poole, Michael A. and O'Farrell, Patrick N. "The Assumptions of the Linear Regression Model," Transactions of British Geographers, Vol. 52 (1971), 145-158.

Taaffe, E.J., Morrill, R.L., and Gould, P.R. "Transport Expansion in Underdeveloped Countries: A Comparative Analysis," The Geographical Review, Vol. 53 (October, 1963), 503-529.

Tapiero, Charles S. "Transportation-Location-Allocation Problems over Time," Journal of Regional Science, Vol. 11, No. 3 (1971), 377-384.

Thomas, Benjamin E. "Methods and Objectives in Transportation Geography," The Professional Geographer, Vol. 8, No. 4 (July, 1956), 2-5.

Ford, L. R., Jr. and Fulkerson, D.C. "Solving the Transportation Problem," Management Science, Vol. 3, No. 24(October, 1956), 24-32.

Gardner, Marilyn Tschanner. "The Basic Geometric Approach to Network Optimization Applied to Systems Design," Proceedings of the American Association Geographers, Vol. 3(1971), 52-55.

Garrison, W.L. and Marble, D.F. "Factor-Analytic Study of the Connectivity of a Transportation Network," Papers, Regional Science Association: European Congress, 1963, Vol. 12(Lund Congress, 1964), 231-238.

Gifford, Gilbert L. "The Small Shipment Problem," Transportation Journal, Fall(1970), 17-27.

Hitchcock, F.L. "The Distribution of a Product from Several Sources to Numerous Localities," Journal of Mathematics and Physics, Vol. 20(1941), 224-230.

Koopmans, T.C. "A Model of Transportation," Chapter XIV, Activity Analysis of Production and Allocation. T.C. Koopmans ed. New York: John Wiley and Sons, Inc., 1951.

Kriebel, Charles H. "Warehousing with Transhipment Under Seasonal Demand," Journal of Regional Science, Vol 3, No. 1(1961), 57-69.

Nordbeck, Stig. "Computing Distances in Road Nets," Papers, Regional Science Association: European Congress, 1963, Vol. 12(Lund Congress, 1964), 207-220.

Poole, Michael A. and O'Farrell, Patrick N. "The Assumptions of the Linear Regression Model," Transactions of British Geographers, Vol. 52 (1971), 145-158.

Taaffe, E.J., Morrill, R.L., and Gould, P.R. "Transport Expansion in Underdeveloped Countries: A Comparative Analysis," The Geographical Review, Vol. 53 ()ctober, 1963), 503-529.

Tapiero, Charles S. "Transportation-Location-Allocation Problems over Time," Journal of Regional Science, Vol. 11, No. 3 (1971), 377-384.

Thomas, Benjamin E. "Methods and Objectives in Transportation Geography," The Professional Geographer, Vol. 8, No. 4 (July, 1956), 2-5.

_____. Interviews with owners or managers of all business establishments in Arnett, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Eldorado, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Geary, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Hinton, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Hydro, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Laverne, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Olustee, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Sharon, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Snyder, Oklahoma. October, 1972.

_____. Interviews with owners or managers of all business establishments in Tipton, Oklahoma. October, 1972.

_____. Interviews and personal conversations with owners or managers of all Oklahoma intrastate common carriers during the period from July, 1972 to May, 1974.

_____. Service Schedules of all Oklahoma interstate common carriers of general freight.