A STUDY OF INTERCOUNTY COMMUTING IN OKLAHOMA, 1970

By

CHI-PING JOSEPH HU

Bachelor of Arts in Economics
National Taiwan University
Taipei, Taiwan
The Republic of China
1968

Master of Arts
The University of New Mexico
Albuquerque, New Mexico
1971

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
DOCTOR OF PHILOSOPHY
December, 1974

A STUDY OF INTERCOUNTY COMMUTING

IN OKLAHOMA, 1970

Thesis Approved:

Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGEMENT

The author wishes to express his sincere appreciation and indebtedness to his major adviser, Dr. Larkin B. Warner, for his encouragement, guidance and assistance throughout this study.

Appreciation is also extended to the members of the committee: Dr. Gerald M. Lage, Dr. Dean F. Schreiner and Dr. John C. Shearer for their helpful suggestions and comments.

Helpful comments by Dr. Frank G. Steidl, Dr. Wallace E. Huffman, Prof. Ronald L. Moomaw, Mr. J. Patrick O'Brien, Mr. Douglas W. McNiel and Mr. Ronald W. Presley are gratefully acknowledged.

Dr. Richard H. Leftwich, Head of the Economics Department, and Dr. Robert L. Sandmeyer, the Graduate Student Adviser, deserve my special thanks for their constant encouragement and friendship which made my three years of graduate study at Oklahoma State University a pleasant memory.

Finally, special gratitude is expressed to my wife, Linda, for her understanding, encouragement and many sacrifices.

TABLE OF CONTENTS

LIST OF TABLES

Table		Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Purposes of the Study

The 1970 Census of Population showed that about one out of every nine workers in the state of Oklahoma worked outside their counties of residence. These flows of intercounty commuting present an important research problem for two related reasons: (1) they place a burden on transportation facilities and (2) they require economic resources and time to be devoted to daily commuting.[1]

The purposes of this study are: (1) to provide an overall view of the 1970 intercounty commuting flows in Oklahoma and their relationships to selected economic growth characteristics, (2) to describe the typical characteristics of intercounty commuters in Oklahoma and (3) to develop a theoretical model analyzing the determinants of intercounty commuting. Thus, in addition to providing a detailed study of Oklahoma intercounty commuting flows, the present study also attempts to answer two fundamental questions: (1) What are the typical characteristics of intercounty commuters in Oklahoma? and (2) What are the determinants of intercounty commuting?

---

[1]As shown in Table 50 of the U. S. 1970 Census of Population, out of 950,293 workers in Oklahoma in 1970, 84 percent of them depended on private automobile as a means of transportation to work. This is a good indication of the extent of burdens on transportation and requirement of economic resources that were caused by intercounty commuting.

Since the 1960 Census of Population reported the number of workers working outside their counties of residence but did not report their counties of work, before 1970 it was impossible to use the Census of Population data to analyze state-wide intercounty commuting. The Summary User Tapes of the 1970 Census of Population, for the first time, reported county of work as well as county of residence for commuters.[2] The availability of this valuable information should also be counted as an additional motivation of the present study.

Methodology of the Study

In the analysis of intercounty commuting, two models are developed: a model of commuting characteristics and a model of commuting flows. There are differences as well as similarities between the two models. Both models are built in the form of a multiple regression equation and have analytical content concerning intercounty commuting. However, the model of commuting characteristics estimates the typical characteristics of intercounty commuters in Oklahoma, while the model of commuting flows estimates the determinants of intercounty commuting. The differences between the two models lie in the utilization of dependent variables and the process of developing the models.

Since the model of commuting characteristics is designed to estimate

[2]The data on 1960 intercounty commuting flows comparable to the 1970 data were finally made available through the Bureau of Economic Analysis, U. S. Department of Commerce, on June 27, 1974 after the present study was completed. The information on the number of commuters from one county to another was collected on the basis of a 15 percent sample. The sampling results were then expanded by the U. S. Bureau of the Census to obtain the total number of intercounty commuters. Consequently, this information is subject to sampling error and all the problems related thereto.

the typical characteristics of intercounty commuters in Oklahoma, this model is concerned only with the county of origin, and the county of destination is irrelevant. Therefore, the county commuting rate of the origin county is used as the dependent variable. Since there are seventy-seven counties in Oklahoma, the regression analysis of this model is based on seventy-seven observations. The purpose of the model of commuting flows is to estimate the determinants of intercounty commuting; therefore, both counties of origin and destination must be considered. Hence, the dependent variable used in the model is the number of commuters from one county to another. In Oklahoma, there were 586 combinations of origin-destination intercounty flows in 1970; consequently, this model is based on 586 observations.

Furthermore, the process of developing the two models is different. In the model of commuting characteristics, independent variables are tentatively selected in initial stage based on selected but diverse empirical studies and economics theories. A stepwise multiple regression technique is adopted to select a best set of independent variables which explains most of the variation of county commuting rates. In the model of commuting flows, each independent variable is selected on the basis of the discussion of the functions of commuting in Chapter II. The functional relationships between the dependent and independent variables are hypothesized within the framework of household behavior theory assuming utility maximization. In general, the model of commuting characteristics is developed by deduction whereas the model of commuting flows is built by induction.

Important Definitions

Several definitions which are important in the study are presented as follows.

(1) Intercounty commuters refers to a person who was employed and actually on the job during the week prior to when the census was taken, and who reported living in one county but working in another. The data usually apply to the last week in March, 1970. The group covered includes persons 14 years old and over. Persons are treated as employed for this purpose who "did any work at all as paid employees or in their own business or profession, or on their own farm or in a family business."[3]

Throughout the study, the word "commuter", if not otherwise specified, means intercounty commuter. The difference between an intercounty commuter and an intracounty commuter is that the former commutes across the county boundary whereas the latter does not. County boundaries are arbitrary lines. Some intercounty commuting is for very short distances, while some intracounty commuting is for very long distances. In general, it is assumed in this study that intercounty commuting reflects more substantial distances than intracounty commuting.

(2) County commuting rate is defined as the number of workers who worked outside the county of residence divided by the total workers

---

[3]U. S. Bureau of the Census, Census of Population: 1970, Characteristics of the Population, Vol. 1, Part 38, Oklahoma, Appendix B, p. 20.

residing in the county.[4] Regional and state commuting rates are defined in the same manner.

(3) <u>Substate planning regions</u> are multiple regions designated by the state of Oklahoma for planning purposes. The eleven planning regions are shown in the figure on page 19.

Organization of the Study

A synthesis of the theoretical studies of different approaches to the commuting phenomenon, as they are often mentioned in the recent literature, is presented in Chapter II.

In Chapter III, the growth of intercounty commuting from 1960 to 1970 by substate planning region is examined. The origins and destinations of intercounty commuting flows in 1970 are also studied by substate planning region. Moreover, commuting across state boundaries is also presented by substate planning region. A typology is provided based on a classification of a county's commuting rate in 1970, population size in 1970 and population growth from 1960 to 1970. The purpose is to study the role of intercounty commuting in the growth of population and employment of a county.

Chapter IV presents the model of commuting characteristics. The model is built in the form of a multiple regression equation. County commuting rate is used as the dependent variable. Twelve variables reflecting a county's social, economic, geographic and demographic

---

[4]A worker is defined by the U. S. Bureau of the Census as a person 14 years old or over who was employed and actually on the job during the week prior to when the census was taken. An "employed" person may not be a "worker" if he was not on the job during the week prior to when the census was taken.

characteristics are tentatively selected to describe the typical characteristics of intercounty commuters in Oklahoma. The importance of each independent variable and its expected relationship with the county commuting rate is briefly discussed. In order to select a set of independent variables which explains most of the variation of county commuting rates, a stepwise regression technique is adopted. The regression results are interpreted and their properties are examined after the regression analysis.

A model of commuting flows is developed in Chapter V. The model is also built in the form of a multiple regression equation. The number of commuters from one county to another is adopted as the dependent variable in the model. The price of a given quality of housing services, employment opportunities, commuting distance and population between 18 and 64 years of age in the counties of origin and destination are used as independent variables. The functional relationships between the dependent and independent variables are discussed, hypothesized and then tested by Oklahoma intercounty commuting data.

Summary and conclusions of the present study are presented in the final chapter.

CHAPTER II

APPROACHES TO THE COMMUTING PHENOMENON

Introduction

The purpose of this chapter is to synthesize some different approaches to the commuting phenomenon as they are often mentioned in the recent literature. The discussion of commuting in the present chapter is inclusive of intercounty and intracounty commuting.

For the last two decades many aspects of commuting have been studied empirically as well as theoretically. Most empirical studies of commuting were focused on the identification of the commuting patterns for the labor force of a large employer[1] or a region. In these studies, various factors such as occupational status,[2] social-economic level of workers,[3]

---

[1]A. R. Grimes, Jr., "An Analysis of the Determinants of the Commuting and Residence Patterns of the Oklahoma City Air Materiel Area Labor Force" (unpub. Ph.D. dissertation, Oklahoma State University, 1970).

[2]J. O. Wheeler, "Occupational Status and Work-Trips: A Minimum Distance Approach," Social Forces, 45(June, 1967), pp. 508-515.

[3]B. Duncan, "Factors in Work-Residence Separation: Wage and Salary Workers, Chicago, 1951," American Sociological Review, 21(February, 1956), pp. 48-56.

education,[4] wage, age, sex and length of service,[5] family income,[6] mode of travel,[7] etc. are generally discussed. As for theoretical studies, analysis of the functions of commuting is usually the focus of research.

Since each region has its own unique social economic and topographic characteristics, results of empirical studies which are based on these settings may be "highly tentative and often unsupported by other investigation."[8] In Peterson's words, this becomes even more clear: "The one general conclusion that can be drawn from previous studies is that commuting patterns are highly unique and vary widely from place to place and from time to time."[9] Accordingly, to generalize results of a diverse set of empirical findings is not the main concern of this chapter.

Generally speaking, the functions of commuting can be synthesized into three categories. These functions, which are not mutually exclusive, are:

(1) a substitute for migration;

---

[4]A. Scaff, "The Effect of Commuting on Participation in Community Organizations," American Sociological Review, 17(April, 1952), pp. 215-220.

[5]R. Lonsdale, "Two North Carolina Commuting Patterns," Economic Geography, 42(April, 1966), pp. 114-138.

[6]A. J. Catanese, "Home and Workplace Separation in Four Urban Regions," American Institute of Planners Journal, 37(September, 1971), pp. 331-337.

[7]L. Reeder, "Social Differentials in Mode of Travel, Time and Cost in the Journey to Work," American Sociological Review, 21(February, 1956), pp. 56-63.

[8]J. O. Wheeler, "Research on the Journey-to-Work: Introduction and Bibliography," Council of Planning Librarians, Exchange Bibliography, 65(January, 1969), p. 1.

[9]C. A. Peterson, An Iowa Commuting Pattern and Labor Market Area in General (Iowa City, 1961), p. 5.

(2) an adjustment for maldistribution of employment opportunities; and

(3) a balance of locational preference between residence and workplace.

The following discussion will examine these approaches.

Commuting as a Substitute for Migration

A pioneer study of commuting done by Liepmann suggested two basic motivating forces behind daily commuting.

> In describing the various trends, it has already been mentioned that some journeys are due to the way in which urban settlements have grown; topographic conditions are one main cause of the journey-to-work. Others lie in the economic and social fields: in the structure and requirements of the modern system of society.[10]

Thus, daily commuting is considered as a coordination between residence and workplace. It enhances the labor mobility and widens the labor market.

In the eyes of labor market analysts, commuting has long been considered as a possible substitute for migration.[11] In the context of the relationship between residence and workplace, migration involves changes in residential location whereas commuting does not. Before commuting by automobile became practical, a worker who took a job, for example, fifty miles away from his home would generally have to move closer to the workplace in order to keep that job. Nowadays, this kind of migration is no

---

[10] K. Liepmann, The Journey to Work (New York, 1944), p. 7.

[11] For instance: K. Goldstein and S. Mayer, "Migration and the Journey-to-Work," Social Forces, 42(May, 1964), pp. 472-481. L. Yapa, M. Polese and J. Wolpert, "Interdependence of Commuting, Migration and Job Site Relocation," Economic Geography, 47(January, 1971), pp. 59-72.

longer necessary. Improvement in transportation system as a result of economic growth has shortened the time and reduced the costs of commuting between residence and workplace.[12] Goldstien and Mayer therefore concluded:

> Historically, migration has served as a major medium through which labor could adjust to changes in the employment opportunities. In recent decades, however, the possibility of commuting and thereby greatly extending the area in which job opportunities can be found without residential mobility provides an important alternative to migration; it greatly increases the flexibility of both the labor market and the individual participant in it.[13]

The extent that daily substitutes for migration is generally interpreted as the "tolerable daily commuting distance". There is no empirical evidence showing what distance should be tolerable for daily commuting. The length of the distance really depends on a number of variables such as road condition,[14] mode of transportation, individual driving behavior and climate.[15] However, a suggestion of a 50-mile driving distance one way, or one-hour driving time made by Fox and Krisna seems to be quite reasonable in light of Oklahoma commuting data.[16]

---

[12]J. W. Martin and J. L. Johnson, "Labor Market Boundaries---Intercounty Commuting to Employment," Current Economic Comment, 17, No. 2(1955), pp. 29-37.

[13]K. Goldstein and S. Mayer, "Migration and Social Status Differentials in the Journey to Work," Rural Sociology, 29(September, 1964), p. 278.

[14]Martin and Johnson, p. 31.

[15]L. Adams and T. MacKesey, Commuting Pattern of Industrial Workers (Ithaca, 1955), p. 62.

[16]K. A. Fox and T. Krisna, "The Functional Economic Area: Delineation and Implication for Economic Analysis and Policy," Papers and Proceedings of the Regional Science Association, 15(1965), pp. 57-85.

Commuting as an Adjustment for Maldistribution of Employment Opportunities

It was pointed out by Wolforth that some regions may have, proportionately, a residential population larger than their working population; some regions may have just the opposite.[17] The discrepancy between a residential population and working population leads to different employment opportunities among these regions. Consequently, regions with relatively good employment opportunities will "pull" workers from regions with relatively poor employment opportunities. In Gerard's words, "the availability of jobs has been introduced as a significant factor inducing commuting from home to a distant place of work."[18] In this regard, the function of commuting is to serve as a link between regions with different employment opportunities.

Furthermore, the improvement of transportation facilities enhances the efficiency of labor market with a fixed pattern of residence. As a result, through commuting, a particular workers has greater opportunities for finding a job where his value of marginal product is highest. The employment opportunities where he works may not necessarily be as good as his residence county. Commuting in this context is therefore not necessarily a one-way movement from regions of poor employment opportunities to regions with good employment opportunities. This concept is clarified by Holmes that "journey to work is a solution to problems of spatial disequilibrium in the labor market, expressed by maldistribution of labor

---

[17]J. Wolforth, Residential Location and the Place of Work (Vancouver, Canada, 1965), p. 18.

[18]R. Gerard, "Commuting and the Labor Market Area," Journal of Regional Science, 1(Summer, 1958), p. 124.

in relation to employment opportunities."[19]

Commuting as a Balance of Location Preference Between Residence and Workplace

Early theoretical studies by Carroll[20] were influenced by the concept of the "principle of least effort". Carroll proposed two main hypotheses concerning the behavior of commuting: (1) forces tend to minimize distance between home and place of work and (2) the concentrative effect of these forces is an important factor conditioning the total residential arrangement of urban population. Following these hypotheses, each individual worker's selection of home and workplace will be confined by the persistence of the desire to minimize the distance from home to work.

According to Catanese,[21] Carroll's studies were concerned with the planning of urban regions. Carroll suggested that the form and structure of urban regions should be planned compactly in order to minimize the distance from home to workplace. The effect of commuting, in Carroll's analysis is nothing but a residual of a worker's persistent effort trying to minimize the commuting distance.

Schnore disagreed with Carroll's hypotheses of "minimizing commuting distance" in three respects.[22] First, he claimed that Carroll's

---

[19] J. H. Holmes, "External Commuting as a Prelude to Suburbanization," Association of American Geographical Annual, 61(December, 1971), p. 775.

[20] J. D. Carroll, Jr., "Some Aspects of Home-Work Relationships of Industrial Workers," Land Economics, 24(November, 1949), pp. 414-422.

[21] Catanese, p. 331.

[22] L. F. Schnore, "The Separation of Home and Work: A Problem for Human Ecology," Social Forces, 32(May, 1954), pp. 336-343.

hypotheses confused an individual worker's motivation of commuting with his external limiting condition. In Schnore's words,

> It might be argued, however, that should an individual have at his disposal time and money in quantities sufficient to relieve him, to some extent, from the ordinary restrictions imposed by transport costs, he might locate his residence almost anywhere, and for any of a variety of motives. The latter might include, in fact, a desire to maximize the distance between home and work.[23]

Second, on logical grounds, Schnore thought that these "least effort" hypotheses can only explain the situation of concentration of residences near workplaces but fail to explain the opposite situation of scattering away of residences from the sites of work. Third, he argued that an explanation of residential decentralization in recent years would require an assumption that the desire to minimize effort has been weakened through time.

To approach the issue of spatial separation of home and work, Schnore proposed concepts of "cost of transport" and "cost of occupancy of a site". Schnore considered these costs as two very important factors accounting for the increasing spatial separation in the modern commuting. In his words: "It is, perhaps, in the interaction of these two broadly conceived 'cost' factors that an explanation of the residential distributions of employees may be found".[24] By assuming distance is negatively related to the cost of occupancy of a site and positively related to the cost of transport, Schnore formulated the following hypotheses:[25]

> The maximum distance from significant centers of activity at which a unit tends to locate is fixed at that point beyond

---

[23]Ibid., p. 337.

[24]Ibid., p. 342.

[25]Ibid.

which further savings in rent are insufficient to cover the added costs of transportation to these centers.

Some further studies with respect to the location of home and workplace done by Alonso,[26] Muth,[27] and Kain,[28] following Schnore's analysis, suggested that there should be a trade-off point where an individual decides to locate his home and workplace. More clearly, there should be an "interdependence between housing and job location through the linkage of the journey to work".[29] Other factors which influence this location decision could be, among other things: (1) ability to pay transport costs, (2) workers' attitudes toward commuting,[30] (3) availability of good roads, (4) educational facilities,[31] and (5) housing segregation due to the racial problem.

Summary

Based on a brief survey of recent literature on the functions of commuting, this chapter has synthesized different approaches to the commuting phenomenon.

People commute to work for different reasons. These reasons could

---

[26]W. Alonso, "A Theory of the Urban Land Market," _Papers and Proceedings of the Regional Science Association_, 6(1960), pp. 149-157.

[27]R. Muth, "The Spatial Structure of the Housing Market," _Papers and Proceedings of the Regional Association_, 7(1961), pp. 207-220.

[28]J. Kain, "The Journey to Work as a Determinant of Residential Location," _Papers and Proceedings of the Regional Science Association_, 9(1962), pp. 137-160.

[29]Yapa, Polese, and Wolpert, p. 60.

[30]Holmes suggested, for instance, satisfying behavior, inadequate search for close jobs and unwillingness to accept risk.

[31]Gerard, p. 124.

be economic and/or non-economic. In other words, commuting can be functioning differently for different individuals. Economically, the functions of commuting can be, among other things: (1) a substitute for migration, (2) an adjustment for maldistribution of employment opportunities, and (3) a locational balance between residence and workplace.

CHAPTER III

COMMUTING FLOWS IN OKLAHOMA, 1970

Introduction

Commuting flows are important indicators of regional economic and social interdependence. They may exhibit certain regularities which could provide directions to planning for economic growth. The present chapter studies several important aspects of intercounty commuting in Oklahoma in 1970. The incidence of intercounty commuting in 1960 is occasionally referred to in order to compare the increase of intercounty commuting over the decade.[1]

Changes in Intercounty Commuting by Substate Planning Region, 1960-1970

The incidence of intercounty commuting by substate planning region in Oklahoma in 1960 and 1970 is shown in Table I. The share of state commuting in each region in 1960 and 1970 is presented in Table II. Furthermore, the share of increased commuting over the decade is also presented in Table II.[2] The eleven regions are presented in Figure 1.

---

[1]Most of the discussion in this chapter is derived from J. Hu and R. Moomaw, Commuting Patterns in Oklahoma, Research Foundation, Oklahoma State University, Stillwater, Oklahoma, 1974.

[2]The share of state commuting in each region is defined as the number of intercounty commuters in the region divided by the state total commuters.

TABLE I

THE INCIDENCE OF INTERCOUNTY COMMUTING BY SUBSTATE PLANNING REGION, OKLAHOMA, 1960 AND 1970

Planning Region	1960		Regional Commuting Rate	1970		Regional Commuting Rate
	All Workers	Worked Outside Residence County		All Workers	Worked Outside Residence County	
1	47,915	6,261	13.1	58,283	12,426	21.3
2	48,592	6,161	12.7	58,302	13,833	23.7
3	33,897	2,853	8.4	40,651	6,300	15.5
4	51,426	4,025	7.8	54,402	7,017	12.9
5	53,319	7,232	13.6	60,734	10,639	17.5
6	153,196	9,139	5.7	184,699	15,115	8.2
7	57,635	2,766	4.8	59,664	3,927	6.6
8	203,599	10,207	5.0	270,190	24,209	9.0
9	82,362	5,570	6.8	94,562	8,236	8.7
10	42,772	2,515	5.9	40,997	3,496	8.5
11	25,424	1,715	6.7	27,809	2,355	8.5
State Total	799,137	58,444	7.3	950,293	107,552	11.3

Source: U. S. Census of Population, General Social and Economic Characteristics, Oklahoma, 1960 and 1970.

TABLE II

THE SHARE OF INTERCOUNTY COMMUTING BY SUBSTATE PLANNING REGION, OKLAHOMA, 1960 AND 1970

Planning Region	1960 Percent	1970 Percent	Increased Commuting 1960-1970 Percent
1	10.7	11.5	12.6
2	10.6	12.9	15.6
3	4.9	5.9	7.0
4	6.9	6.5	6.1
5	12.4	9.9	6.9
6	15.6	14.0	12.2
7	4.7	3.7	2.4
8	17.5	22.5	28.5
9	9.5	7.7	5.4
10	4.3	3.2	2.0
11	2.9	2.2	1.3
Total	100.0	100.0	100.0

Source: U. S. Bureau of the Census, *Census of Population: 1960, General Social and Economic Characteristics*, Oklahoma, Table 82.

U. S. Bureau of the Census, *Census of Population: 1970, General Social and Economic Characteristics*, Oklahoma, Table 119.

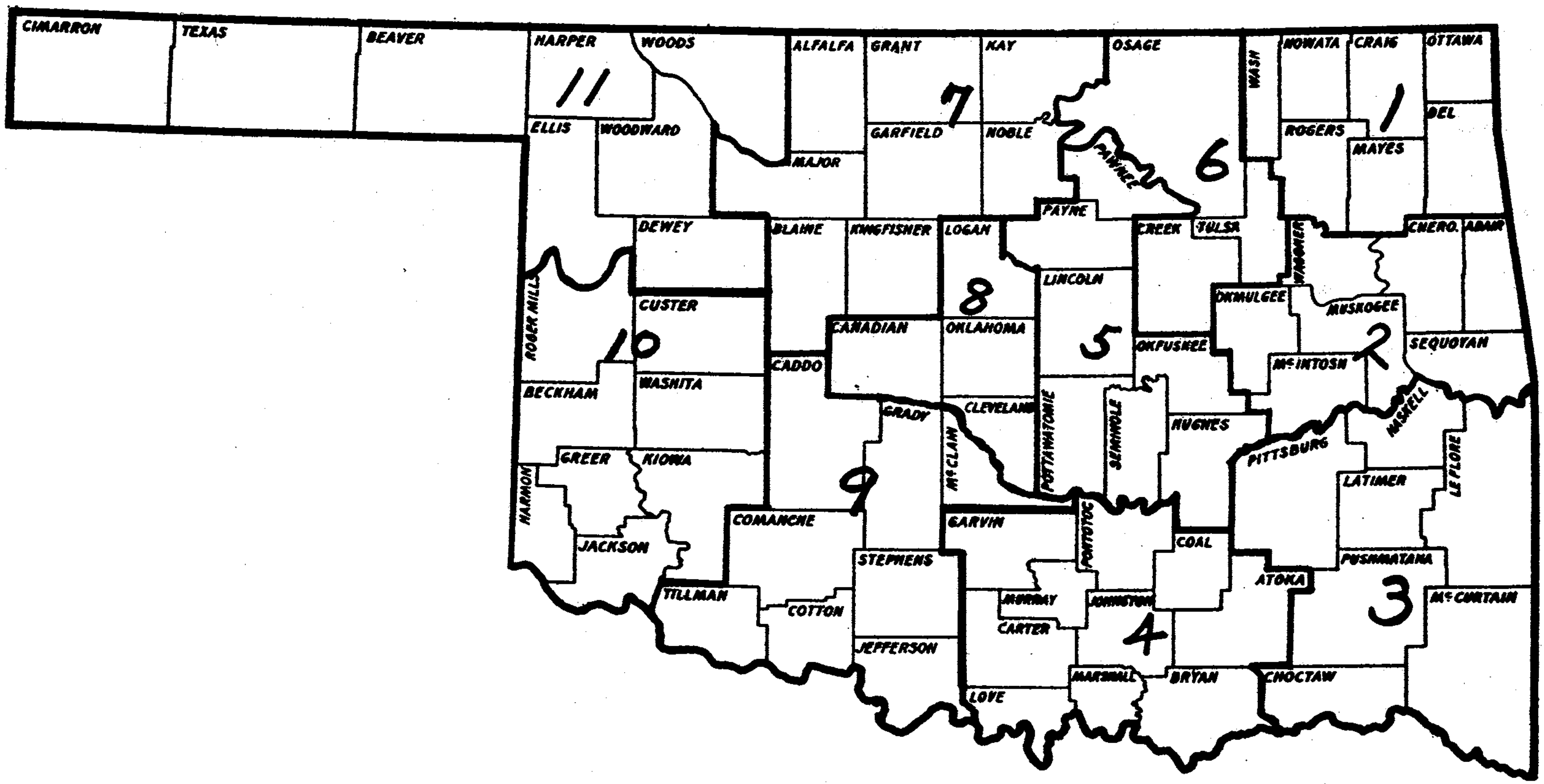

Figure 1. Oklahoma Substate Planning Regions

As shown in Table I, Planning Regions 1 and 2 in northeastern Oklahoma experienced the largest increase in commuting during the ten-year period from 1960 to 1970. Their regional commuting rates went from 13.1 and 12.7 percent in 1960 to 21.3 and 23.7 percent in 1970, respectively. Furthermore, these two regions had the highest commuting rates in 1970. Somewhat over one out of every five workers in Regions 1 and 2 worked outside their counties of residence. The geographic location of the two regions being between the Tulsa and Fort Smith, Arkansas, metropolitan areas helps to account for their high commuting rates. The share of state commuting of the two regions combined rose slightly from 21.3 percent of the state total in 1960 to 24.4 percent in 1970, according to the calculation of Table II. Out of 49,108 new commuters during the decade, 13,837 of them, about 28 percent of the total, originated in Regions 1 and 2.

In southeast and southcentral Oklahoma, Planning Regions 3 and 4 had regional commuting rates in 1960 and 1970 lower than Regions 1 and 2, but higher than the state average. Respectively, the regional commuting rates of these two regions, as shown in Table I, were 8.4 and 7.8 percent in 1960, and 15.5 and 12.9 percent in 1970. The share of new commuters originating in Regions 3 and 4, as shown in Table II, was 13.1 percent of the state total.

Planning Region 5 in central Oklahoma, like Regions 1 and 2, is also located between two metropolitan areas -- Tulsa and Oklahoma City. In 1960, commuting rate in Region 5 was 13.5, the highest in the state. However, due to a relatively small increase in the number of new commuters, its regional commuting rate increased only about 4 percentage points to a rate of 17.5 in 1970. As a result, its share of commuting dropped from 12.4 percent in 1960 to 9.9 percent in 1970. With an increase of about 2,400 new commuters over the decade, Region 5 captured only about 7 percent of the increase in state commuting.

The metropolitan Planning Regions 6 and 8 (Tulsa and Oklahoma City) had the two largest number of commuters in the state: 9,139 and 10,207 in 1960, and 15,115 and 24,209 in 1970, respectively. However, their regional commuting rates were relatively low. The increase in commuting rates were also relatively small. The low commuting rates of these two regions are due to the large concentration of persons living and working in Tulsa and Oklahoma Counties. The share of commuting of these two regions was about 33 percent in 1960 and 37 percent in 1970. Approximately, 40 percent of the increased number of commuters originated in these two regions.

Planning Regions 7, 9, 10 and 11 in western Oklahoma had more or less similar commuting status. In 1960, regional commuting rates of these four regions varied roughly from 5 to 7 percent. The rates went slightly higher to somewhere between 6 and 9 percent. Only 11 percent of the increased commuters in the state originated in Regions 7, 9, 10 and 11 over the ten-year period.

Interstate Commuting in Oklahoma, 1970

Table III presents the incidence of interstate commuting between Oklahoma's boundary planning regions and adjacent states. To supplement the presentation, Figure 2 presents a map of interstate commuting. Destination counties in the adjacent states for Oklahoma's out-of-state commuters are outlined. The number of workers who commuted across the state boundaries seeking employment in the states of Arkansas, Colorado,

TABLE III

INTERSTATE COMMUTING BY SUBSTATE PLANNING REGION, OKLAHOMA, 1970

County	Out-commuting	In-commuting	Net[1]-commuting
Region 1	2,559	678	-1,881
Craig	89	25	- 64
Delaware	1,008	102	- 906
Mayes	12	0	- 12
Nowata	515	34	- 481
Ottawa	868	465	- 403
Rogers	13	0	- 13
Washington	54	52	- 2
Region 2	3,237	248	-2,989
Adair	613	78	- 535
Cherokee	91	0	- 91
Mushogee	8	23	15
Sequoyah	2,525	147	-2,378
Region 3	3,164	343	-2,821
Choctow	262	25	- 237
Haskell	124	0	- 124
Latimer	0	7	7
LeFlore	2,124	191	-1,933
McCurtain	650	120	- 530
Pushmataha	4	0	- 4
Region 4	1,889	143	-1,746
Atoka	51	0	- 51
Bryan	1,445	103	-1,342
Love	0	13	13
Marshall	307	15	- 292
Murray	78	12	- 66
	8	0	- 8
Region 6	27	178	151
Osage	27	106	79
Tulsa	0	72	72
Region 7	426	153	- 273
Alfalfa	39	19	- 20
Garfield	0	15	15
Grant	41	0	- 41
Kay	346	119	- 227

TABLE III (Continued)

County	Out-commuting	In-commuting	Net[1]-commuting
Region 9	216	122	- 94
Comanche	43	31	- 12
Cotton	79	14	- 65
Jefferson	20	6	- 14
Stephens	12	9	- 3
Tillman	62	62	0
Region 10	204	41	- 163
Beckham	84	8	- 76
Harmon	79	6	- 73
Jachson	14	27	13
Roger Mills	27	0	- 27
Region 11	651	304	- 347
Beaver	199	30	- 169
Cimarron	12	63	51
Ellis	21	0	- 21
Harper	13	0	- 13
Texas	323	204	- 119
Woods	59	0	- 59
Woodward	24	7	- 17
State	12,373	2,210	-10,163

[1]A positive net commuting means in-commuting; negative, out-commuting.

Source: U. S. Bureau of the Census, Summary User Tapes, Fourth Count, (Population), Table 35, Arkansas, Colorado, Kansas, Missouri, New Mexico, Oklahoma and Texas, 1970.

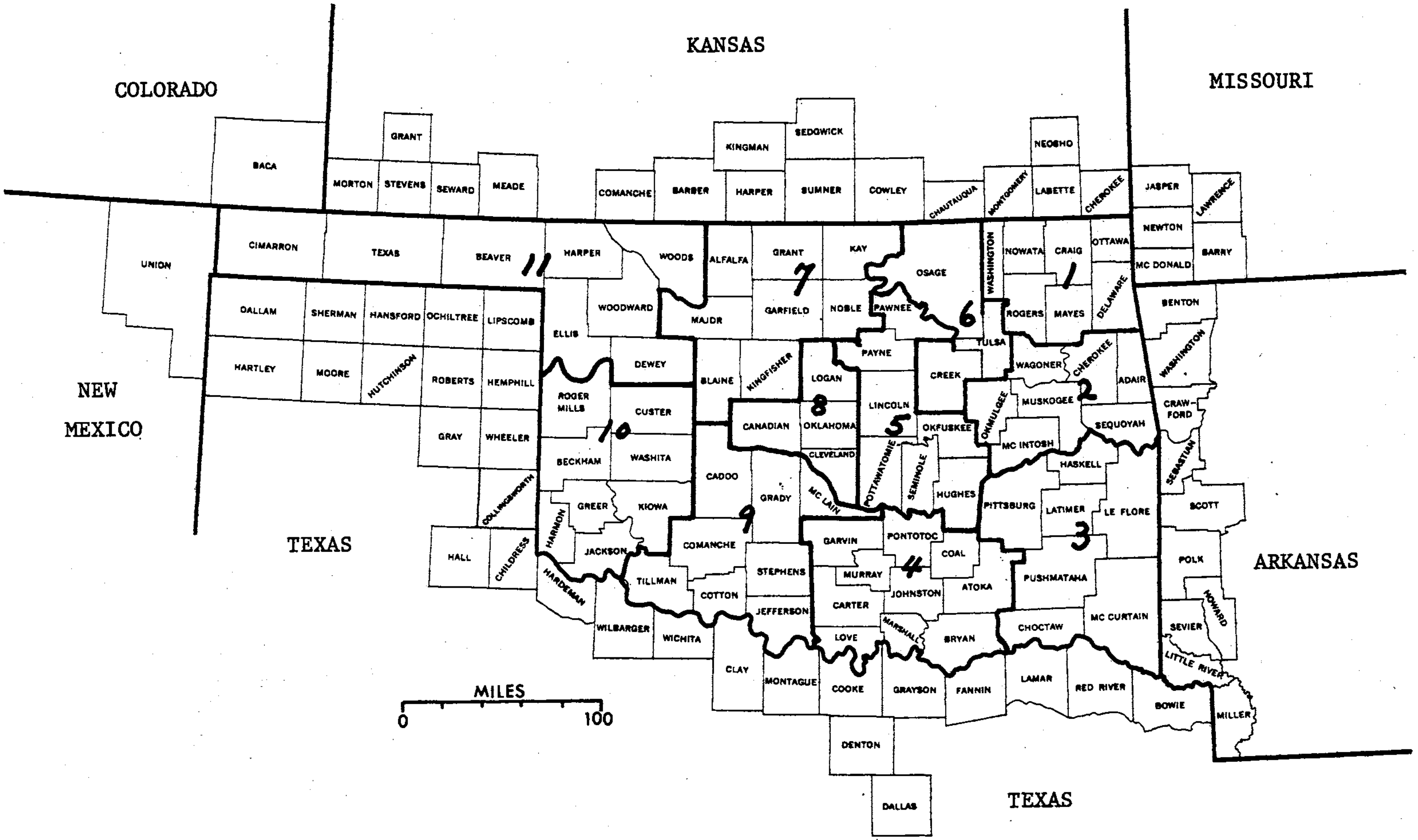

Figure 2. Destination Counties of Adjacent States for Oklahoma's Out-of-State Commuters

Kansas, Missouri and Texas was 12,373. Compared with 2,210 workers who lived in these states and commuted to the state of Oklahoma to work, Oklahoma experienced a net loss of 10,163 workers.

More than one-half of the Oklahoma's out-of-state commuters worked in the state of Arkansas. Primarily, this is because metropolitan Fort Smith (Sebastian County) abuts the border of eastern Oklahoma. The abundant employment opportunities in Fort Smith have attracted a considerable number of Oklahomans commuting to the area to work. Approximately, 3,000 Oklahomans commuted to Texas for employment. More than half of them worked in Garison and Lamar Counties where Denison, Sherman and Paris are located. With 17 Oklahoma counties bordering Texas, the interaction of commuting between the two states is quite sizeable. Kansas and Missouri together employed about 2,500 Oklahoma workers. A little under one-half jobs provided by these two states originated in Cherokee, Montgomery and Labette Counties in Arkansas, a little over one-third in Jasper and McDonald Counties in Missouri. Colorado employed only six workers from Oklahoma.

Generally speaking, Oklahoma experienced considerable net out-commuting almost all over the boundary regions. The only exception is Planning Region 6 where Tulsa is located. The principal explanation lies in the fact that Oklahoma's two largest employment centers, Oklahoma City and Tulsa are located at some distance from the state boundaries. Furthermore, employment centers of bordering states are close to Oklahoma boundaries. Consequently, a large number of residents in Oklahoma's boundary counties commuted out of the state to work.

Interregional Commuting, 1970

The first section of this chapter has dealt with regional commuting rates. To provide further information about the intercounty commuting flows, this section examines the origins and destinations of commuting flows by substate planning region. Table IV provides a matrix of interregional commuting flows. The region of residence is displayed in the table horizontally and the region of work vertically. For example, row 5 column 8 shows that there were 5,479 workers who lived in Region 5 but worked in Region 8. The row total for each region indicates total out-commuting from the region; and column total shows the total in-commuting to the region. Net commuting is obtained by subtracting the row total from the corresponding column total. A positive net commuting of the region means that the total out-commuting from the region is smaller than the total in-commuting to the region. A negative net commuting indicates the opposite situation.

The total number of interregional commuters was 34,899 in 1970. It was about one third of the total commuters in the state. Region 1, 2, 5 and 9 combined had almost 26,000 commuters who crossed the regional boundaries for employment. A large portion of them went to the two large metropolitan regions, Regions 6 (Tulsa) and 8 (Oklahoma City), to work. Net out-commuting from these four regions varied from 3,000 to 6,400. The converse of the phenomenon, then, was the significant net in-commuting of regions 6 and 8, about 11,700 and 8,700, respectively.

Commuting across regional boundaries appeared less important for the remaining regions -- Regions 3, 4, 7, 10 and 11. The gross flows out of these five regions were relatively smaller compared with other regions. It varied from 384 to 1,454. The largest net out-flow was 350 from

TABLE IV

INTERREGIONAL COMMUTING FLOWS, OKLAHOMA, 1970

Place of Residence (Planning Region No.)	Place of Work (Planning Region No.)											Row[1] Total	Net[2] Commuting
	1	2	3	4	5	6 (Tulsa)	7	8 (Okla. City)	9	10	11		
1	---	147	0	0	10	6,400	0	0	0	0	0	6,557	- 5,112
2	394	---	407	0	67	6,182	0	0	0	0	0	7,050	- 6,202
3	0	193	---	116	25	50	0	0	0	0	0	384	648
4	0	0	397	---	236	0	257	453	368	0	0	1,454	- 260
5	0	144	228	223	---	1,553	596	5,479	3	0	0	7,887	- 6,406
6	1,051	364	0	0	459	---	---	574	0	0	137	3,004	11,665
7	0	0	0	0	249	154	409	552	29	34	0	1,155	529
8	0	0	0	72	415	370	0	---	495	0	0	1,761	8,679
9	0	0	0	783	20	0	68	3,239	---	366	100	4,408	- 3,019
10	0	0	0	0	0	0	354	128	494	---	---	790	- 350
11	0	0	0	0	0	0	---	15	0	40		409	- 172
Column[3] Total	1,445	848	1,032	1,194	1,481	14,709	1,684	10,440	1,389	440	237	34,899	0

[1]Total out-commuting from the region.

[2]Total in-commuting minus total out-commuting.

[3]Total in-commuting to the region.

Source: U. S. Bureau of the Census, Summary User Tapes, Fourth Count, Population, Table 35, Oklahoma, 1970.

Region 10, and the largest net in-flow was 648 in Region 3.

County Commuting Rate, Population Size and Growth, 1970

In the previous section of this chapter, intercounty commuting flows are studied by substate planning region. It is identified that metropolitan Regions 6 (Tulsa) and 8 (Oklahoma City) have played a very important role, through intercounty commuting, in providing employment opportunities for their bordering regions. In this section, the study of intercounty commuting is concentrated in individual counties. In order to analyze the role of commuting in a county's growth of population and employment, a typology is provided in Table V.

Since the importance of commuting in a county's growth varies with the size of county population, all seventy seven counties in the state are first subdivided by the size of county population in 1970. The subdivisions are: (a) counties with population of greater than 100,000, (b) counties with population between 25,000 and 100,000, (c) counties with population between 10,000 and 24,999 and (d) counties with population of less than 10,000. Within each population category, counties are further classified according to the 1970 county commuting rate and population growth from 1960 to 1970. Thus, the role of intercounty commuting can be studied based on this classification. A county with a county commuting rate above the state average of 11.3 percent by definition is one with a _high commuting rate_ and one with a rate below the state average is one with a _low commuting rate_. Similarly, if the rate of population growth is above the state average of 9.9 percent, it is a county of _high population growth_ and if the rate is positive but below the state

TABLE V

COMMUTING, MIGRATION AND GROWTH OF POPULATION AND COVERED EMPLOYMENT BY POPULATION SIZE OF COUNTY, OKLAHOMA, 1960 AND 1970

Population Size	County* Commuting Rate, 1970 (percent)	Growth of† Population 1960-1970 (percent)	Growth of§ Covered Employment 1960-1970 (percent)	Changes in County Commuting Rate 1960-1970 (percent)	Net[1] Commuting 1970	Net[2] Migration 1960-1970
More than 100,000						
Classification 2						
Comanche	2.0	19.1	34.7	0.5	814	- 4,710
Oklahoma	3.0	19.9	45.9	0.5	21,124	22,545
Tulsa	2.8	16.1	33.9	0.4	19,434	13,778
25,000 - 100,000						
Classification 1						
Canadian	38.8	30.4	113.8	21.5	- 3,416	5,578
Cleveland	36.0	71.9	129.4	13.9	- 7,825	25,329
Creek	39.2	12.4	10.3	15.3	- 4,795	2,402
LeFlore	28.3	10.4	49.7	9.6	- 1,710	1,417
McCurtain	12.6	10.8	92.7	8.4	- 452	55
Rogers	40.2	37.9	20.6	10.1	- 3,289	6,092
Classification 2						
Payne	6.8	14.5	34.3	- 0.1	- 214	1,881
Classification 3						
Bryan	19.9	5.4	48.3	8.4	- 1,176	657
Caddo	11.9	1.1	47.5	3.9	- 378	- 1,882
Ottawa	12.6	9.3	38.3	2.4	- 136	736
Pottawatomie	25.8	4.0	- 0.3	8.0	- 2,923	- 233

TABLE V (Continued)

Population Size	County* Commuting Rate, 1970 (percent)	Growth of† Population 1960-1970 (percent)	Growth of§ Covered Employment 1960-1970 (percent)	Changes in County Commuting Rate 1960-1970 (percent)	Net[1] Commuting 1970	Net[2] Migration 1960-1970
Classification 4						
Garfield	3.2	4.5	45.7	0.0	294	- 2,616
Jackson	3.0	3.9	24.5	0.7	303	- 4,936
Pittsburg	4.5	9.2	40.3	1.0	1,096	1,326
Classification 5						
Grady	17.3	- 0.8	33.4	5.0	- 1,067	- 1,376
Okmulgee	17.2	- 4.3	-14.6	9.1	- 1,103	- 3,308
Osage	41.9	- 8.3	- 0.9	14.5	- 2,895	- 3,924
Seminole	11.5	-10.4	29.2	0.5	- 144	- 4,133
Classification 6						
Carter	5.1	- 4.3	29.1	0.4	562	- 3,469
Kay	4.6	- 4.4	12.5	1.2	291	- 5,037
Muskogee	8.1	- 3.8	18.4	2.0	271	- 5,688
Pontotoc	8.2	- 0.8	14.1	2.1	- 51	- 1,264
Stephens	7.8	- 5.5	10.3	0.8	- 362	- 3,923
Washington	8.4	- 0.2	16.0	3.5	73	- 3,868
<u>10,000 - 24,999</u>						
Classification 1						
Adair	25.0	15.5	82.8	12.1	- 624	794
Cherokee	21.3	30.5	72.7	5.6	- 1,057	3,696
Delaware	35.8	34.6	166.0	15.0	- 1,081	3,960
Kingfisher	11.8	20.9	81.9	4.5	173	1,354
McClain	44.0	11.1	45.1	17.4	- 1,449	731
Mayes	25.7	16.1	55.3	11.4	- 1,262	2,089
Sequoyah	42.9	29.8	114.1	11.2	- 2,280	3,067
Wagoner	58.3	41.4	50.7	24.6	- 3,858	5,160

TABLE V (Continued)

Population Size	County[*] Commuting Rate, 1970 (percent)	Growth of[†] Population 1960-1970 (percent)	Growth of[§] Covered Employment 1960-1970 (percent)	Changes in County Commuting Rate 1960-1970 (percent)	Net[1] Commuting 1970	Net[2] Migration 1960-1970
Classification 2						
Texas	7.4	15.5	55.7	- 2.7	- 107	424
Woodward	6.1	11.8	86.9	2.1	118	648
Classification 3						
Atoka	19.7	6.0	63.8	12.0	- 307	192
Custer	12.6	7.7	47.9	4.8	- 184	- 721
Lincoln	28.2	3.7	34.7	7.4	- 1,326	256
Logan	25.0	5.3	34.3	11.5	- 1,204	940
McIntosh	24.3	0.8	3.7	12.8	- 540	- 402
Murray	14.4	0.4	72.7	3.2	- 93	84
Pawnee	28.3	4.2	58.9	9.9	- 672	426
Classification 5						
Choctaw	16.7	- 3.2	20.2	11.9	- 302	- 672
Craig	15.7	- 9.7	24.5	5.5	- 271	- 1,583
Hughes	22.0	-12.7	-13.2	8.8	- 683	- 1,843
Okfuskee	20.3	- 8.7	30.3	3.4	- 444	- 1,358
Washita	16.3	-33.0	-37.0	11.0	- 441	- 8,361
Classification 6						
Beckham	5.6	-11.4	15.6	- 3.5	142	- 2,670
Blaine	11.1	- 2.3	32.4	6.6	- 103	- 681
Garvin	11.0	-12.1	8.1	4.1	- 84	- 4,925
Kiowa	9.4	-15.5	-10.3	1.2	- 140	- 2,904
Noble	10.0	- 3.2	27.1	- 1.0	14	- 694
Tillman	7.4	-12.0	52.0	0.9	- 66	- 2,869
Woods	9.1	- 0.1	13.1	3.6	- 244	- 404

TABLE V (Continued)

Population Size	County[*] Commuting Rate, 1970 (percent)	Growth of[†] Population 1960-1970 (percent)	Growth of[§] Covered Employment 1960-1970 (percent)	Changes in County Commuting Rate 1960-1970 (percent)	Net[1] Commuting 1970	Net[2] Migration 1960-1970
<u>Less Than 10,000</u>						
Classification 1						
Latimer	21.8	11.2	224.7	9.0	- 247	663
Classification 3						
Haskell	23.7	5.0	46.4	12.9	- 466	- 40
Marshall	11.6	4.8	- 0.7	5.4	- 19	379
Pushmataha	13.2	3.3	65.3	3.7	- 92	- 13
Classification 5						
Coal	27.1	- 0.4	43.5	13.1	- 287	79
Cotton	19.0	-14.9	- 5.1	1.0	- 278	- 1,377
Dewey	12.2	- 6.5	82.4	3.1	0	- 466
Harper	13.4	-13.5	- 10.8	8.1	- 80	- 1,036
Jefferson	21.1	-13.0	28.1	2.3	- 327	- 840
Johnston	25.6	- 7.6	4.1	15.2	- 247	- 750
Love	26.4	- 3.8	178.2	11.7	- 304	- 750
Major	19.8	- 3.6	53.7	11.9	- 206	- 367
Nowata	34.7	- 9.9	- 24.3	15.1	- 984	- 1,245
Roger Mills	11.9	-12.5	- 15.6	7.1	- 50	- 808

TABLE V (Continued)

Population Size	County Commuting Rate, 1970 (percent)*	Growth of Population 1960-1970 (percent)†	Growth of Covered Employment 1960-1970 (percent)§	Changes in County Commuting Rate 1960-1970 (percent)	Net[1] Commuting 1970	Net[2] Migration 1960-1970
Classification 6						
Alfalfa	9.9	-14.5	- 0.1	3.5	- 16	- 1,002
Beaver	10.9	- 9.8	12.8	4.1	- 153	- 841
Cimarron	3.9	- 7.8	5.5	2.1	- 8	- 759
Ellis	9.5	- 6.0	39.3	- 0.9	- 82	- 277
Grant	10.6	-12.6	0.3	5.0	- 191	- 843
Greer	8.1	-10.1	- 8.5	2.1	- 99	- 827
Harmon	11.2	-12.2	2.2	7.2	- 44	- 966
State	11.3	9.9	32.8	4.0	---	---

[1]Total in-commuting to the county minus total out-commuting from the county in 1970.

[2]Total in-migration to the county minus total out-migration from the county from 1960 to 1970.

Source: *U. S. Bureau of the Census, Census of Population: 1970, General Social and Economic Characteristics, Final Report PC (1)-C 38, Table 119, Oklahoma.

†U. S. Bureau of the Census, Census of Population: 1970, Number of Inhabitants, Final Report PC (1)-A 38, Oklahoma.

§Oklahoma Employment Security Commission, County Employment and Wage Data, Table 1, 1970.

average, the county is one of low population growth. Finally, those counties with population decline are classified as ones of negative population growth.

Thus, for each population category, counties are classified in Table V as follows:

Classification 1 - high commuting rate and high population growth;

Classification 2 - low commuting rate and high population growth;

Classification 3 - high commuting rate and low population growth;

Classification 4 - low commuting rate and low population growth;

Classification 5 - high commuting rate and negative population growth; and

Classification 6 - low commuting rate and negative population growth.

Table V also provides information on a county's growth of covered employment, 1960-1970,[3] the change of county commuting rate, 1960-1970, net migration, 1960-1970, and net commuting, 1970. This information is used in the discussion for reference purposes. The text also refers to commuting flows to and from individual counties.[4] Counties are listed in Table V alphabetically under the category of population size.

---

[3]Covered employment is the number of workers employed each month in the payroll period which includes the 12th of the month by all employers subject to the Oklahoma Employment Security Act. The Act was effective on January 1, 1956. An employer is subject to this Act when he has four or more employees in each of twenty different calendar weeks within one year. Covered employment does not include government, interstate railroads, agriculture, religious or charitable organizations, domestic service, self-employed, or family workers. This is the only set of data reporting employment by establishment as early as 1960 by county for all 77 counties.

[4]For a detailed report of origins and destinations of commuting flows by county in Oklahoma, see J. Hu, R. Moomaw and L. Warner, Commuting Flows for Counties and Substate Planning Regions, Oklahoma, 1970, Research Foundation, Oklahoma State University, Stillwater, Oklahoma, 1974.

Counties With Population Greater Than 100,000

Classification 2: Comanche, Oklahoma, and Tulsa. The three largest counties in Oklahoma, as the order suggests, -- Oklahoma, Tulsa and Comanche -- are the sites of the state's three largest cities. Basically, these counties are characterized by low commuting rates and high population growth. Over the decade, their commuting rates increased marginally. Even though the growth of employment in these counties was not substantially above the state average, it was large in absolute terms. All three counties had a net in-flow of labor via intercounty commuting. Net migration also supplemented this increased supply of labor for Oklahoma and Tulsa Counties. These three counties acted as employment centers with Oklahoma and Tulsa particularly providing employment opportunities to residents of many counties in northeastern and central Oklahoma.

Counties With Population Between 25,000 - 100,000

Classification 1: Canadian, Cleveland, Creek, LeFlore, McCurtain, and Rogers. It is tempting to describe the six counties with high commuting rates and high population growth as residential growth centers or perhaps "bedroom" counties. However, this characterization is not strictly accurate. McCurtain County in Region 3 is not closely tied to a large metropolitan area. Its commuting rate is not substantially above the state average and its net export of labor is absolutely and relatively small. A massive operation of lumber and wood products developing in the county has employed a considerable number of resident workers.

The remaining counties are closely tied via commuting to either Oklahoma City, Tulsa or Fort Smith, Arkansas. Over the decade, these five counties had substantial increases in their county commuting rates.

Canadian and Cleveland Counties also had substantial employment growth. The growth in commuting interacting with the growth of employment provided a great stimulus to economic development in Canadian and Cleveland Counties. These two counties may appropriately be classified as joint employment-residential growth centers. To a somewhat lesser extent, LeFlore County may also be classified in this way.

Creek and Rogers Counties, both of which are adjacent to Tulsa, can be classified as bedroom counties or residential growth centers. Their high and increased commuting rates coupled with net out-commuting are associated with high rates of population growth particularly for Rogers County. The employment growth over the decade in these two counties was much lower than the state average.

<u>Classification 2</u>: <u>Payne</u>. Payne County stands alone in this population category as a low commuting-rate-high-population-growth county. Net immigration and the reduction in its commuting rate coupled with net in-commuting indicates that it is emerging as an employment growth point. However, its growth in employment was not substantially above the state average.

<u>Classification 3</u>: <u>Bryan</u>, <u>Caddo</u>, <u>Ottawa</u>, <u>and Pottawatomie</u>. The four counties in this classification may be further subdivided into those with relative high commuting rates (Bryan and Pottawatomie) and with rates just above the state average (Caddo and Ottawa). Bryan and Pottawatomie Counties experienced large increases in their commuting rates and a moderate growth in population. Pottawatomie underwent a decline in employment growth wheras Bryan enjoyed a healthy growth in employment. Caddo and Ottawa both had a slight net out-commuting and small increases in

their commuting rates. The growth of employment of these two counties were slightly higher than the state average.

Classification 4: Garfield, Jackson, and Pittsburg. In this category, Garfield and Jackson Counties showed similarities with respect to the situation of commuting and migration situations. Both of the counties experienced very low rates of change in commuting and had small net in-commuting in 1960 and great out-migration from 1960 to 1970. The growth of employment is somewhat higher than the state average in Garfield County and lower in Jackson County.

With a growth rate of employment slightly above the state average, Pittsburg County not only provided about 1,400 jobs for commuters from other counties but also some opportunities for a number of immigrants.

Classification 5: Grady, Okmulgee, Osage, and Seminole. Except for Osage County, the commuting rates of the other three counties were only slightly higher than the state average. All four counties have experienced net out-commuting. Osage and Okmulgee are exporters of labor to Tulsa County, and Grady and Seminole, Oklahoma County. Residents of these counties have resorted to commuting as well as migration in search of employment opportunities. Intercounty commuting apparently did not stimulate the growth of employment in these counties. This may be explicable in terms of the geographical direction of employment growth in Tulsa and Oklahoma Counties.

Classification 6: Carter, Kay, Muskogee, Pontotoc, Stephens, and Washington. All six counties experienced lower than 4 percent increase in commuting over the decade. Negative population growth, low commuting rate together with tremendous out-flow of migrants showed that some of the residents of these counties may have chosen migration rather than commuting in search of employment opportunities.

Counties With Population Between 10,000 - 24,999

Classification 1: Adair, Cherokee, Delaware, Kingfisher, McClain, Mayes, Sequoyah, and Wagoner. Except for Kingfisher County, these smaller counties in Classification 1 are similar to those counties discussed in the same classification of the previous population category. They all had substantial out-flows of commuting with rates varied from 21 to 58 percent. They also have experienced net immigration which is suggestive of their roles as residential growth centers. Simplistically, it could be that one who immigrates into one of these counties proceeds to commute outside of the county for employment. All the counties under this classification enjoyed a rapid growth of employment over the decade.

As for the commuting flows, the principal net flow of labor from Adair and Delaware Counties is to the northwest corner of Arkansas. For Mayes and Wagoner, the principal flows are to Tulsa County. Cherokee has two large flows to Tulsa and Muskogee Counties. Finally, Sequoyah is linked to Fort Smith, Arkansas and McClain to Oklahoma County. Kingfisher County in Region 7 does not fit this pattern. Its commuting rate is only marginally above the state average and, perhaps more significantly, it has a net in-flow of labor. Employment growth within the county rather than out-commuting would appear to better explain its high population growth.

Classification 2: Texas and Woodward. Texas County has a low and decreasing commuting rate with a net out-flow of labor. Woodward County has a low but slightly increasing commuting rate with a net in-flow of labor. Both counties have relatively high employment growth and net immigration. The two counties taken together attract labor from all of the other counties in Region 11.

Classification 3: Atoka, Custer, Lincoln, Logan, McIntosh, Murray, and Pawnee. Lincoln and Logan (with links to Oklahoma County) and Pawnee (with links to Tulsa County) have the highest commuting rates in this classification. Just as the counties in Classification 1, they have experienced net immigration. However, their distance from the center of economic activity in the metropolitan counties had moderated both their population and employment growth.

The other two counties with net immigration, Atoka and Murray, are linked to counties in Classifications 4 and 6 -- Pittsburg and Carter -- respectively. This suggests that link to counties of low or negative population growth moderates these two counties' growth.

Custer and McIntosh with their net out-migration are not strongly tied to any one county as a destination for their out-commuting. They have had net out-migration and net out-commuting. It could be that some residents of these counties have relied both on commuting as well as migration in their search for employment.

Classification 5 and 6: Choctow, Craig, Hughes, Okfuskee, Washita; Beckham, Blaine, Garvin, Kiowa, Noble, Tillman, and Woods. Without exception, the counties in Classifications 5 and 6 have experienced net out-migration. Residents of counties in Classification 5 (high commuting rates) are generally closer to employment centers and engage in both out-commuting and out-migration in search of employment. Commuting opportunities are somewhat more restricted for the residents of the counties in

Classification 6. Hence, they may be more dependent upon migration or local sources of employment.

Counties With Population Less Than 10,000: Latimer (Classification 1); Haskell, Marshall, Pushmataha, Coal, Cotton, Dewey, Harper, Jefferson, Johnson, Love, Major, Nowata, and Roger Mills (Classification 5); Alfalfa, Beaver, Cimarron, Ellis, Grant, Greer, and Harmon (Classification 6). These smaller counties in the various classifications exhibit characteristics similar to those in the corresponding classifications for the larger counties. A detailed examination of each classification would not add to an elaboration of the usefulness of the typology. Latimer County in Classification 1, for instance, is similar to many of the residential counties except that its commuting ties are to Pittsburg and LeFlore Counties rather than the large metropolitan counties.

The other counties with high commuting rates (Classifications 3 and 5) in general had net out-migration along with net out-commuting. Both methods of search for employment opportunities -- commuting and migration may be utilized.

The counties in Classification 6 (low commuting rates and negative population growth) are somewhat more distant from employment centers, hence, commuting is a somewhat less viable alternative for their residents.

Summary

This chapter has examined various aspects of intercounty commuting flows in the state of Oklahoma in 1970 with some references to the intercounty commuting in 1960. About 80 percent of all intercounty commuting in 1970 and 85 percent of the increase in intercounty commuting over the decade originated in eastern and central Oklahoma (Regions 1, 2, 3, 5, 6 and 8). Regions 1, 2, 5 and 9 had large commuting flows into metropolitan regions 6 (Tulsa) and 8 (Oklahoma City). A little over one-third of all intercounty commuters in the state in 1970 commuted across planning region boundaries, and a little under one-seventh of all intercounty commuters commuted across the state boundaries to the adjacent states.

A typology of commuting based on county commuting rate, population size and growth was developed. Employment growth centers or potential centers which had a significant influence, through intercounty commuting, on employment in other counties may be identified as populous counties with low county commuting rates.

Counties with high population growth and high commuting rates are generally located near employment growth centers. Out-commuting stimulated employment growth in some of these counties and not in others. The former counties may aptly be entitled employment-residential growth centers, and the latter, residential growth centers.

Counties with population decline are subdivided into those with low and high commuting rates. The residents of counties with low commuting rates may have mainly relied on out-migration in the search for employment opportunities. For those counties with high commuting rates, both methods of out-commuting as well as out-migration may be used in seeking employment.

CHAPTER IV

A MODEL OF COMMUTING CHARACTERISTICS OF OKLAHOMA INTERCOUNTY COMMUTERS, 1970

Introduction

The purpose of this chapter is to describe the typical characteristics of intercounty commuters in Oklahoma in 1970. Since an ideal set of data reflecting intercounty commuters' social and economic characteristics is not available, several social and economic county data are used as substitutes. Moreover, in order to observe the possible impact of an individual's surrounding environment and geographic location on his tendency to commute, several additional demographic and geographic variables are employed.

This chapter presents a model of commuting characteristics built in the form of a linear multiple regression equation. In the equation, the county commuting rate is used as the dependent variable. Twelve variables revealing a county's social, economic, demographic and geographic characteristics are tentatively selected as independent variables.

The multiple regression model, as pointed out by Rao and Miller, is designed to "explain observed changes in a dependent variable as being caused by changes in the independent variables."[1] Furthermore, it is

[1]P. Rao and R. Miller, Applied Economics (Belmont, California, 1970), p. 1.

also suggested by them that "an explicit functional form widely used to express the causal relation between a dependent and independent variables is the linear form."[2] Hence, to construct the present model in the form of a linear multiple regression equation is considered appropriate in detecting the causal relationships between county commuting rates and county characteristics.

Nevertheless, the use of multiple regression techniques in this study has two problems; one is involved with the problem of data aggregation, the other is caused by the correlations between independent variables. With the knowledge of these two problems, the present study proceeds to regress county commuting rates on county characteristics. The regression results are expected to have some implications on the typical characteristics of intercounty commuters.

A Discussion of Independent Variables

On the basis of some previous empirical studies of commuting,[3] the independent variables selected for the study of the present chapter are listed under four categories as follows:

(1) Social variables:

AG = median age, all population, 1970;

ED = median school years completed, all persons, 25 years old and over, 1970;

SX = male-female ratio, employed 16 years old and over, 1970 and

FS = persons per household, 1970.

---

[2]Ibid., p. 2.

[3]Some of the empirical studies on commuting were mentioned in Chapter II on page 6.

2) Economic variables:

HM = percent of owner-occupied out of all housing units, 1970;

WA = average weekly earnings, covered employment, 1970;

FI = median family income, 1970; and

EC = percent change of covered employment, 1960-1970.

3) Demographic variables:

PC = percent change of population, 1960-1970; and

PD = population density, population per square mile, 1970.

4) Geographic variables:

SM = dummy variable

= 1, if a county is located within a 50-mile commuting distance of a SMSA central city;

= 0, if otherwise.

RD = dummy variable

= 1, if a county has a four-lane highway passing through it;

= 0, if otherwise.

The data on all social, economic and demographic variables are shown in Table VI. The following discussion presents the respective importance of each independent variable and its expected relationship with the county commuting rate, assuming other independent variables are held constant. The relationship between race and commuting will be studied separately after the regression analysis.

Age (AG)

In migration analysis, age has been usually found to be negatively associated with labor mobility. For instance, an empirical study of migration by Ladinsky found that age accounted for most of the explained

TABLE VI

COUNTY DATA ON SOCIAL, ECONOMIC AND DEMOGRAPHIC VARIABLES, BY SUBSTATE PLANNING REGION, OKLAHOMA, 1970

County	AG[1]	ED[1]	SX[1]	FS[1]	WA[2]	FI[1]	HM[3]	EC[2]	PC[4]	PD[1]
Region 1										
Craig	39.0	10.9	1.59	2.78	107.47	6215	66.7	24.5	- 9.7	19.3
Delaware	36.0	9.8	1.81	2.91	74.76	4398	56.0	166.0	34.6	25.1
Mayes	33.5	10.7	2.03	2.90	116.43	6255	67.1	55.3	16.1	36.0
Nowata	37.9	10.0	1.85	2.72	90.12	5278	68.1	- 24.3	- 9.9	18.2
Ottawa	32.0	11.5	1.83	2.79	127.71	7264	66.8	38.3	5.3	64.2
Rogers	29.8	11.6	1.99	3.04	114.87	7836	67.0	20.6	37.9	41.5
Washington	32.5	12.5	1.79	2.88	163.56	9984	67.2	16.0	- 0.2	99.7
Region 2										
Adair	29.7	8.8	1.55	3.23	82.44	3997	63.2	82.8	15.5	26.6
Cherokee	24.8	9.9	1.64	3.02	73.36	4870	55.2	72.7	30.5	30.7
McIntosh	36.7	9.1	1.55	2.89	85.37	4705	58.1	3.7	0.8	20.5
Muskogee	32.2	11.1	1.70	2.87	118.74	6554	64.0	18.4	- 3.8	72.8
Okmulgee	33.1	10.6	1.76	2.81	112.41	6060	63.2	- 14.6	- 4.3	50.5
Sequoyah	27.9	9.4	1.96	3.23	113.08	5433	66.3	114.1	29.8	33.6
Wagoner	29.0	10.7	2.09	3.08	108.56	7267	65.6	50.7	41.4	39.4
Region 3										
Choctow	35.9	8.8	1.54	2.83	97.23	4791	59.7	20.2	- 3.2	19.5
Haskell	34.8	8.8	2.02	2.93	109.81	4861	64.8	46.4	5.0	15.9
Latimer	30.0	9.2	1.82	2.97	111.24	4826	60.2	224.7	11.2	11.7
LeFlore	32.7	9.1	1.91	2.97	103.08	5093	64.9	49.7	10.4	20.6
McCurtain	29.6	8.8	1.88	3.11	106.78	4793	62.6	92.7	10.8	15.9
Pittsburg	33.2	10.7	1.62	2.84	105.46	6690	62.9	40.3	9.2	30.2
Pushmataha	36.2	8.9	1.71	2.89	87.73	3979	59.2	65.3	3.3	6.6

TABLE VI (Continued)

County	AG[1]	ED[1]	SX[1]	FS[1]	WA[2]	FI[1]	HM[3]	EC[2]	PC[4]	PD[1]
Region 4										
Atoka	32.8	8.9	2.04	3.04	76.08	4836	61.6	63.8	12.0	11.1
Bryan	33.5	10.6	1.70	2.73	94.19	5542	58.7	48.3	8.4	28.7
Carter	34.6	11.4	1.75	2.82	114.52	6820	62.8	29.1	0.4	45.0
Coal	38.0	8.9	1.51	2.86	81.84	4602	66.0	43.5	13.1	10.5
Garvin	36.5	10.4	1.85	2.78	118.42	6624	65.5	8.1	4.1	30.6
Johnson	35.8	8.9	1.88	2.78	85.36	4265	60.5	4.1	15.2	12.3
Love	36.4	9.9	1.63	2.87	74.94	5621	66.0	178.2	11.7	11.0
Marshall	42.2	10.0	1.85	2.67	87.28	5561	56.0	- 0.7	5.4	21.0
Murray	38.5	10.3	1.61	2.66	110.18	6167	58.6	72.2	3.2	25.2
Pontotoc	33.9	11.2	1.71	2.71	105.21	6424	62.0	14.1	2.1	39.0
Region 5										
Hughes	41.9	9.5	1.57	2.67	90.57	5330	65.7	- 13.2	8.8	16.4
Lincoln	35.8	10.6	2.00	2.82	92.91	6440	67.7	34.7	7.4	20.0
Okfuskee	35.3	9.5	1.98	2.89	80.16	4549	63.1	30.3	3.4	16.8
Pawnee	38.7	10.8	1.71	2.71	92.15	6644	65.3	58.9	9.9	20.2
Payne	23.7	12.5	1.57	2.66	98.77	6972	53.7	34.3	- 0.1	70.3
Pottawatomie	32.8	11.4	1.71	2.79	102.34	6979	68.2	- 0.3	8.5	54.3
Seminole	36.5	10.2	1.55	2.81	103.87	5563	62.5	29.2	0.5	39.9
Region 6										
Creek	30.3	10.5	1.85	2.95	109.43	7355	68.1	10.3	15.3	48.6
Osage	34.1	11.5	1.91	2.85	110.21	7460	64.3	- 0.9	14.5	13.1
Tulsa	28.3	12.3	1.67	2.96	144.56	9652	62.8	33.9	0.4	701.0

TABLE VI (Continued)

County	AG[1]	ED[1]	SX[1]	FS[1]	WA[2]	FI[1]	HM[3]	EC[2]	PC[4]	PD[1]
Region 7										
Alfalfa	43.3	12.2	2.08	2.52	92.13	6511	66.8	- 0.1	3.5	8.3
Blaine	36.0	11.3	1.79	2.79	94.71	6161	63.0	32.4	6.6	12.9
Garfield	30.2	12.3	1.61	2.78	116.71	8073	65.7	45.7	0.0	52.5
Grant	42.6	12.2	2.35	2.59	95.80	6291	67.9	0.3	5.0	7.1
Kay	34.0	12.3	1.85	2.80	138.52	8277	65.3	12.5	1.2	51.4
Kingfisher	32.1	12.0	2.00	2.99	99.12	8382	66.5	81.9	4.5	14.2
Major	36.3	11.7	2.41	2.81	106.35	6684	66.9	53.7	7.8	7.8
Noble	35.7	11.8	1.80	2.81	114.75	6702	64.9	27.1	- 1.0	13.5
Region 8										
Canadian	28.0	12.2	1.94	3.07	122.78	8462	65.2	113.8	21.5	35.9
Cleveland	23.9	12.5	1.55	3.04	100.25	9091	60.1	129.4	13.9	155.3
Logan	31.9	11.5	1.51	2.76	98.25	6748	65.4	34.3	11.5	26.2
Oklahoma	27.7	12.3	1.49	2.94	130.25	9437	62.9	45.9	- 0.5	752.6
Region 9										
Caddo	31.4	10.5	2.04	2.98	108.59	5764	59.9	47.5	3.9	22.7
Comanche	22.7	12.3	1.35	3.18	95.42	7295	52.1	34.7	0.5	99.8
Cotton	38.0	10.8	1.78	2.73	94.47	6687	67.8	- 5.1	1.0	10.5
Grady	34.0	11.1	1.85	2.82	105.86	6671	65.6	33.4	5.0	26.8
Jefferson	42.8	10.3	1.62	2.60	71.19	5277	60.8	28.1	2.3	9.1
McClain	32.3	10.5	2.02	3.11	89.77	6732	64.0	45.1	17.4	24.7
Stephens	35.6	10.7	1.86	2.77	124.59	7406	68.0	10.3	0.8	40.3
Tillman	34.5	10.8	1.74	2.80	83.29	6178	60.4	52.0	0.9	14.3

TABLE VI (Continued)

County	AG[1]	ED[1]	SX[1]	FS[1]	WA[2]	FI[1]	HM[3]	EC[2]	PC[4]	PD[1]
Region 10										
Beckham	40.5	10.6	1.75	2.61	85.56	6193	63.0	15.6	- 3.5	17.4
Custer	26.0	12.2	1.73	2.72	89.26	6939	57.5	47.9	4.8	23.1
Greer	42.9	10.6	1.84	2.48	80.61	5106	64.2	- 8.5	2.1	12.6
Harmon	40.1	10.1	1.82	2.75	77.36	5231	63.1	2.2	7.2	9.4
Jackson	24.8	12.1	1.44	3.08	95.95	66.10	54.4	24.5	0.7	38.2
Kiowa	40.9	11.0	1.87	2.65	84.76	5437	66.4	- 10.3	1.2	12.2
Roger Mills	39.7	10.4	2.93	2.81	100.33	6354	63.2	- 15.6	7.1	3.9
Washita	37.0	11.2	1.96	2.78	84.91	5880	53.6	- 37.0	11.0	12.0
Region 11										
Beaver	34.2	12.0	2.66	2.92	132.29	5996	67.2	12.8	4.1	3.5
Cimarron	31.1	12.1	2.69	3.04	99.40	7665	62.5	5.5	2.1	2.2
Dewey	40.8	11.1	1.81	2.70	83.49	6669	71.3	82.4	3.1	5.6
Ellis	40.6	10.0	1.87	2.65	106.98	6571	69.1	39.3	- 0.9	4.1
Harper	35.7	12.1	1.93	2.86	110.22	7362	65.4	- 10.8	8.1	4.9
Texas	26.4	12.2	1.90	3.02	116.62	8321	59.6	55.7	- 2.7	7.9
Woods	32.1	12.2	1.66	2.59	84.64	7037	63.1	13.1	3.6	9.2
Woodward	32.7	12.1	1.65	2.87	116.98	8259	64.5	86.9	2.1	12.4

Source: [1]U. S. Bureau of the Census, Census of Population: 1970, General Social and Economic Characteristics, Final Report PC (1)-C 38, Tables 35, 120 and 121, Oklahoma.

[2]Oklahoma Employment Security Commission, County Employment and Wage Data, Table 1, 1970.

[3]U. S. Bureau of the Census, Census of Housing: 1970, Detailed Housing Characteristics, Final Report HC (1)-A 38, Table 60, Oklahoma.

[4]U. S. Bureau of the Census, Census of Population: 1970, Number of Inhabitants, Final Report PC (1)-A 38, Oklahoma.

variation in migration.[4] In commuting, Scaff's study of commuting patterns in Claremont, California showed that the average age of breadwinner for metropolitan commuters was 17.1 years younger than the non-commuters.[5] Analysis of commuting distance also revealed that "average age of workers declined with increased distance."[6] Accordingly, it would be expected that the county commuting rate to be negatively associated with median age in the Oklahoma commuting patterns.

Education (ED)

The median school years completed by all persons, 25 years old and over is selected to measure the education level in each county. According to Scaff's study, the average school years completed for metropolitan commuters was 0.3 year higher than the non-commuters.[7] Tarver also found in his study of intercounty migration that educational attainment was positively associated with migration.[8] Therefore, in intercounty commuting, a positive relationship between the level of education and commuting may be expected.

---

[4]J. Ladinsky, "The Geographic Mobility of Professional and Technical Manpower," Journal of Human Resources, 2(1967), p. 475.

[5]A. Scaff, "The Effect of Commuting on Participation in Community Organizations," American Sociological Review, 17(April, 1952), p. 217.

[6]R. Lonsdale, "Two North Carolina Commuting Patterns," Economic Geography, 42(April, 1966), p. 130.

[7]Scaff, p. 217.

[8]J. Tarver, "Metropolitan Area Intercounty Migration Rates: A Test of Labor Market Theory," Industrial and Labor Relations Review, 18, No. 2(January, 1965), p. 220.

Sex (SX)

To show the influence of an individual's sex on his/(her) tendency to commute, a ratio of employed males to employed females is considered more appropriate than the ratio of males to females of the population. Hence, the ratio of employed males to employed females by residence is adopted in the analysis to compare the relative tendency of commuting between male and female workers. Peterson has concluded in his empirical study of Iowa commuting patterns that "the lack of any consistent relationship between sex and commuting behavior is the only safe generalization that can be made."[9] However, since the female workers usually have the responsibility of housework in addition to other employment, they might be expected to be more reluctant to commute than the male workers. The relationship between the sex ratio and commuting is therefore expected to be positive.

Family Size (FS)

The average size of families in a county is estimated by persons per household. In general, a relatively large family incurs heavier costs in migration than a relatively small family. Since within a certain distance, commuting can be a substitute for migration, the head of a relatively large family is then expected to have a relatively high tendency to substitute migration with commuting than the head of a small family. Scaff has found empirical evidence that the average family size of metropolitan commuters was 1.5 persons greater than the non-commuters'

---

[9]C. A. Peterson, An Iowa Commuting Pattern and Labor Market Area in General (Iowa City, 1961), p. 11.

families.[10] Consequently, it may be expected that family size has positive association with the county commuting rate.

Home Ownership (HM)

The extent of home ownership in each county is measured by the percent of all year-round owner-occupied housing units. This is derived from dividing the number of all year-round housing units by the number of owner-occupied housing units and then multiply by 100. Adams and MacKesey pointed out that "home ownership is a 'deterrent' to moving to the place of work."[11] Implicitly, this statement suggests a positive relationship between home ownership and commuting. Therefore, it can be expected that a county with a relatively higher percent of owner-occupied housing units to have a relatively higher commuting rate.

Average Weekly Earnings (WA)

To investigate the relationship between wages in each county and its commuting rate, average weekly earnings of the covered employment is adopted in the analysis to measure the prevailing wages in each county. A worker, in deciding whether to commute or not, presumably, is more interested in comparing the difference in total earnings for a period of time than the hourly wage rate. A county with a relatively higher wage is expected to draw workers from its neighboring counties where prevailing wages are relatively lower. Consequently, the variable of average weekly earnings is expected to be negatively associated with the county

---

[10]Scaff, p. 217.

[11]L. Adams and T. MacKesey, Commuting Pattern of Industrial Workers (Ithaca, 1955), p. 60.

commuting rate.

Percent Change of Covered Employment (EC)

A county with rapid increase of covered employment is expected to have expanding employment opportunities for its residents. Consequently, it may be expected that out-commuting from this county to be relatively less frequent than other counties whose increases of covered employment were relatively slow. Therefore, a negative relationship between the percent change of covered employment and county commuting rate might be expected.

Family Income (FI)

To find out whether family income has any influence over workers' tendency to commute, median family income is utilized. A study of commuting in four urban regions by Catanese showed that income was significantly associated with commuting.[12] According to Catanese, household tends to live farther from the workplace as family income increases. Since it was assumed in Chapter I that intercounty commuting generally reflects substantial commuting distances, a positive relationship between family income and commuting may be expected.

Percent Change of Population (PC)

As pointed out in Chapter III, the rapid growth of some of the counties may be because of their roles as the "bedroom" counties of the

---

[12]A. J. Catanese, "Home and Workplace Separation in Four Urban Regions," American Institute of Planners Journal, 37(September, 1971), p. 337.

nearby employment growth centers. A high county commuting rate is therefore expected to be positively associated with population growth.

Population Density (PD)

The population per square mile is used to measure the population density of a county. Supposing population density is positively related to employment opportunities, a densely populated county would be expected to have a better employment opportunities than a sparsely populated county. More commuters will then be expected to be originated from a sparsely populated county than a densely populated county. A negative relationship therefore can be expected between population density and county commuting rate.

Dummy Variable SM

In order to estimate the impact of a county's geographic location on its commuting rate, a dummy variable technique is applied. A county which is located with a 50-mile commuting distance of either Lawton, Fort Smith, Arkansas, Oklahoma City or Tulsa is coded 1; otherwise, it is 0. In Oklahoma, counties with this particular geographic characteristic are: Adair, Caddo, Canadian, Cleveland, Cotton, Creek, Grady, Haskell, Kingfisher, LeFlore, McClain, Mayes, Nowata, Okmulgee, Pottawatomie, Rogers, Sequoyah, Stephens, Tillman, Wagoner and Washington. The geographic location of a county is expected to have a positive impact on its commuting rate.

Dummy Variable RD

The condition of roads was suggested in Chapter II to have some positive impact on the length of the tolerable commuting distance. To evaluate the effect of road conditions on commuting from a different angle, another dummy variable is employed. The availability of good roads is expected to have a positive influence on the county commuting rate. A county with a four-lane highway passing through is coded 1; otherwise, it is 0. The counties with the availability of an interstate highway are as follows: Canadian, Carter, Choctow, Cleveland, Comanche, Craig, Creek, Custer, Grady, Kay, Lincoln, Logan, Love, McClain, McIntosh, Mayes, Muskogee, Noble, Okfuskee, Oklahoma, Okmulgee, Ottawa, Payne, Pittsburg, Pottawatomie, Pushmataha, Rogers, Seminole, Sequoyah, Tulsa, Wagoner and Washita.

Analysis of the Data

In order to select a set of independent variables which explains most of the variation of county commuting rates, a stepwise regression technique is adopted.[13] Out of twelve tentatively selected independent variables, seven of them are finally selected in the regression model. These seven variables are all statistically significant at the 1 or 5 percent level. Median school years completed, percent change of population, percent owner-occupied of all housing units, average weekly earnings and dummy variable SM are significant at the 1 percent level; sex ratio

[13]There are five techniques which stepwise regression can apply. The technique adopted by the present chapter is called "maximum R^2 improvement". For a discussion of the advantages of using this technique, see J. Services, A. J. Barr and J. H. Goodnight, A User's Guide to the Statistical Analysis System (Raleigh, North Carolina, 1972), pp. 127-137.

and dummy variable RD are significant at the 5 percent level. Median school years completed is the only significant variable appearing in the regression equation with an unexpected negative relationship with the county commuting age. Median age, persons per household, median family income, population per square mile and percent change of covered employment over the decade are statistically insignificant at the 5 percent level. These variables are therefore not included in the regression model.[14]

The regression results of the fully specified model of commuting characteristics are presented in Table VII (see footnote 14). Detailed regression results are presented in Tables VIII and IX. As shown in Table VIII, the coefficient of determination (R^2) of the regression is 0.59. This indicates that 59 percent of the variation of county commuting rates can be explained by the set of independent variables in the regression equation.

---

[14]In the early experimentation of regression analysis, a model of commuting characteristics was fully specified which contained eleven independent variables. Family size and median family income were not included and the percent of white population (WH) was included in the model. A multiple regression technique was utilized to regress the dependent variable of county commuting rate on all eleven independent variables. The regression results were somewhat different from the results of stepwise regression analysis. The coefficient of determination of the fully specified model was 0.63. Sex ratio and home ownership, which were originally not significant, became significant at the 5 percent level. Population per square mile, which was significant at the 5 percent level, ceased to be significant in the stepwise regression equation. The significance of other independent variables remained more or less unchanged in both models (see Table VII).

TABLE VII

REGRESSION RESULTS, FULLY SPECIFIED MODEL OF COMMUTING CHARACTERISTICS, DEPENDENT VARIABLE: COUNTY COMMUTING RATE

Independent Variable	Regression Coefficient	Standard Error	t-Statistic	Level of Significance
AG	0.14	0.34	0.43	0.6721
ED	-3.12	1.23	-2.53	0.0137
WH	0.15	0.18	0.87	0.3878
SX	6.70	3.73	1.80	0.0765
HM	0.54	3.19	1.71	0.0929
WA	-0.15	0.07	-2.24	0.0284
EC	-0.02	0.27	-0.77	0.4440
PC	0.40	0.92	4.36	0.0001
PD	-0.03	0.12	-2.02	0.0479
SM	6.67	2.46	2.72	0.0085
RD	5.80	2.02	2.87	0.0055

TABLE VIII

ANALYSIS OF VARIANCE, THE MODEL OF COMMUTING CHARACTERISTICS, DEPENDENT VARIABLE: COUNTY COMMUTING RATE

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	R^2
Corrected Total	76	10,649.27		0.59
Regression	7	6,251.68	893.10	
ED	1	1,392.82		
SX	1	289.67		
WA	1	505.57		
HM	1	388.71		
PC	1	1,262.76		
RD	1	196.38		
SM	1	2,216.76		
Error	69	4,397.59	63.73	

TABLE IX

REGRESSION RESULTS, THE MODEL OF COMMUTING CHARACTERISTICS, DEPENDENT VARIABLE: COUNTY COMMUTING RATE

Independent Variable	Regression Coefficient	Standard Error	t-Statistic	Level of Significance
ED	-3.05	0.93	-3.28	0.0020
SX	7.93	3.71	2.13	0.0344
WA	-0.20	0.06	-3.14	0.0028
HM	0.75	0.27	2.75	0.0075
PC	0.36	0.06	5.58	0.0001
RD	4.45	2.00	2.13	0.0344
SM	6.51	2.35	2.76	0.0073

The regression coefficients of the seven significant independent variables are presented in Table IX. The dummy variable SM has a large regression coefficient in the equation. This variable can be interpreted as the proximity to a SMSA central city. The regression coefficient is 6.51 indicating that, other things being equal, the average commuting rate of counties near metropolitan areas is 6.51 percentage points higher than other counties. The relative attractiveness of metropolitan areas in drawing labor from nearby counties is then obvious.

The level of education has an unexpected negative relationship with commuting. This negative relationship suggests that the residents of Oklahoma counties with lower levels of education have a greater tendency to go outside their counties of residence to find employment. For a county with limited employment opportunities there may be a greater tendency for the people with relatively higher education to migrate. Thus, the county would tend to have a relatively lower level of education, if the median level of education in a county is increased by one year, other things held constant, the commuting rate of this county will be decreased by 3.06 percentage points.

The change of population over the decade exerts a positive influence on the county commuting rate. The regression coefficient of this variable is 0.36. If a county's population change over the decade was one percentage greater, its commuting rate would be increased by 0.36 percentage point, other things remaining unchanged.

The regression coefficient of the availability of good roads, as represented by dummy variable RD, is 4.45. If two counties are homogeneous in social, economic and demographic characteristics, one county will have a commuting rate 4.45 percentage points higher than the other one if the former has a four-lane highway passing through it. This demonstrates that the availability of good roads not only determines the extent of commuting distance but also affects the commuting tendency as well.

The regression coefficients of the other three independent variables can be interpreted in the same manner as the previous four variables. Holding other county characteristics constant, a $10 increase in the average weekly earnings in a county would reduce its commuting rate by 2.0 percentage points; likewise, one percentage increase in the home ownership would reduce the commuting rate by 0.75 percentage point. The county commuting rate would be raised by 7.93 percentage points if the sex ratio of employed male and female is increased by one percentage point.

Since the Summary User Tapes of the 1970 Census of Population provide a race breakdown of the number of commuters in each county, the tendency of commuting of Whites, Negroes and Indians was studied separately.[15] As presented in Table X, a comparison of actual commuting rates of Whites, Negroes and Indians shows that Indians have the highest tendency to commute in most of the counties. If only those counties with 100 or more Negro or Indian workers are compared out of 48 counties, 25 counties have the highest commuting rates for Indians, 15 counties for Whites and only 8 counties for Negroes. In terms of state average, the commuting rate for Whites is 11.5 percent, Indians, 16.1 percent and Negro, 5.9 percent.

Properties of Regression Results

After an interpretation of the regression results, it is important to examine the properties of the results. Two problems concerning the properties of regression results need to be discussed.

The first problem is related to the validity of the regression results. A fundamental disadvantage of using multiple regression technique in social or economic analysis is that some of the independent variables are almost certain to be intercorrelated with one another. This was explicitly pointed out by Farrar and Glauber that

> The econometrician, then, is in a box. Whether his goal is to estimate complex structural relationships in order to distinguish between alternative hypotheses or to develop reliable forecasts, the number of variables required is likely to be large, and past experience demonstrates with depressing regularity that large number of economic variables from a single sample are almost certain to be highly intercorrelated.[16]

---

[15]The number of Indian commuters in each county is derived by subtracting the White and Negro commuters from the total commuters. Thus, the number of Indian commuters includes an insignificant number of other races, e.g., Orientals and Filipinoes.

[16]D. E. Farrar and R. R. Glauber, "Multicollinearity in Regression Analysis: The Problem Revisited," Review of Economics and Statistics, 49(February, 1967), pp. 94-95.

TABLE X

COUNTY COMMUTING RATE BY RACE, SELECTED COUNTIES, OKLAHOMA, 1970

County	White	Negro	Indian
Adair	23.5	0	29.9
Atoka	19.7	20.8	18.5
Blaine	11.4	4.8	9.7
Bryan	19.2	47.1	17.6
Caddo	11.3	8.3	19.1
Canadian	39.4	21.0	23.4
Carter	5.1	2.0	13.4
Cherokee	22.6	16.1	15.4
Choctow	16.5	18.0	17.0
Cleveland	36.1	10.0	37.4
Coal	26.2	0	42.4
Commanche	2.0	2.0	2.4
Craig	16.1	10.0	5.5
Creek	39.6	26.7	44.0
Custer	12.8	7.8	10.0
Delaware	34.8	0	41.6
Garfield	3.2	1.5	18.3
Garvin	10.2	34.9	32.9
Hughes	20.4	5.3	41.6
Jackson	3.1	3.4	0
Johnston	26.3	15.0	22.0
Kiowa	9.5	6.2	14.6
Latimer	21.8	0	26.8
LeFlore	28.4	33.2	22.3
Lincoln	28.5	14.6	41.0
Logan	26.3	18.1	21.7
McIntosh	23.6	16.0	26.4
Mayes	24.8	0	38.9
Muskogee	8.3	8.0	5.7
Nowata	35.4	16.4	35.9
Okfuskee	20.2	20.4	21.7
Oklahoma	3.1	1.3	3.4
Okmulgee	15.8	21.1	35.0
Osage	42.9	41.8	28.6
Ottawa	12.8	0	9.7
Pawnee	28.7	14.1	26.3
Payne	6.9	1.4	10.2
Pittsburg	4.6	3.7	3.2
Pontotoc	8.3	4.9	8.4
Pottawatomie	26.3	1.7	27.6

TABLE X (Continued)

County	White	Negro	Indian
Pushmataha	12.6	46.7	22.0
Rogers	41.1	5.8	31.9
Seminole	10.6	23.6	9.4
Sequoyah	42.7	53.7	40.0
Stephens	8.0	0	6.6
Tulsa	2.9	2.0	4.1
Wagoner	59.4	40.7	61.9
Washington	8.4	5.0	13.8
State	11.5	5.9	16.1

Source: U. S. Bureau of the Census, Census of Population: 1970, Summary User Tapes, Fourth County, (Population), Table 35, Oklahoma.

The regression model contains seven independent variables; consequently, the model might have the problem of multicollinearity. The main consequence of having multicollinearity in the regression equation is that it becomes very difficult to disentangle the relative influence of the independent variables. The precision of the estimation therefore falls.[17] To test the extent of multicollinearity in the equation, the multiple correlation coefficients of each independent variable with the rest of the independent variables are compared with the multiple correlation coefficient of the estimated equation.[18] Table XI presents the

[17]For a detailed discussion of the presence and consequences of multicollinearity in a multiple regression equation, see J. Johnston Econometric Methods (New York, 1972), pp. 159-168.

[18]This method was proposed by Farrar and Glauber; see D. E. Farrar and R. R. Glauber, p. 98. This method in Johnston's opinion was a "more generally reliable guide" in testing multicollinearity; see J. Johnston, p. 163.

multiple correlation coefficient of each independent variable. As the table indicates, none of the seven finally selected variables is any "harmfully"[19] correlated with other independent variables. Consequently, the estimated regression equation does not have serious problems of multicollinearity. Hence, the regression results and their interpretations are considered to be statistically valid.[20]

---

[19]According to Farrar and Glauber, an independent variable is said to be "harmfully" correlated with the other independent variables if its multiple correlation coefficient associated with other independent variables is higher than the multiple correlation coefficient of the regression. In the present case, the correlation coefficient of the estimated regression equation is 0.77; therefore, none of the independent variables is involved with the problem of multicollinearity; see D. E. Farrar and R. R. Glauber, p. 98.

[20]Another statistical problem involved in the present model is that the value of the dependent variable is confined to the interval of zero and one hundred percentage points. Since the dependent variable is limited to a certain range, the disturbance term of the regression equation will not be distributed normally. Consequently, the model is involved with the problem of heteroskedasticity and the tests of significance of the independent variables are therefore suspect. In order to assure that the t-test of the present model is still meaningful, the regression equation was transformed into a semi-log form. In the transformed equation, the county commuting rate was in log value. The value of the transformed dependent variable, then, was between minus infinity and 4.61. The disturbance term was therefore close to be normally distributed. The regression results of the transformed equation were almost consistent with the original ones. The availability of good roads was the only variable whose significance level was changed from the original 5 percent level to the 10 percent level. This indicates that the limited range of dependent variable in the present model does not present a serious problem in the test of the significance of the independent variables.

TABLE XI

MULTIPLE CORRELATION COEFFICIENTS (MCC) OF THE DEPENDENT AND INDEPENDENT VARIABLES, MODEL OF COMMUTING CHARACTERISTICS

	CM[1]	ED	SX	WA	HM	PC	RD	SM
MCC With Other Independent Variables	0.77	0.50	0.41	0.58	0.55	0.45	0.40	0.50
R^2	0.59	0.25	0.17	0.34	0.30	0.20	0.16	0.25

[1]CM = County commuting rate.

The second problem of the present study concerns the applicability of the regression results to individual commuters. Due to lack of data on characteristics of commuters, county data are used instead of individual responses. The problem involved in this context is that county data are aggregate data. Sometimes, this kind of aggregate data may not reveal the true characteristics of commuters. Neither are aggregate data able to control the variation of characteristics of individuals. For example, the residents' median school years completed 25 years old and over in Adair County is 8.8. First, this median number does not always show the true level of education of intercounty commuters who lived in Adair County. Second, the single number, 8.8, does not control the variation of education among individual commuters. Therefore, there are limitations in drawing conclusions on individuals relying on the regression results which are based on aggregate data.

Although aggregate data have shortcomings, at least, they provide information on a general basis. The median years of schooling of a county shows the general level of education of residents in the county. County commuting rate indicates in general the commuting status of the residents in the county. If most of the counties with a low level of education are those counties with high county commuting rates, it may be expected that, other things being equal, education is negatively associated with commuting.

The present chapter does proceed to utilize regression analysis based on the idea that aggregate data provide relevant information. The regression results and their interpretations are therefore expected to have implications in describing the characteristics of commuters.

Summary

The present chapter describes the typical characteristics of inter-county commuters in Oklahoma. A stepwise regression technique is applied to regress county commuting rate on twelve tentatively selected independent variables. Each independent variable reflects a county's social, economic, geographic and demographic characteristics. The regression results show that seven out of twelve variables have, as expected, statistically significant relationships with the county commuting rate at the 1 or 5 percent significance level. Proximity to a SMSA central city, percent change of population, median school years completed, average weekly earnings and home ownership are significant at the 1 percent level; availability of good roads and the sex ratio of employed workers are at the 5 percent level. Median age, family size, median family income and population density are not statistically significant at the 5 percent level; therefore, they are not included in the final regression equation.

In general, the regression results imply that a typical intercounty commuter in Oklahoma may be expected to be the one who: (1) has a relatively low level of education, (2) lives in a county in which the prevailing wage rate is relatively low, (3) lives in a county in which the population growth is relatively high, (4) lives close to a SMSA central city and (5) lives in a county in which good roads are available. In addition, a male worker and/or a homeowner may also be expected to have a relatively high tendency to commute than if otherwise. A separate study on race indicates that the tendency to commute of Whites is relatively lower than Indians but higher than Negroes.

CHAPTER V

THE DETERMINANTS OF INTERCOUNTY COMMUTING

Introduction

The purpose of this chapter is to build a model to analyze the determinants of intercounty commuting. The model is built in the form of a multiple regression equation. The number of commuters from one county to another is used as the dependent variable.

Since no single variable is capable of explaining the variation of intercounty commuting flows, the present chapter attempts to select several important independent variables for the model which determine intercounty commuting flows. These independent variables are derived from the theoretical discussion of the functions of commuting. The functional relationships between the dependent and independent variables are hypothesized on the basis of a priori economic theories. These independent variables are: the price of a given quality of housing services, employment opportunities, commuting distance and county population between 18 and 64 years of age. In the first section, the functional relationships between dependent and independent variables are discussed and then hypothesized. An integrated theory of intercounty commuting is then synthesized in the section. The second section provides the related Oklahoma intercounty commuting data which will be used to test the hypotheses of the model. An empirical test of the model is performed in the same section. The results of the empirical test are discussed in the third section. The final section summarizes the analysis of the present chapter.

Theoretical Framework

Household Behavior Theory

As pointed out earlier, one of the functions of commuting was considered as a locational balance between residence and workplace. Hence, a determinant of intercounty commuting can be traced through a comparison of the relative prices of a given quality of housing services in the counties of origin and destination.

Consider an individual with utility function:[1]

$$U = U(X, H, R) \tag{1}$$

where X is any composite commodity which consists of market goods and the time of consuming that commodity.[2] H stands for a given quality of housing services, and R, hours of leisure.

To maximize his utility, this individual is subject to money income and time constraints:

$$P_x X + P_h(k)H + M(k) - W\bar{t}_w - V \geq 0 \tag{2}$$

$$\bar{t}_w + \bar{t}_x + t_m(k) + R - 24 \geq 0 \tag{3}$$

---

[1]This kind of utility function is used by W. Mankin, "A New Look at the Muth Model," The American Economic Review, 62(December, 1972), pp. 980-982. The composite commodity and leisure in the Muth model are lumped together, whereas in Mankin's model they are separated.

[2]The "time" of consuming a composite commodity, in this context, is interpreted very broadly. For instance, the time of consuming breakfast includes the shopping time, preparing time and the time of actually consuming the breakfast. See G. S. Becker, Economic Theory (New York, 1971), p. 45.

where X = composite commodity;

P_x = the price of a composite commodity, X;

$\bar{t}_x$ = the fixed time of consuming composite commodity X

H = a given quality of housing services;

$P_h(k)$ = the price of a given quality of housing services which is a function of commuting distance, k;

k = commuting distance between the place of work and the place of residence;

M(k) = commuting cost in terms of money;

W = wage rate per hour;

$\bar{t}_w$ = fixed hours of work;

V = income other than wage; and

$t_m(k)$ = commuting time.

For the sake of simplicity, several assumptions are made: (1) hours of work and the time of consuming composite commodities are not affected by the change of commuting distance;[3] (2) the price of a given quality of housing services is a negative function of commuting distance between residence and workplace;[4] and (3) commuting cost and commuting time are a positive function of commuting distance. That is:

---

[3]It is implicitly assumed that an individual's consumption pattern is fixed. The only thing that can be adjusted due to the change of commuting distance is hours of leisure.

[4]This assumption has been used by Schnore and Kain in their studies of commuting. See L. F. Schnore, "The Separation of Home and Work: A Problem for Human Ecology," Social Forces, 32(May, 1954), p. 342 and J. F. Kain, "The Journey to Work as a Determinant of Residential Location," Papers and Proceedings of the Regional Science Association, 9(1962), p. 140.

$$\frac{\partial \bar{t}_w}{\partial k} = 0 \ ; \quad \frac{\partial \bar{t}_x}{\partial k} = 0 \ ; \quad \frac{\partial t_m(k)}{\partial k} = t_m'(k) > 0$$

$$\frac{\partial P_h(k)}{\partial k} = P_h'(k) < 0 \ ; \quad \frac{\partial M(k)}{\partial k} = M'(k) > 0 \quad .$$

To find this individual equilibrium condition, set up a LaGrangian:

$$L = U(X, H, R) + \lambda[W\bar{t}_w + V - P_x X - P_h(k)H - M(k)]$$
$$+ \mu[24 - \bar{t}_w - \bar{t}_x - t_m(k) - R] \quad . \tag{4}$$

The first order condition requires the following:

$$\frac{\partial L}{\partial X} = U_X - \lambda P_x \quad = 0 \tag{5}$$

$$\frac{\partial L}{\partial H} = U_H - \lambda P_h(k) = 0 \tag{6}$$

$$\frac{\partial L}{\partial R} = U_R - \mu \quad = 0 \tag{7}$$

$$\frac{\partial L}{\partial k} = u_k + \lambda[-P_h'(k)H - M'(k)] + \mu[-t_m'(k)] = 0 \quad . \tag{8}$$

Equation (8) states the condition of locational equilibrium for this individual. If commuting yields disutility or, at most, zero utility,[5] Equation (8) can be rewritten as

---

[5]Since marginal utility of work is negative, if commuting is considered part of work, then a plausible assumption is that marginal utility of commuting is negative. See "So Stop Whining: for Some Americans, the Commute-to-Work is Almost a Job Itself," Wall Street Journal, (June 27, 1973), p. 1.

$$-P_h'(k)H \leq M'(k) + \frac{\lambda}{\mu} t_m'(k)^6 \quad . \qquad (9)$$

Essentially, Equation (9) indicates that the saving on housing expenditure by moving farther from the place of work should be at least as great as the increase of transportation cost plus some monetary compensation of the loss of leisure time due to the increasing commuting distance.

Mathematically, to assure the equilibrium location yields maximum utility, the second order condition requires:[7]

$$\lambda[-P_h''(k)H - M''(k)] + \mu[-t_m''(k)] < 0 \quad . \qquad (10)$$

Rearrange Equation (1), it becomes

$$-\lambda P_h''(k)H < M''(k) + \frac{\mu}{\lambda} \cdot t_m''(k) \quad .$$

Equation (11) shows that additional saving on housing expenditures by moving away from the place of work is less than the additional costs of

---

[6]The notation λ refers to the marginal utility of income per dollar, and μ, the marginal utility of time per hour. Thus, λ/μ is the shadow price of time. Generally, the shadow price of time is not equal to wage. For a detailed discussion on the price of time, see M. B. Johnson, " "Travel Time and Price of Leisure," Western Economic Journal, 4(Spring, 1966), p. 137.

[7]Totally differentiating Equations (5), (6), (7) and (8) gives the following Hessian:

$$|S| = \begin{vmatrix} U_{XX} & U_{XH} & U_{XR} & 0 \\ U_{HX} & U_{HH} & U_{HR} & -\lambda P_h'(k) \\ U_{RX} & U_{RH} & U_{RR} & 0 \\ 0 & -\lambda P_h'(k) & 0 & \lambda[-P''(k)H-M''(k)]+\mu[-t_m''(k)] \end{vmatrix} .$$

The second-order condition requires the factors on the main diagonal of the Hessian to be negative; therefore, $\lambda[-P''(k)H-M''(k)]+\mu[-t_m''(k)]$ has to be negative. For an extensive discussion of second-order condition of maximization and minimization, see A. Chiang, Fundamental Methods of Mathematical Economics (New York, 1967), pp. 326-342.

commuting. It actually sets a limit on moving away from the place of work. Consequently, there is a maximum distance an individual can benefit by locating himself at a distance from the place of work. Beyond this distance the "benefit" will become a cost.

Labor Market Theory

The determinant of intercounty commuting can also be inferred by comparing the employment opportunities in the county of residence and its neighboring counties. A county with employment increasing less rapidly or even declining relative to its neighboring counties can be another factor which induces its residents to commute out to work. Moreover, wage differences among the residence county and the adjacent counties may also affect intercounty commuting. The following figures will help to show the significance of employment opportunities and wage differences in intercounty commuting.

To start with, assume that two counties have identical amounts of labor supply, OE; however, due to different economic situations, county i has a lower demand for labor than county j. The wage rate in county i therefore is lower than in county j. The rates are W_i and W_j, respectively, as shown in Figure 3. Supposing commuting cost is zero, an equilibrating force will enable workers in county i commuting to county j to obtain employment and higher wages. Final equilibrium will be achieved when the wage rates in both counties converge to W. The employment in county i will be E_i, and county j, E_j.

However, in reality, commuting does involve money and time. A more realistic situation of equilibrium is shown in Figure 4. The equilibrating force will not be able to close completely the wage gap between

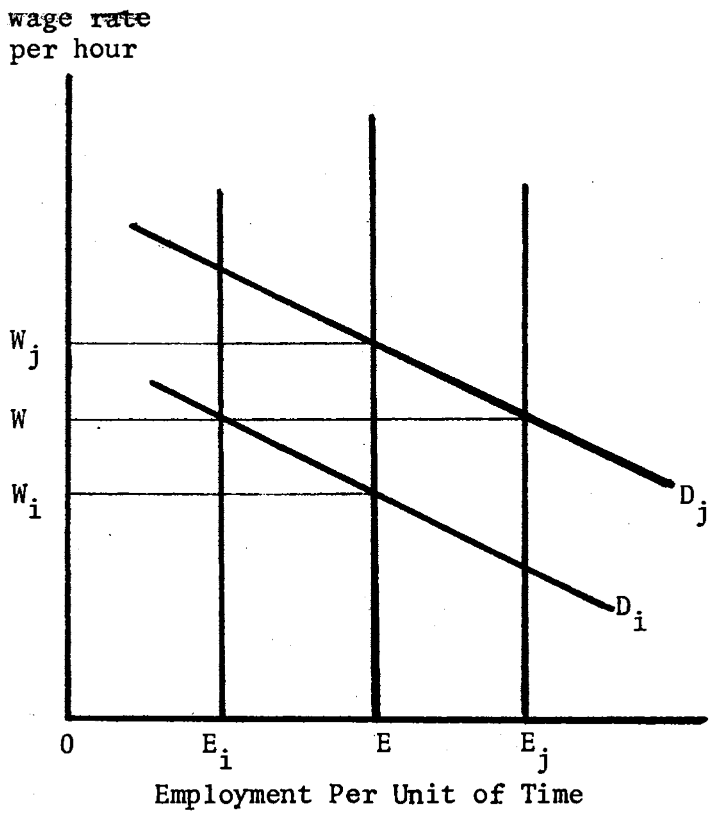

Figure 3. Equilibrium Employment and Wage Rate, No Commuting Costs

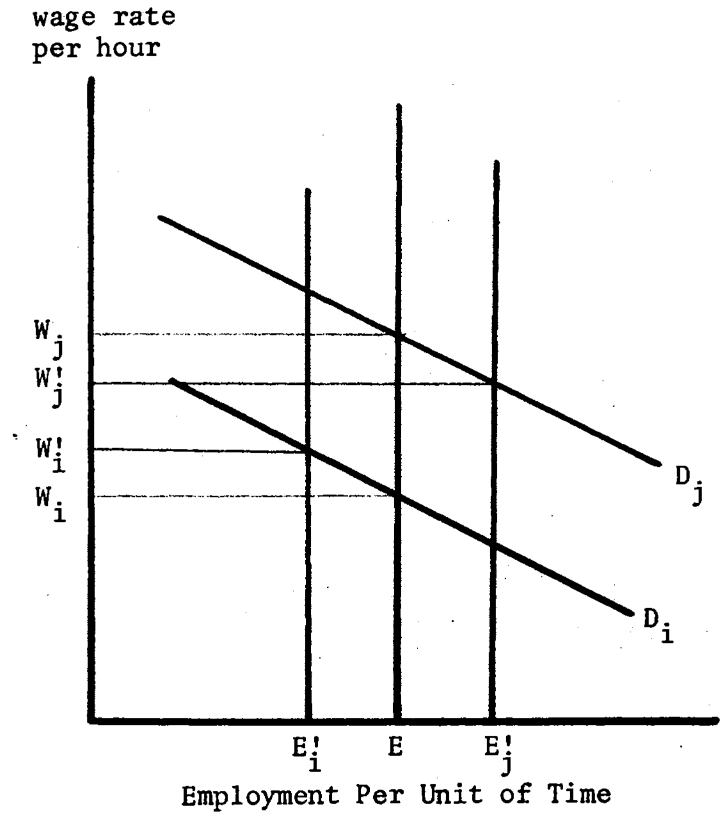

Figure 4. Equilibrium Employment and Wage Rate, With Commuting Costs

the two counties. There are still some difference in wage rates between the two counties; some workers do commute from county i to county j, though the number is smaller compared with Figure 3. OE_i' workers are actually employed in county i; OE_j' workers are employed in county j.

Holding the labor supply constant, workers will commute from county i to county j if the employment opportunities in county j are relatively better in county i. The model thus hypothesizes that the number of commuters from county i to j is positively related to the ratio of employment opportunities in county j to counti i, E_j/E_i.

Gravity Model

The concept of a gravity model is borrowed from Newtonian physics' role of gravitational force. According to the role, the interaction between the two masses vary positively with the size of the masses and negatively with the distance between the two masses. In terms of intercounty commuting, the size of mass in each county is measured by county population between 18 and 64 years of age. Average distance between two counties is estimated by the distance between the county seats.

To develop a gravity model of intercounty commuting, several important assumptions have to be made:[8] (1) all workers are homogeneous with respect to social and economic characteristics so that a theoretical study of commuting can be carried out by analyzing a representative worker's commuting behavior, (2) no money and time cost are actually involved in commuting, and (3) other things are held constant.

[8]For a detailed discussion of this topic, see W. Isard, Methods of Regional Analysis: An Introduction to Regional Science (Cambridge, Massachusetts, 1960), pp. 493-544.

In probability theory, the possibility of a representative worker living in county i who will commute to county j to work is P_j/P. Where P_j is the population as defined in county j and P stands for the total population between 18 and 64 years of age in the commuter-shed area surrounding county i.[9] Since the defined population in county i is P_i, the total expected number of commuters originated in county i and terminated in county j, T_{ij}, will be $P_i \cdot P_j/P_i$.

The next step is to find out the possible effect of distance on commuting. Let M_{ij} be the actual number of commuters from i to j, assuming that the ratio of actual and expected number of commuters from i to j is a log-linear negative function of distance.[10] That is,

$$\log \frac{M_{ij}}{T_{ij}} = a - b \log D_{ij} \tag{11}$$

where D_{ij} stands for the distance between county i and county j. Transforming (11) into a non-log form:

$$\frac{M_{ij}}{T_{ij}} = \frac{c}{D_{ij}^{b}} \tag{12}$$

where c is the anti-log of constant a. Rearranging (12) by substituting T_{ij} with $P_i \cdot P_j/P$

$$M_{ij} = c \cdot \frac{\frac{P_i \cdot P_j}{P}}{D_{ij}^{b}} \tag{13}$$

---

[9]Commuter shed of county i is defined as the area inclusive of all counties receiving commuters from county i.

[10]Intuitively, the expected number of commuters is calculated regardless of distance. A gap between the expected and actual figures will be smaller if the distance is shorter than it is otherwise. The ratio of expected and actual number of commuters is therefore negatively associated with distance. See Isard, p. 494.

Since P can be considered as a constant, let G = c/P, a final form of gravity model of intercounty commuting can be written as;

$$M_{ij} = G \cdot \frac{P_i \cdot P_j}{D_{ij}^b} \quad . \qquad (14)$$

Equation (14) indicates that the number of commuters from county i to county j is positively associated with the size of population between 18 and 64 years of age of both counties and negatively associated with the distance between the two counties.

A Synthesized Theory of Intercounty Commuting

On the basis of the above discussion, three hypotheses concerning intercounty commuting flows are formulated. Following the household behavior theory, the number of commuters from county i to county j is hypothesized positively associated with the price ratio of a given quality of housing services between the two counties, i.e., H_j/H_i. From the labor market theory, the intercounty commuting flow from county i to county j is also hypothesized positively related to the ratio of employment opportunities, E_j/E_i, in the two counties. Based on the gravity concept, the hypothesis is that the magnitude of commuting flow from county i to county j varies positively with the defined population of the two counties and negatively with the distance between the two counties.

To develop a theoretical model of intercounty commuting, three hypotheses formulated above are integrated together into the following form:

$$M_{ij} = f\left(\frac{H_j}{H_i}, \frac{E_j}{E_i}, D_{ij}, P_i, P_j\right) \qquad (15)$$

where:

$$\frac{\partial M_{ij}}{\partial \frac{H_j}{H_i}} > 0 \; ; \quad \frac{\partial M_{ij}}{\partial \frac{E_j}{E_i}} > 0 \; ; \quad \frac{\partial M_{ij}}{\partial D_{ij}} < 0 \; ;$$

$$\frac{\partial M_{ij}}{\partial P_i} > 0 \; ; \quad \frac{\partial M_{ij}}{\partial P_j} > 0 \quad .$$

The theoretical model can, in turn, be interpreted from the viewpoint of household behavior theory. The interpretation is that an individual who commutes to work does so because: (1) he can achieve a desirable trade-off between housing expenditures and commuting costs and (2) he can obtain better employment in the destination county. The distance variable in the model can be treated as an aggregate disutility which offsets the savings on housing expenditures and discounts the employment opportunities in the destination county. Population between 18 and 64 years of age in the origin and destination are used in the model as scale factors to control the intercounty commuting flows.

Empirical Test of the Hypotheses

To measure the price of a given quality of housing services in each county, three kinds of measurement are used. They are: the median value of owner-occupied housing units, the median contract rent and real estate and improvement per square mile. These data along with employment by establishment and county population between 18 and 64 years of age are presented in Table XII. The average distance between counties of origin and destination is measured by the distance between their county seats. The measurement is based on the Official Highway Map prepared by Oklahoma Highway Commission. The number of commuters from one county to another is identified from the Summary User Tapes of 1970 Census of Population, fourth count, population, Table 35. There are 92,953 intercounty

TABLE XII

COUNTY DATA ON THE PRICE OF HOUSING, EMPLOYMENT AND WORKING POPULATION, OKLAHOMA, 1970

County	Median Contract Rent[1]	Real Estate and Improvements per Square Mile[2]	Median Value of Owner-Occupied Housing[1]	Employment by Establishment[3]	County Population Between 18 and 64 Years of Age[4]
Region 1					
Craig	48	122.26	75	5,800	8,121
Delaware	40	133.35	90	3,560	9,112
Mayes	51	196.43	90	6,690	12,309
Nowata	43	99.10	61	2,430	5,158
Ottawa	47	257.40	77	10,625	16,905
Rogers	58	229.05	114	5,810	15,494
Washington	65	584.90	131	19,520	23,734
Region 2					
Adair	40	78.04	64	4,140	7,562
Cherokee	55	97.08	98	6,030	13,122
McIntosh	38	93.91	67	3,300	6,432
Muskogee	52	285.63	88	20,875	31,189
Okmulgee	46	178.29	65	10,150	18,832
Sequoyah	43	61.40	68	4,400	11,853
Wagoner	49	151.99	91	3,600	11,748
Region 3					
Choctow	37	95.31	51	4,300	7,465
Haskell	38	62.63	59	2,480	4,990
Latimer	44	43.85	64	2,400	4,767
LeFlore	39	63.26	61	6,940	16,555
McCurtain	38	64.76	55	7,550	14,101
Pittsburg	49	116.65	81	13,225	20,803
Pushmataha	38	33.94	53	2,700	4,602
Region 4					
Atoka	41	61.42	60	2,750	5,790
Bryan	44	134.04	68	7,360	14,060
Carter	49	202.51	83	14,175	19,667
Coal	38	62.91	50	1,610	2,448
Garvin	47	147.87	76	8,970	13,221
Johnson	38	64.88	50	2,000	4,164
Love	41	67.36	67	1,950	2,945
Marshall	39	113.23	66	2,310	4,041
Murray	46	113.94	68	3,530	5,465
Pontotoc	47	222.89	87	10,380	15,659

TABLE XII (Continued)

County	Median Contract Rent[1]	Real Estate and Improvements per Square Mile[2]	Median Value of Owner-Occupied Housing[1]	Employment by Establishment[3]	County Population Between 18 and 64 Years of Age[4]
Region 5					
Hughes	38	65.04	52	4,030	6,799
Lincoln	42	94.67	72	5,180	10,078
Okfuskee	38	62.60	50	2,880	5,173
Pawnee	44	128.70	72	2,960	5,889
Payne	76	311.88	121	18,000	33,233
Pottawatomie	50	228.81	84	12,075	23,362
Seminole	42	124.41	64	8,960	13,065
Region 6					
Creek	53	150.37	78	10,903	24,041
Osage	48	67.07	79	7,950	16,267
Tulsa	82	4,045.61	138	187,647	228,425
Region 7					
Alfalfa	45	164.32	66	2,870	3,585
Blaine	44	116.27	80	4,430	6,032
Garfield	67	398.13	166	22,900	30,563
Grant	51	166.83	67	3,300	3,702
Kay	56	382.27	119	20,200	26,578
Kingfisher	60	172.04	116	5,590	6,563
Major	55	103.90	83	3,400	3,957
Noble	48	114.14	85	4,450	5,236
Region 8					
Canadian	60	235.83	121	8,800	17,382
Cleveland	89	694.32	139	24,622	50,645
Logan	47	141.65	80	5,560	10,448
Oklahoma	76	3,965.66	133	260,838	300,359
Region 9					
Caddo	44	141.84	78	7,740	14,835
Comanche	89	375.82	135	25,175	67,157
Cotton	43	100.58	66	2,640	3,604
Grady	48	153.84	78	9,330	15,469
Jefferson	38	77.41	52	2,160	3,682
McClain	45	133.86	80	3,350	7,450
Stephens	51	181.07	72	13,440	19,814
Tillman	44	139.87	68	5,910	6,494

TABLE XII (Continued)

County	Median Contract Rent[1]	Real Estate and Improvements per Square Mile[2]	Median Value of Owner-Occupied Housing[1]	Employment by Establishment[3]	County Population Between 18 and 64 Years of Age[4]
Region 10					
Beckham	46	111.11	70	6,830	8,232
Custer	64	183.86	117	8,460	13,770
Greer	39	101.76	66	2,510	4,275
Harmon	38	87.69	72	1,930	2,533
Jackson	66	198.89	100	9,420	17,002
Kiowa	41	111.65	63	4,410	6,392
Roger Mills	38	49.82	58	1,510	2,402
Washita	49	122.84	72	5,110	6,502
Region 11					
Beaver	59	53.45	97	2,740	3,521
Cimarron	56	38.20	89	1,560	2,202
Dewey	43	73.12	61	2,800	3,043
Ellis	52	57.33	72	2,430	2,705
Harper	51	65.33	79	2,090	2,778
Texas	64	95.72	121	6,120	9,278
Woods	56	95.53	87	4,820	7,070
Woodward	64	170.89	120	6,120	8,454

Source: [1]U. S. Bureau of the Census, Census of Housing: 1970, General Housing Characteristics, Oklahoma, Table 29.

[2]Oklahoma Tax Commission, Assessment of Real Estate and Improvements, and Real Estate Assessment-Sales Ratio, 1970.

[3]Oklahoma Employment Security Commission, Oklahoma Labor Force Estimates, June, 1967-1971.

[4]U. S. Bureau of the Census, Census of Population: 1970, General Population Characteristics, Oklahoma, Table 35.

commuters in Oklahoma contained in 586 observations. The number of commuters in each observation varies. For instance, one observation contains 10,278 workers who commuted from Cleveland County to Oklahoma County whereas another observation has only two workers from Okfuskee County to Pottawatomie County.

The multiple regression analysis is applied to regress the number of commuters from one county to another against all the independent variables. Several different forms of regression equations were tried in order to get the best fit for the model. A natural log, linear equation was finally adopted because it provided the best fit for the model. The regression results are shown in Tables XIII and XIV.

As indicated in Table XIV, the functional relationships between the intercounty commuting flows and employment opportunities, distance and working population are as hypothesized. Statistically, the employment, distance and population in the origin are significant at the 1 percent level. Population in the destination is significant at the 5 percent level. The housing variable, estimated by the median value of owner-occupied housing units, shows an unexpected sign and is not statistically significant at the 5 percent significance level. The coefficient of determination (R^2) is 0.52 indicating that the set of independent variables in the model explains up to 52 percent of the variation of intercounty commuting flows in Oklahoma.

In addition to the median value of owner-occupied housing units, the median contract rent and the real estate and improvements per square mile in each county were tried to measure the price of housing services. In the estimated regression equation, the median contract rent showed a negative sign and real estate per square mile appeared with a positive

TABLE XIII

ANALYSIS OF VARIANCE, THE MODEL OF COMMUTING FLOWS, DEPENDENT VARIABLES: NUMBER OF COMMUTERS FROM ONE COUNTY TO ANOTHER

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Squares	R^2
Corrected Total	585	1,075.83		0.52
Regression	5	562.74	112.55	
$\ln \frac{H_j}{H_i}$	1	5.15		
$\ln \frac{E_j}{E_i}$	1	52.10		
$\ln P_i$	1	259.61		
$\ln P_j$	1	3.64		
$\ln D_{ij}$	1	242.23		
Error	580	513.10	0.88	

TABLE XIV

REGRESSION RESULTS, THE MODEL OF COMMUTING FLOWS, DEPENDENT VARIABLES: NUMBER OF COMMUTERS FROM ONE COUNTY TO ANOTHER

Independent Variable	Regression Coefficient	Standard Error	t-statistic	Level of Significance
Intercept	2.15	0.51	4.20	0.0001
$\ln \frac{H_j}{H_i}$	-0.03	0.15	-0.17	0.8666
$\ln \frac{E_j}{E_i}$	0.40	0.09	4.38	0.0001
$\ln P_i$	0.65	0.11	6.00	0.0001
$\ln P_j$	0.21	0.10	2.02	0.0429
$\ln D_{ij}$	-1.74	0.09	-20.00	0.0001

sign. Both of them failed to be statistically significant at the 5 percent level.

The regression equation using median contract rent to measure the price of housing was:

$$\ln M_{ij} = \underset{(4.19)}{2.14} - \underset{(0.01)}{0.01} \ln \frac{H_j}{H_i} + \underset{(4.38)}{0.39} \ln \frac{E_j}{E_i}^{**} + \underset{(6.21)}{0.65} \ln P_i^{**} + \underset{(2.02)}{0.20} \ln P_j^{*}$$

$$- \underset{(-20.00)}{1.74} \ln D_{ij}^{**}$$

When real estate and improvements per square mile was used as the estimate of the price of housing, the equation was:

$$\ln M_{ij} = \underset{(1.37)}{1.01} + \underset{(1.24)}{0.09} \ln \frac{H_j}{H_i} + \underset{(6.17)}{0.42} \ln \frac{E_j}{E_i}^{**} + \underset{(13.45)}{0.76} \ln P_i^{**} + \underset{(2.47)}{0.47} \ln P_j^{*}$$

$$- \underset{(-20.00)}{1.74} \ln D_{ij}^{**}$$

where ** and * stand for the significance of the independent variables at the 1 and 5 percent level. The t-statistics are presented in the parentheses below their responding regression coefficients.

As will be discussed later, the county aggregate data on the price of housing and the presence of multicollinearity may have caused it to become statistically insignificant. Although the other variables also face the same problems, they have shown the expected signs and are statistically significant.

Since the regression equation is estimated in a log, linear form, the regression coefficients of the independent variables can be interpreted in terms of elasticities. In the estimated equation, the elasticity of commuting with respect to distance is -1.74. Other things held constant, one percent increase in the distance between counties will reduce the number of commuters from one county to another by 1.74 percent. The constraint of distance in an individual's commuting behavior is quite substantial. The size of population between 18 and 64 years of age in the county of origin has a greater influence over the flows of intercounty commuting than the county of destination. The elasticity of commuting with respect to the size of the defined population in the origin county is 0.64; the destination county is 0.21. As to the ratio of employment opportunities, the elasticity is 0.40. If somehow the employment opportunities in the origin county are deteriorated and/or they are improved in the destination county such that the ratio is raised by one percent, the commuting flow from the origin to the destination will be increased by 0.40 percent, other things being equal. The ratio of the price of housing has the lowest influence over intercounty commuting. The elasticity of commuting with respect to housing price is -0.03.

Properties of the Regression Results

To test the hypotheses of the theoretical model by using Oklahoma intercounty commuting data, several data and statistical problems have occurred in the process. A brief discussion with respect to each problem is therefore needed.

Data Problem

The advantage of using the information on employment provided by the Oklahoma Employment Security Commission rather than the U. S. 1970 Census of Population is that the former reports employment by establishment, while the latter, by place of residence.[11] Consequently, if a worker, for instance, is employed in Tulsa County but is living in Wagoner County, then in reporting employment, the Oklahoma Employment Security Commission will include him in Tulsa County but the Census will include him in Wagoner County. In order to have a better measurement of employment opportunities, the Oklahoma Employment Security Commission's report is used.

However, the problem lies in the fact that the report of employment of Creek, Osage and Tulsa Counties is included in the Tulsa SMSA; C Canadian, Cleveland and Oklahoma Counties are included in the Oklahoma SMSA, respectively. Consequently, there are no separate reports on employment for these counties. To obtain an estimate of employment of these individual counties, total employment of the Tulsa and the Oklahoma SMSAs is broken down by certain percentages. The steps of deriving the percentages are as follows: (1) sum up individually the number of workers who worked in the county of residence and the number of in-commuters of these six counties, (2) total the sums for the Tulsa SMSA and the Oklahoma SMSA, respectively, and (3) divide the sum derived in (1) by the sum derived in (2) individually for each county and then multiply by 100 yielding the percentages. The estimated employment of each county is then obtained by multiplying the percentages by the Commission's report of total employment of the Tulsa and the Oklahoma SMSAs. These

---

[11]This was also pointed out by J. K. Kuehn and L. D. Bender that "to use census report of county employment will have a bias of overestimating the major centers' employment opportunities." See J. A. Kuehn and L. D. Bender, "An Empirical Identification of Growth Centers," Land Economics, 45(November, 1969), p. 439.

steps are summarized in Table XV.

Since the percentages are calculated based on the number of each county's residence workers and in-commuters and both the number of residence worker and in-commuters measure accurately the employment by the place of work, the derived figures are expected to estimate closely the true employment in these counties. Still, the possibility that these estimates may have wrongly led to a highly significant relationship between commuting and employment opportunities should not be ruled out.

As pointed out in the previous chapter, another data problem in the analysis is the problem of aggregation. The data on the price of housing and commuting distance are particularly involved with this problem. Median housing value can not really control the variation of the prices for a given quality of housing services among individuals. To find out whether the difference of the prices of a given quality of housing services between two counties is an important determinant in intercounty commuting, the actual data on the individual basis are needed.

<u>Observation Problem</u>

The study of the present chapter is limited to the intercounty commuting in Oklahoma. Thus, the workers who commuted to and from out-of-state are excluded from the study. As a result, the out-of-state commuting data are not used in testing the hypothesized relationships between the dependent and independent variables.

Based on the discussion of interstate commuting in Chapter III, the economic situations of the Oklahoma boundary counties are compared with their neighboring counties in the adjacent states. The employment opportunities of the latter are expected to be better and the price of

TABLE XV

ESTIMATED EMPLOYMENT OF THE OKLAHOMA AND THE TULSA SMSA COUNTIES, 1970

County	Workers Worked in County of Residence[1]	In-Commuters[2]	SMSA TOTAL	Percent in SMSA	SMSA Employment[3]	Estimated Employment
Oklahoma SMSA			254,262	100.00	294,300	
Canadian	6,589	1,015	7,640	2.99		8,800
Cleveland	18,321	2,796	21,297	8.38		24,662
Oklahoma	200,679	24,682	225,361	88.63		260,838
Tulsa SMSA			175,028	100.00	205,600	
Creek	8,649	1,125	9,774	5.28		10,903
Osage	5,643	1,479	7,112	3.85		7,950
Tulsa	146,346	21,786	168,132	90.87		187,647

Source: [1]U. S. Bureau of the Census, Census of Population: 1970, General Population Characteristics, Oklahoma, Table 119.

[2]U. S. Bureau of the Census, Summary User Tapes, Fourth County, (Population), Oklahoma, Table 35.

[3]Oklahoma Employment Security Commission, Oklahoma Labor Force Estimates, June, 1967-1971.

housing to be higher than the former. Therefore, the exclusion of observations of interstate commuting tends to underestimate the significance of the independent variables in the model. Since the regression results show that employment, working population and distance are all significant at the 1 percent level, the housing variable then is the only variable whose significance is possibly underestimated by the observation problem.

Statistical Problem

In the present model, both variables of employment opportunities and population between 18 and 64 years of age are utilized in the analysis. In each county, employment opportunities are estimated by the number of actually employed workers. County population between 18 and 64 years of age can be considered as the number of potential workers. Consequently, the employment opportunities and the defined population are suspected to be highly correlated. To determine the extent of multicollinearity among the independent variables, the same method used previously is again used in the present chapter. As shown in Table XVI, employment, population and housing are "harmfully" correlated with one another. Fortunately, in the present model, except for housing variable, all other independent variables are statistically significant at the 1 or 5 percent level. This indicates that employment and population are strong variables in the model; therefore, multicollinearity although harmful, does not affect the significance of these two variables.

To further assure that housing is the only variable whose significance is affected by the presence of multicollinearity, simple regression analysis is experimented with to regress the intercounty commuting flows on each individual independent variable, respectively. As shown in

Table XVII the results of this experimentation show that all the independent variables have the expected signs and are significant at the 1 percent level. This implies that housing is the only variable whose significance is seriously affected by multicollinearity. It could be that the presence of multicollinearity in the model has caused the housing variable to appear in the estimated regression equation with an unexpected sign.

TABLE XVI

MULTIPLE CORRELATION COEFFICIENTS (MCC) OF THE DEPENDENT AND INDEPENDENT VARIABLES, MODEL OF COMMUTING FLOWS

	$\ln M_{ij}$	$\ln \frac{H_j}{H_i}$	$\ln \frac{E_j}{E_i}$	$\ln P_i$	$\ln P_j$	$\ln D_{ij}$
MCC With Other Independent Variables	0.72	0.74	0.96	0.93	0.95	0.31
R^2	0.52	0.55	0.92	0.86	0.90	0.10

TABLE XVI

RESULTS OF SIMPLE REGRESSION ANALYSIS OF THE MODEL OF COMMUTING FLOWS

Independent Variable	Regression Coefficient	t-Statistic	Level of Significance
$\ln \frac{H_j}{H_i}$	0.35	2.57	0.0102
$\ln \frac{E_j}{E_i}$	0.19	5.45	0.0001
$\ln P_i$	0.28	4.98	0.0001
$\ln P_j$	0.45	10.19	0.0001
$\ln D_{ij}$	-1.21	-11.22	0.0001

Summary

This chapter has attempted to develop a model of commuting flows to analyze the determinants of intercounty commuting. Five variables are selected by the model to explain the existing flows of intercounty commuting. The model hypothesizes the following: (1) commuters trade off higher housing expenditures against commuting costs in their choices of the county of residence and the county of work, (2) commuters are attracted to the counties with relatively abundant employment opportunities, (3) the size of population between 18 and 64 years of age in both counties of origin and destination exert positive influence over the interaction between them through commuting. The interaction is negatively associated with distance between the two counties. The results of the multiple regression analysis support the hypotheses concerning distance, employment opportunities and population, and fail to provide any statistical evidence showing that the difference in the price of housing between counties is a significant determinant in intercounty commuting.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Introduction

The present study attempts to accomplish three objectives: (1) to provide an overall view of the 1970 intercounty commuting flows in Oklahoma and their relationships to selected economic growth characteristics, (2) to describe the typical characteristics of intercounty commuters in Oklahoma and (3) to analyze the determinants of intercounty commuting. The purpose of this chapter is to summarize the findings of the present study and to provide some of the related implications of the findings. In the first section, major findings of the study of intercounty commuting flows and the related policy issues are presented. The relationship between intercounty commuting and the growth of population and employment of a county is provided in the second section. The finding of the typical characteristics of intercounty commuters in Oklahoma are presented in the third section. The last section provides the studied results of the determinants of intercounty commuting. The impact of creating new jobs and high price of gasoline on intercounty commuting are evaluated in the same section.

Intercounty Commuting Flows and Their Related Policy Issues

Intercounty commuting has become increasingly important in the state of Oklahoma. In 1970 almost one out of every nine workers worked outside his residence county. To obtain a closer look at the intercounty commuting flows, the first part of this study examined various aspects of intercounty commuting. The major findings were: (1) about 80 percent of all intercounty commuting in the state originated in eastern and central Oklahoma (Regions 1, 2, 3, 5, 6, and 8), and 85 percent of the increase in intercounty commuting from 1960 to 1970 occurred in the same area, (2) Planning regions 1, 2, 5 and 9 had large out-commuting flows into the metropolitan regions 6 and 8, (3) the interregional and interstate commuting captured about one-third and one-sixth of the state total intercounty commuting, respectively, and (4) the net commuting out of the state of Oklahoma to the adjacent states was about 10,000.

Two related policy issues with respect to the above findings may be noted. One is concerned with the tremendous commuting flows across planning regions. These flows emphasize the importance of multiregional coordination in planning for job development and estimating commuting facilities requirements. The other relates to the problem of public financial disparities due to intercounty commuting. School districts which are located in destination counties benefited from the property tax revenue levied from the establishments where in-commuters work. Consequently, school districts in the origin counties may have insufficient financial support from their residing workers who out-commute to work. The same point can be made by other local services financed through the property tax.

Intercounty Commuting and the Growth of Population and Employment of a County

A typology was developed on the basis of county commuting rates, population size and growth. The purpose was to study the role of intercounty commuting in a county's growth of population and employment. It was found that counties with high population growth and high county commuting rates have a significant economic potential which is generally based on a location near employment growth centers. Out-commuting stimulates employment growth in some of the counties but not in others. The former counties may be entitled employment-residential growth centers; the latter, residential growth centers. Counties with population decline were subdivided into those with low and high county commuting rates. The residents of counties with low commuting rates may have relied mainly on out-migration in the search for employment opportunities. For those counties with high commuting rates, both methods of out-migration and out-commuting were used in seeking employment.

The Typical Characteristics of Intercounty Commuters

In Chapter IV, a model was developed in the form of a linear multiple regression equation to describe the characteristics of Oklahoma's intercounty commuters. The estimated regression equation revealed that a typical Oklahoma intercounty commuter is expected to be the one who: (1) has a relatively low level of education, (2) lives in a county in which the prevailing wage rate is relatively low, (3) lives in a county in which the population growth is relatively high, (4) lives close to a SMSA central city and (5) lives in a county in which good roads are available. A male worker and/or a home owner are also expected to have a relatively higher tendency to commute than if otherwise. A separate study of the tendency to commute of Whites, Indians and Negroes showed that Whites have a relatively lower tendency to commute than Indians but higher than Negroes.

The Determinants of Intercounty Commuting

To analyze the determinants of intercounty commuting, Chapter V developed a model of commuting flows. The model was built in the form of a natural log, linear multiple regression equation. The number of commuters from one county to another was used as the dependent variable. The independent variables utilized in the model were: the price of a given quality of housing services, employment opportunities, county population between 18 and 64 years of age and commuting distance. These variables were interpreted from the viewpoint of household behavior theory. Essentially, the model hypothesized that an individual who commutes to work does so because: (1) he can achieve a desirable trade-off between housing expenditures and commuting costs and (2) he can obtain better employment in the destination county. The distance variable in the model was treated as a measurement of aggregate disutility which offsets the saving on housing expenditures and discounts the employment opportunities in the destination county. County population between 18 and 64 years of age in origin and destination were used in the model as scale factors to control the absolute flows of intercounty commuting. The regression results supported the hypotheses of the model relating employment opportunities, commuting distance and population. The hypothesis concerning an individual's trade-off between housing expenditures and commuting costs was not supported by the regression analysis.

According to the regression coefficient of employment ratio in the estimated equation, intercounty commuting was inelastic with respect to employment opportunities. The elasticity in this context is defined as the percent change of the commuting flows from one county to another divided by the percent change of each independent variable. Since the regression equation was estimated in the form of natural log, the regression coefficients of the independent variables can be interpreted directly as elasticities. Table XVIII provides several numerical examples showing the magnitudes of corresponding changes of in-commuters and out-commuters to and from several selected counties as a result of changes of employment opportunities in these counties. These counties were selected because they were identified as growth centers or potential growth centers in the discussion of Chapter III. They were in the typology of classifications 2 and 4 which had relatively large population and low commuting rates with net in-commuting in 1970 and rapid growth of employment from 1960 to 1970.

Suppose that there are 500 new jobs created in Payne County and other things are held constant. As a result, the employment ratios with respect to Payne County and its related neighboring counties will be changed. Note that the employment ratio was defined in early Chapter V as the employment in destination county divided by the employment in origin county. Therefore, the ratio will be increased by 2.78 percent if Payne is the destination county. (According to Table XII, employment in Payne County was actually 18,000 in 1970.) In the case of Payne being the origin county, the employment ratio will then be decreased by 2.78

TABLE XVIII

ESTIMATED CHANGES OF THE NUMBER OF COMMUTERS AS A RESULT OF AN INCREASE OF 500 JOBS IN SELECTED COUNTIES, OKLAHOMA, 1970

County	In-commuters	Change of In-commuters	Out-commuters	Change of Out-commuters
Classification 2				
Comanche	1,360	10.9	546	- 4.3
Oklahoma	24,682	19.7	3,558	- 2.8
Tulsa	21,786	24.0	2,352	- 2.6
Payne	926	10.3	1,140	-12.3
Texas	253	8.3	360	-10.9
Woodward	364	11.9	246	- 7.5
Classification 4				
Garfield	792	6.9	498	- 4.3
Jackson	495	10.5	192	- 3.9
Pittsburg	1,435	21.7	339	- 4.9

Source: J. Hu, R. Moomaw, and L. Warner, Commuting Flows for Counties and Substate Planning Regions, Oklahoma, 1970, Research Foundation, Oklahoma State University, Stillwater, Oklahoma, 1974.

percent. In order to obtain the corresponding percentage changes of in-commuting and out-commuting to and from Payne County, these calculated percentage changes of employment ratios are multiplied by 0.4 which is the elasticity of commuting with respect to employment opportunities. The resultant changes of the number of in-commuters and out-commuters to and from Payne are obtained by multiplying the original number of Payne County's in-commuters and out-commuters with the corresponding percentage changes of in-commuting and out-commuting.

As shown in Table XVIII, a substantial increase of employment opportunities by 500 jobs in each one of these counties has only a marginal effect on commuting flows. The largest changes of in-commuting and out-commuting were less than 25 commuters. This indicates that although the employment opportunity is a significant variable in determining intercounty commuting, the change of employment opportunities has a small impact on intercounty commuting flows.

The regression coefficient of the distance variable indicated that the elasticity of commuting with respect to commuting distance is elastic. Economically, the distance in the regression equation can be treated as the cost of commuting. The high price of gasoline, as a result of energy shortage, implies high commuting cost. A high commuting cost will obviously reduce the incidence of intercounty commuting. A growth center strategy which intends to provide employment opportunities to surrounding counties will have to consider this high cost of intercounty commuting.

If the relative price of gasoline continues to be high in the future, daily commuting will become a financial burden for most of the wage workers. The incidence of intercounty commuting may be reduced if educational programs lengthen the years of education and wage rate differentials tend to converge. In the long run, it may be expected that jobs would move closer to people and/or people migrate to obtain jobs.

SELECTED BIBLIOGRAPHY

Adams, Leonard and Thomas Mackesey. Commuting Patterns of Industrial Workers. Ithaca: Cornell University Housing Research Center, 1955.

Alonso, William. "A Theory of the Urban Land Market." Papers and Proceedings of the Regional Science Association, Vol. 6 (1960), 149-157.

__________________. Location and Land Use: Toward a General Theory of Land Rent. Cambridge: Harvard University Press, 1964.

Becker, Gary. "A Theory of Allocation of Time." The Economic Journal, Vol. 75 (September, 1965), 493-517.

Carroll, J. Douglas, Jr. "Home-Work Relationships of Industrial Employees." (Unpub. Ph.D. thesis, Harvard University, 1950.)

__________________. "Some Aspects of Home-Work Relationships of Industrial Workers." Land Economics, Vol. 25 (November, 1949), 414-422.

__________________. "The Relationships of Home to Work Places and the Spatial Pattern of Cities." Social Forces, Vol. 30 (March, 1952), 271-282.

Catanese, Anthony J. "Home and Workplace Separation in Four Urban Regions." American Institute of Planners Journal, Vol. 37 (September, 1971), 331-337.

Chiang, Alpha. Fundamental Methods of Mathematical Economics. New York: McGraw Hill, 1967.

Duncan, Beverly. "Factors in Work-Residence Separation: Wage and Salary Workers, Chicago, 1951." American Sociology Review, Vol. 21 (February, 1956), 48-55.

Farrar, Donald E. and Robert R. Glauber. "Multicollinearity in Regression Analysis: The Problem Revisited." Review of Economics and Statistics, Vol. 49 (February, 1967), 92-107.

Fox, Karl A. and Krisna T. Kumar. "The Functional Economic Area." Papers and Proceedings of the Regional Science Association, Vol. 15 (1965), 57-85.

Gallaway, Lowell E. "Industry Variations in Geographic Labor Mobility Patterns." Journal of Human Resources, Vol. 2, No. 4 (Fall, 1967), 465-474.

Gerard, Roy. "Commuting and the Labor Market Area." Journal of Regional Science, Vol. 1 (Summer, 1958), 124-130.

Goldstein, Sidney and Kurt Mayer. "Migration and Social Status Differentials in the Journey-to-Work." Journal of Human Resources, Vol. 29 (September, 1964), 278-287.

________________. "Migration and the Journey-to-Work." Social Forces, Vol. 42 (May, 1964), 472-481.

Grimes, Algie R. Jr. "An Analysis of the Determinants of the Commuting and Residence Patterns of the Oklahoma City Air Materiel Area Labor Force." (Unpub. Ph.D. thesis, Oklahoma State University, 1970.)

Holmes, John H. "External Commuting as a Prelude to Suburbanization." Association of American Geographical Annual, Vol. 61 (December, 1961), 774-790.

________________. "Linkage Between External Commuting and Out-Migration: Evidence From Middle-Eastern Pennsylvania." Economic Geography, Vol. 48 (October, 1972), 406-420.

Isard, Walter. Method of Regional Analysis: An Introduction to Regional Science. Cambridge, Mass.: The M.I.T. Press, 1960.

Johnson, M. Bruce. "Travel Time and Price of Leisure." Western Economic Journal, Vol. 4 (Spring, 1966), 135-145.

Johnston, J. Econometric Methods, 2nd. ed. New York: McGraw Hill, 1972.

Kain, John F. "A Contribution to the Urban Transportation Debate: An Econometric Model of Urban Residential and Travel Behavior." Review of Economics and Statistics, Vol. 46 (February, 1964), 55-64.

________________. "The Journey to Work as a Determinant of Residential Location." Papers and Proceedings of the Regional Science Association, Vol. 9 (1962), 137-160.

Kuehn, John A. and Lloyd D. Bender. "An Empirical Identification of Growth Centers." Land Economics, Vol. 45 (November, 1969), 435-443.

Ladinsky, Jack. "The Geographic Mobility of Professional and Technical Manpower." Journal of Human Resources, Vol. 2, No. 4 (Fall, 1967), 475-494.

Lawton, R. "The Journey to Work in Britain: Some Trends and Problems." Regional Science, Vol. 2 (1968), 27-40.

Liepmann, Kate K. The Journey to Work. New York: Oxford University Press, 1944.

Lonsdale, Richard. "Two North Carolina Commuting Patterns." Economic Geography, Vol. 42 (April, 1966), 114-138.

Mankin, Wyatt. "A New Look at Muth Model." The American Economic Journal, Vol. 62 (December, 1972), 980-982.

Martin, James M. and John L. Johnson. "Labor Market Boundaries -- Intercounty Commuting to Employment." Current Economic Comment, Vol. 17 (May, 1955), 29-38.

Muth, Richard. "The Spatial Structure of the Housing Market." Papers and Proceedings of the Regional Science Association, Vol. 7 (1961), 207-220.

_______________. "Urban Residential Land and Housing Markets." In Issue in Urban Economics, Harvey S. Perloff and Lowdon Wingo, Jr. Baltimore: The Johns Hopkins Press, 1968.

Oklahoma Employment Security Commission. County Employment and Wage Data, 1970. Oklahoma City: Oklahoma Employment Security Commission, 1971.

Oklahoma Employment Security Commission. Oklahoma Labor Force Estimates, 1967-1971. Oklahoma City: Oklahoma Employment Security Commission, 1971.

Peterson, C. A. An Iowa Commuting Pattern and Labor Market Area in General. Iowa City: University of Iowa Press, 1961.

Rao, P. and L. M. Miller. Applied Econometrics. Belmont, California: Wadsworth Publishing Co., 1971.

Reeder, Leo G. "Social Differentials in Model of Travel, Time and Cost in the Journey to Work." American Sociological Review, Vol. 21 (February, 1956), 56-63.

Roseman, Curtis. "Migration, the Journey-to-Work, and Household Characteristics: An Analysis Based on Non-Areal Aggregation." Economic Geography, Vol. 47 (October, 1971), 467-474.

Scaff, Alvin. "The Effect of Commuting on Participation in Community Organizations." American Sociological Review, Vol. 17 (April, 1952), 215-220.

Schnore, Leo F. "Sources of Data on Commuting: Problems and Possibilities." Journal of the American Statistical Association, Vol. 55 (March, 1960), 8-22.

_______________. "The Separation of Home and Work: A Problem for Human Ecology." Social Forces, Vol. 32 (May, 1954), 336-343.

Smith, P. S. An Analysis of Journey-to-Work in Ashford. Canterbury Center for Research in Social Science, University of Kent, 1969.

Taaffe, Edward J., Barry J. Garner, and Maurice H. Jeats. The Peripheral Journey to Work. Evanston, Ill.: Northwestern University Press, 1963.

Tarver, James. "Metropolitan Area Intercounty Migration Rates: A Test of Labor Market Theory." Industrial and Labor Relations Review, Vol. 18, No. 2 (January, 1965), 213-223.

United States Department of Commerce, Bureau of the Census. Census of Housing: 1970, Detailed Housing Characteristics, Tables 60 and 61.

United States Department of Commerce, Bureau of the Census. Census of Population: 1970, General Social and Economic Characteristics, Tables 35, 119, 120, and 121.

United States Department of Commerce, Bureau of the Census. Summary User Tapes, Fourth County, Population, Table 35.

Vance, James E. Jr. "Labor Shed, Employment Field, and Dynamic Analysis in Urban Geography." Economic Geography, Vol. 36 (July, 1960), 189-220.

Wall Street Journal. "So Stop Whinning: For Some Americans, the Commute to Work is Almost a Job Itself." June 29, 1973.

Warnes, A. M. "Estimate of Journey-to-Work Distance From Census Statistics." Regional Science, Vol. 6 (1972), 315-326.

Wheeler, James. "Occupational Status and Work-Trips: A Minimum Distance Approach." Social Forces, Vol. 45 (June, 1967), 508-515.

________________. "Research on the Journey-to-Work: Introduction and Bibliography." Council of Planning Librarians Exchange Bibliography, No. 65 (January, 1969).

Wolforth, John R. Residential Location and the Place of Work. Vancouver, Canada: Tantalus Research Ltd., 1965.

Yapa, Lakshman, Mario Polese, and Julian Wolpert. "Interdependence of Commuting, Migration and Job Site Location." Economic Geography, Vol. 47 (January, 1971), 59-72.

Yu, Eui-young. "Correlations of Commuting Between Central Cities and Rings of SMSAs." Social Forces, Vol. 51 (September, 1972), 74-86.

VITA

Chi-Ping Joseph Hu

Candidate for the Degree of

Doctor of Philosophy

Thesis: A STUDY OF INTERCOUNTY COMMUTING IN OKLAHOMA, 1970

Major Field: Economics

Biographical:

Personal Data: Born in China, April 20, 1946, the son of Mr. and Mrs. Shien-Teh Hu.

Education: Graduated from the National Taiwan Normal University's Affiliated High School in 1964; received Bachelor of Arts degree in Economics from the National Taiwan University in 1968; received Master of Arts degree from the University of New Mexico in 1971; enrolled in doctoral program at Oklahoma State University, 1971-1974; completed requirements for the Doctor of Philosophy degree at Oklahoma State University in 1974.

Professional Experience: Graduate Assistant, the University of New Mexico, 1970; Economic Research Assistant, Bureau of Business Research, the University of New Mexico, 1971; Graduate Assistant, Oklahoma State University, 1971-1973; Instructor, Oklahoma State University, 1973; Graduate Research Assistant, Oklahoma State University, 1974.