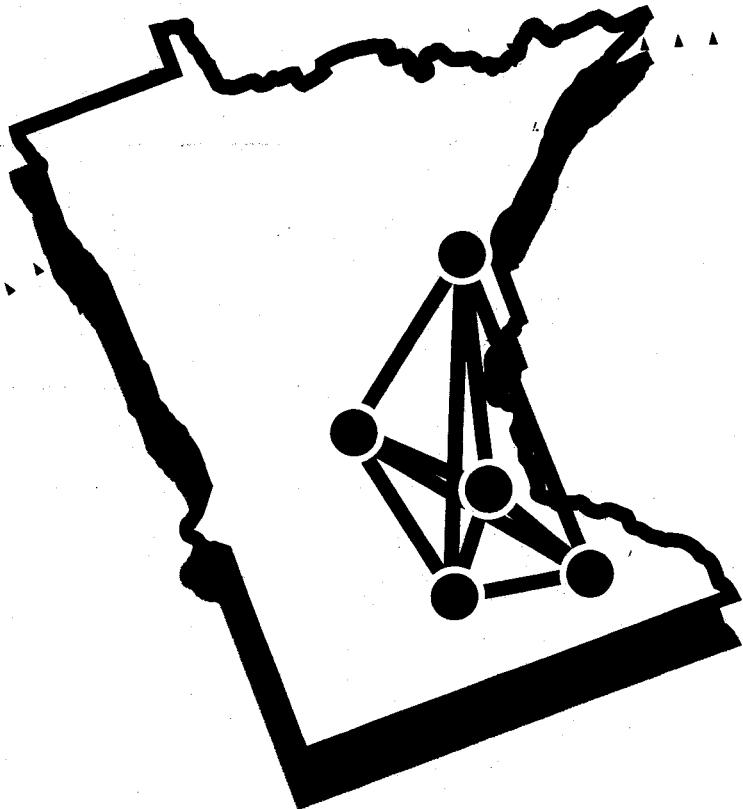




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# Commuter Linkages Among Counties in the Twin Cities and Greater Minnesota

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Findings confirm that inter-county commuting has increased dramatically, from 7% in 1960 to nearly 19% in 1990. The <i>rate</i> of growth is diminishing, but the total number of commuters is considerable. In 1990, over 70,000 workers commuted to the seven-county Twin Cities Metropolitan Area (TCMA) from Greater Minnesota. Results of a multivariate statistical procedure, factor analysis, confirm that exurban counties between the Twin Cities and nearby regional centers have been drawn into a complex web of interconnected, overlapping urban systems.			
These findings support the hypothesis that the daily work journey is creating an interdependent network of urban systems in the densely settled portions of the state. The increasing gap between the seven-county TCMA and the practical extent of the Twin Cities underscores the question whether the jurisdiction of the Metropolitan Council should expand to include counties connected by the daily flow of workers to the Twin Cities.		17. Document Analysis a. Descriptors  commuting fields      factor analysis journey-to-work      suburbanization	
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# **Commuter Linkages Among Counties in the Twin Cities and Greater Minnesota**

## **Final Report and Executive Summary**

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**with assistance from  
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**September 1993**

**Submitted to**

**Minnesota Department of Transportation  
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**This report represents the results of research conducted by the author and does not necessarily reflect the official views or policy of Mn/DOT. This report does not contain a standard or specified technique.**



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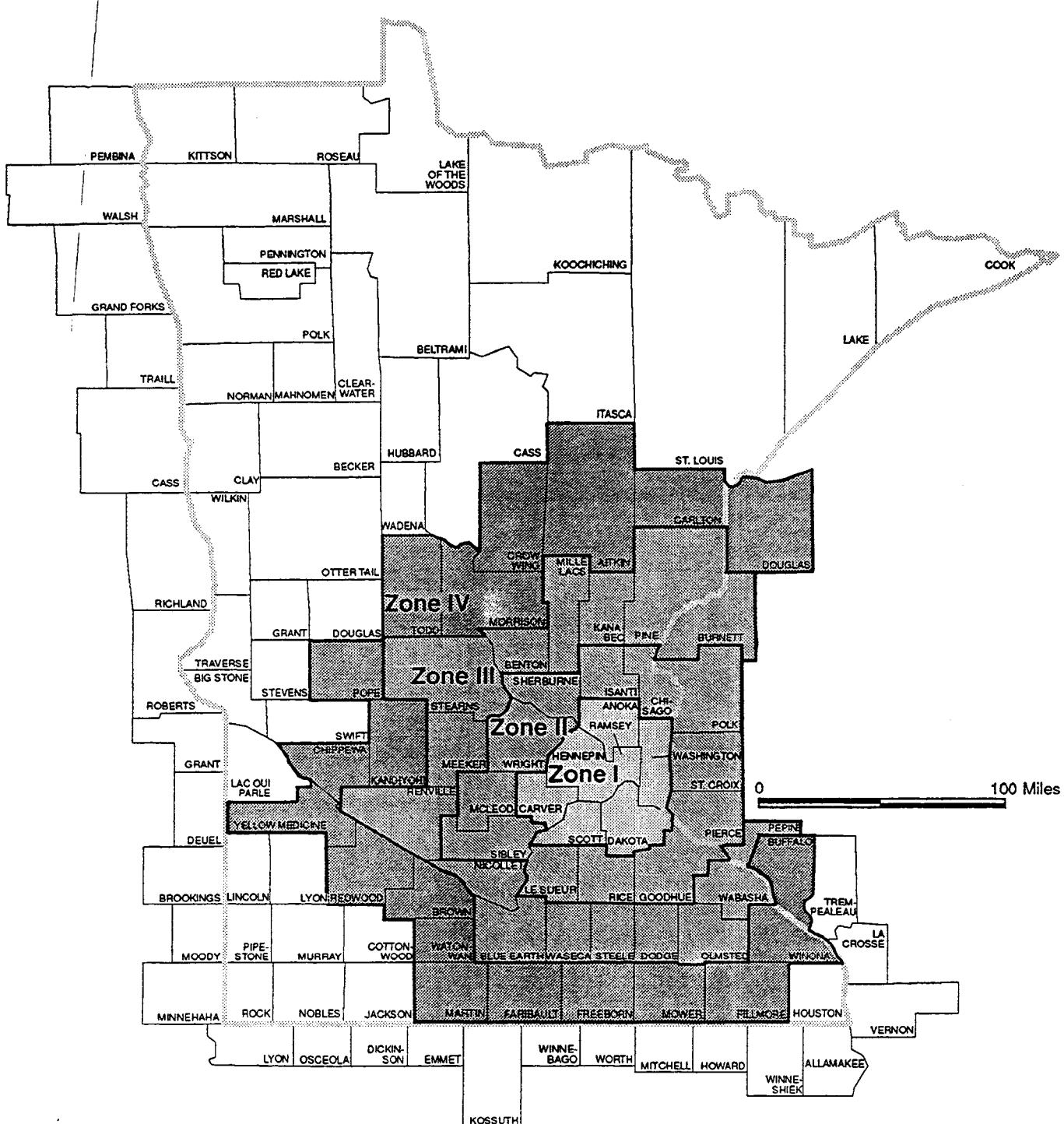


Figure S-1. Project study area, highlighting the seven county Twin Cities region and surrounding zones in greater Minnesota.

## EXECUTIVE SUMMARY

The Metropolitan Council is the regional government and planning agency for the seven county Twin Cities Metropolitan Area (TCMA). At the time of the Council's creation in 1967, the built-up Twin Cities area fit comfortably within the seven county area, and the daily urban system focused on Minneapolis and St. Paul functioned almost entirely within the seven counties. In recent decades, however, the Twin Cities have continued to decentralize, and the increasing interdependence of counties linked by daily flows of commuters has raised questions regarding the appropriate spatial jurisdiction of regional governance. This report uses data on county-to-county commuter flows to examine this interdependence, analyzing changes in the urban fields blanketing the Twin Cities and Greater Minnesota between 1960 and 1990.

### *Findings:*

The continued decentralization of the Twin Cities and other metropolitan areas in Minnesota has created a complex web of overlapping commuting fields. The well-defined daily urban system focused on Minneapolis and St. Paul in 1960 has evolved into a multicentered settlement system incorporating a number of important suburban job centers. This settlement field has developed important links with Greater Minnesota, as the Twin Cities draw workers from exurban counties that are also part of the commuting fields of St. Cloud, Mankato, and Rochester. The highlights of the analysis include four main findings:

*The percentage of  
commuters crossing a  
county boundary  
increased between 1960  
and 1990.*

1. In the study area -- consisting of Minnesota's 87 counties and 33 contiguous counties in adjacent states (Figure S-1) -- only 7 percent of all work journeys crossed a county boundary in 1960. More than 18 percent did so in 1990 (Table S-1).

Year	Total Commuters (millions)	Commuters Crossing a County Boundary (thousands)	%
1960	1.4	100	7.1
1970	1.6	201	12.5
1980	2.0	324	15.8
1990	2.6	474	18.5

Table S-1. Total and Inter-County  
Commuters in Study Area, 1960 - 1990.

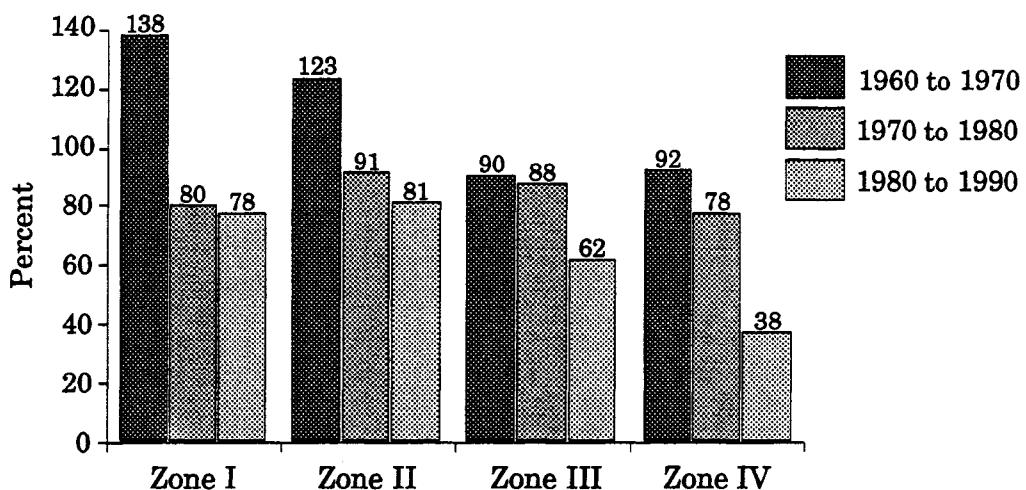
Source: *special tabulations of decennial U.S. Census  
journey-to-work frequency tables and Bureau of  
Economic Analysis data.*

*The rate of growth in  
inter-county commuting  
is diminishing ...*

2. The number of workers crossing the boundaries of successive tiers of counties surrounding the Twin Cities (Figure S-1) is increasing, but at a steadily declining rate. The number of workers journeying to the Twin Cities from areas outside the seven-county TCMA (Zone I, Figure S-1) increased 138 percent in the 1960s, 80 percent in the 1970s, and 78 percent in the 1980s (Figure S-2; Table S-2).

**Figure S-2. Growth in Commuting Between Successive Tiers of Counties, 1960 to 1990.**

*Percentage change in number of workers entering each zone from counties in other zones.*



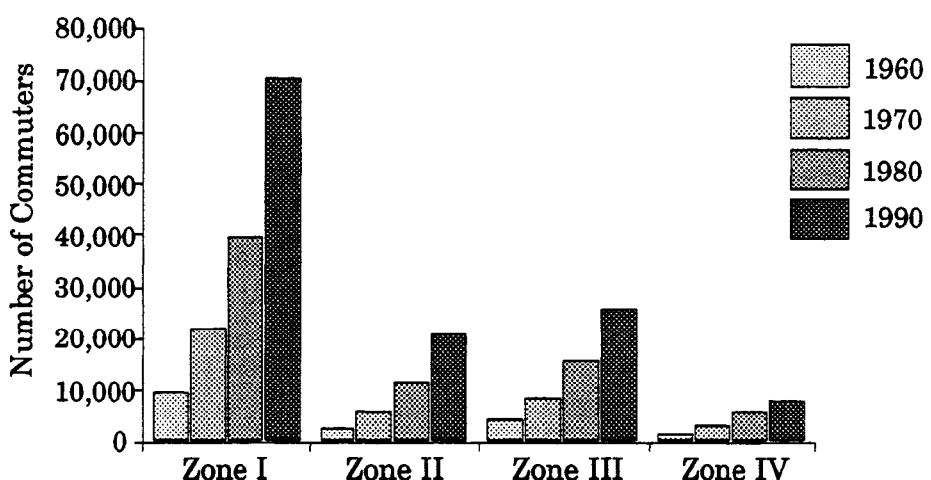
*Source: special tabulations of decennial U.S. Census journey-to-work frequency tables and Bureau of Economic Analysis data.*

*... but the total numbers are considerable: in 1990, more than 70,000 workers commuted to the Twin Cities from counties outside the Metropolitan Council's jurisdiction.*

3. The number of workers commuting to the TCMA from outside the seven-county area has risen steadily since 1960, when only 9,300 did so (Figure S-3; Table S-3). By 1990, nearly 70,600 commuters journeyed to work in the Twin Cities area (Zone I) from counties outside the seven-county metropolitan area.

**Figure S-3. Number of Workers Commuting Between Successive Tiers of Counties, 1960 to 1990.**

*Number of workers entering each zone from counties in other zones.*

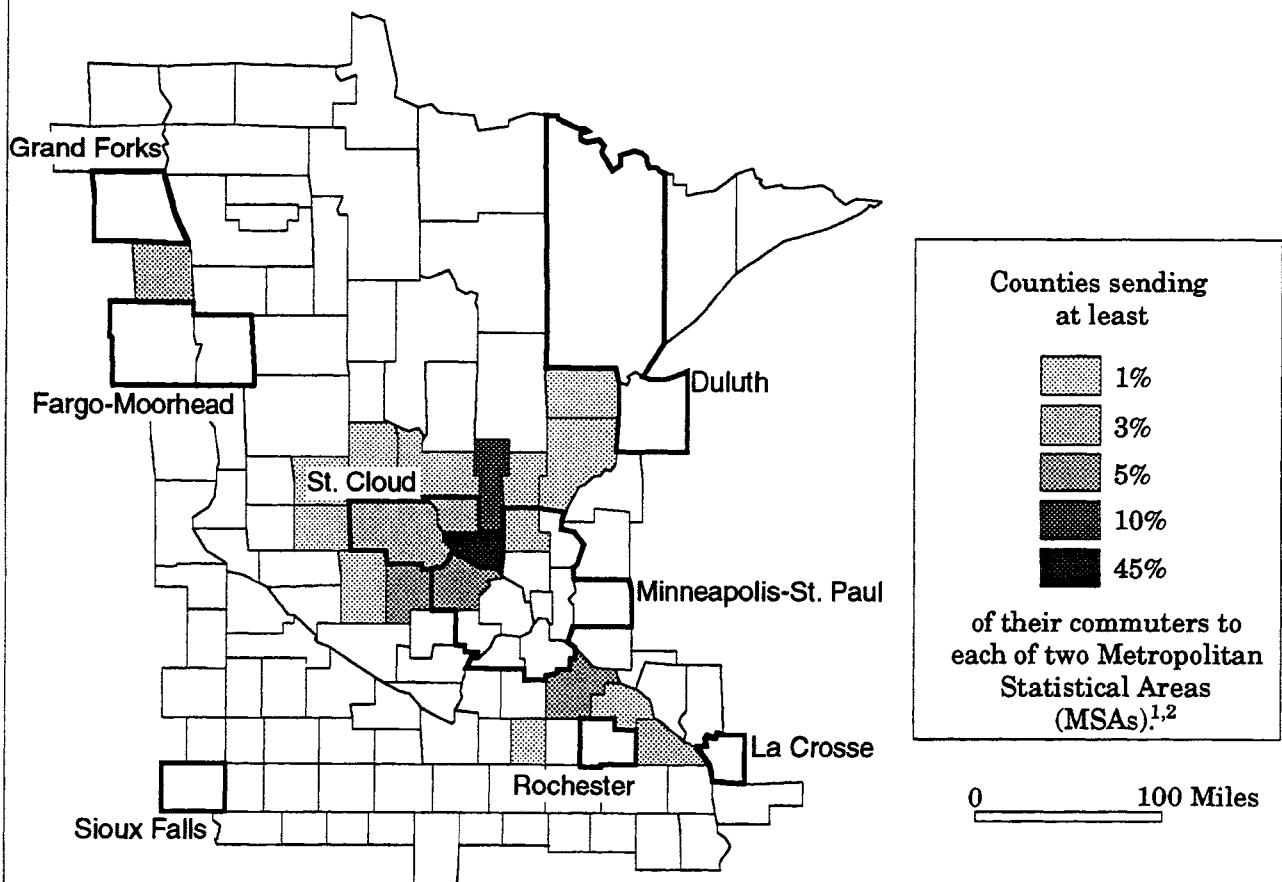


*Source: special tabulations of decennial U.S. Census journey-to-work frequency tables and Bureau of Economic Analysis data.*

*Minnesota's daily urban systems are becoming more interconnected and interdependent.*

4. As the percentage of work journeys ending in the same county declines (Table S-4), the compact, well-focused urban systems of the 1950s are replaced by a series of overlapping commuting fields. Several counties in Minnesota are linked to more than one metropolitan area by the daily flow of commuters, particularly in the historic settlement corridors connecting the Twin Cities with St. Cloud, Duluth, and Rochester (Figure S-4).

Figure S-4. Counties Linked to More than One Metropolitan Statistical Area (MSA).



Notes:

1. Percentages are calculated as follows: the number of workers commuting to each of the eight MSAs in the study area is expressed as a proportion of all commuters for each county of origin (including within-county flows). Counties sending greater than the specified thresholds to *each* of two MSAs are shaded accordingly.
2. MSA Boundaries are as designated by the U.S. Bureau of the Census on June 30, 1990.
3. Sherburne County -- which sent 51% of its commuters to the St. Cloud MSA and 45% to the Minneapolis-St. Paul MSA -- was incorporated into the Twin Cities MSA in December 1992, along with Pierce Co., WI.

Source: *special tabulations of decennial U.S. Census journey-to-work frequency tables and Bureau of Economic Analysis data.*

*Conclusions and Implications:*

As the geographic link between home and work, the daily work journey is both cause and effect of metropolitan spatial structure. In the tier of counties between the Twin Cities and Greater Minnesota, a continually decentralizing metropolitan spatial structure is reflected in an increasing number of inter-county commuters. The functioning daily urban system of the Twin Cities currently extends beyond the seven-county metropolitan area, underscoring the question whether the jurisdiction of the Metropolitan Council should be expanded to include counties connected by the daily flow of workers.

Table S-2. Changes in Commuter Flows among Tiers of Counties Surrounding the Twin Cities, 1960 - 1990.  
(in percent)

		To:			
1960 to 1970		Zone I	Zone II	Zone III	Zone IV
From:	Zone I	30.1	130.6	(31.6)	(100.0)
	Zone II	134.3	3.2	83.9	341.7
	Zone III	165.8	113.7	11.0	97.9
	Zone IV	90.3	212.3	121.9	(4.9)
					Grand Total: 20.7
1970 to 1980		To:			
1980 to 1990		Zone I	Zone II	Zone III	Zone IV
From:	Zone I	28.1	117.1	441.8	---
	Zone II	92.3	34.9	96.5	56.1
	Zone III	10.3	75.4	31.6	63.3
	Zone IV	117.4	(12.8)	57.0	16.8
					Grand Total: 29.4
To:					
		Zone I	Zone II	Zone III	Zone IV
From:	Zone I	31.2	71.8	62.6	58.9
	Zone II	74.4	20.2	44.1	46.5
	Zone III	92.8	85.2	23.7	35.0
	Zone IV	135.0	267.8	86.3	8.3
					Grand Total: 28.5

Notes: Parentheses () indicate negative change. Dashes --- indicate undefined quantities.

Source: special tabulations of decennial U.S. Census journey-to-work frequency tables and Bureau of Economic Analysis data.

Table S-3. Commuter Flows among Tiers of Counties Surrounding the Twin Cities, 1960 - 1990.

		To:			
1960		Zone I	Zone II	Zone III	Zone IV
From:	Zone I	549,607	1,185	339	109
	Zone II	7,761	81,890	2,379	48
	Zone III	1,327	1,480	127,701	1,531
	Zone IV	217	65	1,770	167,615
					Total: 945,024
1970		Zone I	Zone II	Zone III	Zone IV
From:	Zone I	715,280	2,733	232	0
	Zone II	18,185	84,511	4,375	212
	Zone III	3,527	3,162	141,799	3,030
	Zone IV	413	203	3,927	159,413
					Total: 1,141,002
1980		Zone I	Zone II	Zone III	Zone IV
From:	Zone I	916,097	5,933	1,257	508
	Zone II	34,972	113,959	8,597	331
	Zone III	3,890	5,546	186,570	4,947
	Zone IV	898	177	6,165	186,157
					Total: 1,476,006
1990		Zone I	Zone II	Zone III	Zone IV
From:	Zone I	1,201,909	10,191	2,044	807
	Zone II	60,979	136,947	12,391	485
	Zone III	7,501	10,270	230,826	6,680
	Zone IV	2,110	651	11,484	201,578
					Total: 1,896,853

Source: *special tabulations of decennial U.S. Census journey-to-work frequency tables and Bureau of Economic Analysis data.*

Table S-4. Total Commuters (Percentage Ending Within County), Selected Counties, 1960-90.

	1960	1970	1980	1990
Anoka	27,205 (35.0)	55,043 (33.2)	89,086 (40.1)	130,496 (39.6)
Carver	7,353 (72.7)	9,862 (54.1)	16,247 (46.4)	25,579 (46.2)
Dakota	26,118 (55.6)	50,235 (41.7)	88,628 (44.8)	150,548 (44.9)
Hennepin	317,559 (93.0)	384,245 (89.0)	453,800 (88.2)	557,411 (85.9)
Ramsey	150,252 (86.6)	181,290 (78.8)	208,943 (73.7)	247,095 (64.3)
Scott	6,864 (73.7)	10,537 (58.4)	18,452 (50.3)	30,088 (41.0)
Washington	16,434 (49.6)	27,209 (34.2)	49,403 (32.0)	75,029 (31.4)
St. Louis	71,567 (97.4)	71,523 (96.1)	81,333 (94.3)	81,536 (93.3)
Douglas, WI	13,008 (89.0)	13,867 (80.4)	14,691 (83.7)	16,854 (75.6)
Benton	5,529 (63.6)	6,952 (50.3)	10,226 (43.8)	14,737 (42.0)
Sherburne	3,666 (55.5)	5,567 (41.6)	11,419 (34.2)	20,102 (32.4)
Stearns	25,223 (94.4)	29,643 (92.0)	42,800 (88.2)	58,118 (84.6)
Olmsted	24,555 (98.0)	31,705 (96.8)	43,532 (96.9)	56,266 (95.3)
Blue Earth	15,054 (95.6)	17,575 (90.9)	21,602 (85.8)	27,148 (79.0)
Nicollet	7,205 (72.2)	8,339 (58.5)	11,333 (55.4)	14,316 (55.3)

Source: *special tabulations of decennial U.S. Census journey-to-work frequency tables and B.E.A. data.*



## INTRODUCTION

The Minneapolis-St. Paul metropolitan area is the economic, social, cultural, and political capital of the Upper Midwest region. At its core are the cities of Minneapolis (c. 370,000 pop.) and St. Paul (c. 270,000). Together the two cities comprise about a quarter of the metro population of 2.5 million.

In the years since permanent white settlement in the area following the establishment of Fort Snelling in 1819, the Twin Cities area has spilled far beyond central city limits. At least four tiers of suburban municipalities surround the two central cities, and areas far beyond the cities and their suburbs are intimately linked to the built-up area through daily flows of people, goods and information.

The Metropolitan Council, created by an act of the Minnesota Legislature in 1967, is the regional government and planning agency for the seven counties that comprise the largely urbanized portion of the greater Twin Cities region. Twenty-five years have passed since the council was created and questions now arise concerning the increasing gap between the council's area of jurisdiction (the seven counties) and the practical day-to-day extent of the greater Twin Cities settlement system (far beyond the seven counties).

This report examines daily commuting among the 120 counties within and contiguous to Minnesota. It portrays how the metropolitan settlement system has grown in size and expanded spatially since the 1960s. By analyzing commuting patterns, we learn how the metropolitan system centered on the Twin Cities area has been changing, and we inform debate whether current transportation planning and metro governance are proceeding in tune with trends in settlement system change.

The report begins with a discussion of the "daily urban system" definition, followed by an overview of the decentralized growth of the Twin Cities and the implications for greater Minnesota. The question of how best to define Minnesota's daily urban systems is discussed, providing the basis for an analysis of commuting patterns in Minnesota and contiguous counties in adjacent states in 1990. Changes in commuting patterns throughout the entire study area from 1960 to 1990 are examined next, followed by a detailed examination of commuting patterns and their relationships to population, employment, and housing in each of the region's five dominant fields: the Twin Cities, Duluth-Superior, St. Cloud, Rochester, and Mankato.

The final section of the report summarizes the main findings of the study and offers a few concluding remarks. The results of this study underscore the degree to which today's complex and overlapping commuting fields are a reflection of several decades of decentralization and investment in transportation infrastructure. While the rate of growth in commuting between the Twin Cities and surrounding counties in greater Minnesota appears to be settling down to a new equilibrium, the total number of commuters is considerably larger than in the past, lending urgency to questions of whether the current geographic extent of metropolitan jurisdiction accurately reflects contemporary urban systems.



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## I. COMMUTING AND THE DAILY URBAN SYSTEM

Nearly three decades ago the concept of a “daily urban system” (DUS) was introduced to describe the interconnected nature of metropolitan areas bound together by daily flows of commuters. The idea was intuitive and simple: a metropolitan area typically was anchored by one or more central or “core” counties, and neighboring counties were included if the percentage of their commuters journeying to work in the core exceeded a specified threshold.<sup>1</sup> The daily urban system became one of the basic techniques used to delineate and analyze metropolitan areas, and constitutes the underlying basis for the U.S. Census Bureau’s definition of Metropolitan Statistical Areas (MSAs).<sup>2</sup> In recent years, however, geographers and urban planners have become increasingly uneasy with the measure. The continuous urban fabric implied by the daily urban system describes the textbook monocentric urban model of the 1950s better than the complicated web of overlapping settlement fields so common today.<sup>3</sup>

While the difficulties of defining metropolitan areas are more pronounced in larger cities such as New York or Los Angeles, the issue has been important in the state of Minnesota ever since the establishment of the Metropolitan Council required a definition of the Twin Cities Metropolitan Area (TCMA) in the late 1960s. Most recently, commuting data from the 1990 Census of Population and Housing provided the basis for a revised Minneapolis-St. Paul Metropolitan Statistical Area (MSA) incorporating Sherburne County, resulting in a paper loss of

<sup>1</sup>See Doxiadis, C.A. (1966), *Emergence and Growth of an Urban Region: The Developing Detroit Area* (Detroit: Detroit Edison Co.); Berry, B.J.L. and E. Neils (1969), “Location, Size and Shape of Cities as Influenced by Environmental Factors: The Urban Environment Writ Large,” in H.S. Perloff, ed., *The Quality of the Urban Environment* (Baltimore: Johns Hopkins), pp. 257-302; Berry, B.J.L. (1972), “Latent Structure of the American Urban System, with International Comparisons,” in B.J.L. Berry, ed., *City Classification Handbook* (New York: Wiley), pp. 11-60.

<sup>2</sup>Office of Management and Budget (1990), “Revised Standards for Defining Metropolitan Areas in the 1990s,” *Federal Register* 55(62), pp. 12154-12160.

<sup>3</sup>See, for example, Plane, D.A. (1981), “The Geography of Urban Commuting Fields,” *Professional Geographer* 33(2), pp. 182-188.

one fifth of the population of the St. Cloud MSA. The southeastern portion of the city of St. Cloud is now designated for census purposes as part of the Twin Cities.

The anomaly created by the Bureau's new designation highlights the interdependence of the settlement fields blanketing southern Minnesota. This report analyzes this interdependent system and some of its changes since 1960, using data from the U.S. Census of Population and Housing to examine commuter linkages among counties in the Twin Cities and Greater Minnesota. In particular, we test the hypothesis that the settlement fields in southern and central Minnesota are becoming more interdependent, as more counties are drawn into multiple urban fields by daily commuter flows.

## II. SUBURBAN GROWTH OF THE TWIN CITIES

In the pattern of the typical North American metropolis, the Twin Cities have been decentralizing outward from the urban core of the pre-automotive settlement for nearly a century. In response to the metropolitan-wide problems associated with decentralized growth, the Minnesota Legislature created the Metropolitan Council of the Twin Cities, a metropolitan planning organization that soon became a national model for regional government. When established in 1967, the Council obtained jurisdiction over a seven-county area encompassing most of the functioning urban system around Minneapolis and St. Paul.<sup>4</sup>

In the quarter-century since the establishment of the council, the Twin Cities have continued to spread outward, lending urgency to renewed questions about the growing gap between metropolitan development and regional government jurisdiction. While Minneapolis and

<sup>4</sup>The Twin Cities Metropolitan Area (TCMA) as defined for the Metropolitan Council includes Anoka, Carver, Hennepin, Dakota, Ramsey, Scott, and Washington Counties. The eleven-county Minneapolis-St. Paul MSA as defined by the U.S. Bureau of the Census also includes Isanti, Wright, Chisago, and St. Croix (Wisconsin) counties, and the most recent revision in late 1992 added Sherburne and Pierce (WI) counties.

St. Paul have been more successful than many American cities in maintaining downtown viability in the face of peripheral growth, the balance of population and employment continues to shift in favor of municipalities in the expanding suburban ring. Together, the cities of Minneapolis and St. Paul lost 100,000 people between 1970 and 1990, and the proportion of the metro area's population outside the central cities increased from 63 percent to 74 percent.<sup>5</sup> Of the 255,000 jobs gained in the metropolitan area in the 1980s, the central cities garnered only 5,000.<sup>6</sup>

The continued decentralization of population and employment carries several significant implications for the metropolitan area as a whole. The growing employment base of many second- and third-ring suburbs is now within commuting distance of counties on the metropolitan fringe, creating incentives for new residential construction to "leapfrog" the TCMA's development controls. Decentralized growth threatens to envelope portions of the metro area in "suburban gridlock," as both ends of the work journey realign from the suburb-to-central city axis of peak-period travel of the 1940s, to a more complex and overlapping web of lateral, suburb-to-suburb commutes.<sup>7</sup> The persistent imbalance of growth imposes costly demands on the transportation system in the southwest quadrant of the metropolitan area, while excess capacity remains elsewhere in the system. The white, middle-class character of many of the suburbs enjoying growing population and employment appears to exacerbate metropolitan-wide disparities, leading some to explain concentrated urban poverty in terms of a "spatial mismatch" between the location of affordable housing and jobs available to poor, inner-city minority populations.<sup>8</sup>

<sup>5</sup>U.S. Bureau of the Census, *Census of Population and Housing: 1970, 1990*.

<sup>6</sup>Metropolitan Council (1992), *Trouble at the Core: The Twin Cities Under Stress* (St. Paul: Metropolitan Council), p. 18.

<sup>7</sup>See, for example, Cervero, R. (1986), *Suburban Gridlock* (New Brunswick, NJ: Center for Urban Policy Research). For a summary of the local transportation policy implications of suburban growth, see Office of the Legislative Auditor (1992), *Regional Transit Planning* (St. Paul: State of Minnesota).

<sup>8</sup>The evidence on this point is far from conclusive, but some analysts argue for policy prescriptions based on the explanation. For relevant data on the socioeconomic composition of the Twin Cities' suburbs and central cities, see Metropolitan Council (1992), *op. cit.*, p. 18 ff.

The decentralization of the Twin Cities also carries important implications for Greater Minnesota. As Minneapolis and St. Paul have continued suburbanizing, the state's network of trade centers has undergone a gradual reorganization. Cities and towns in close proximity to the metropolitan area have moved up the urban hierarchy, and some centers in the realm of exurban growth have attracted specialized functions not commonly found in small-town Minnesota. Many smaller centers further outstate have lost population and abandoned their roles as providers of frequently purchased goods and services, as working-age people leave and consumers drive farther to large regional shopping centers for basic needs.<sup>9</sup>

The decentralization of the Twin Cities is both cause and effect of the increasing interdependence of the system of settlement fields blanketing southern Minnesota. While the question of metropolitan area delineation in the 1960s originated first with a concern for the disparities between the central cities and first- and second-tier suburbs, the scale of exurban growth has proceeded far enough to spill out beyond the seven-county area itself. The proportion of the metropolitan area's population residing in Hennepin and Ramsey counties fell from seventy percent in 1970 to sixty-two percent in 1990, and by 1990 over 70,000 workers commuted into the seven-county TCMA from counties beyond the Metropolitan Council's jurisdiction. These trends suggest that the growth differentials previously evident only between central city and suburb are now emerging at the county level.

### III. DEFINING MINNESOTA'S COMMUTING FIELDS

The Census Bureau's decision to incorporate Sherburne County into the Twin Cities Metropolitan Statistical Area is only the latest indication of the interdependence characterizing the historic settlement corridors between St. Cloud, Minneapolis-St. Paul, Mankato, and

<sup>9</sup>See Anding, et al. (1990), *Trade Centers of the Upper Midwest: Changes from 1960 to 1989* (Minneapolis: Center for Urban and Regional Affairs).

Rochester. The new MSA definitions also illustrate the loss of detail entailed in county-level summaries of complicated flow matrices. Depending upon how the respective urban systems are defined, Sherburne County's 20,150 commuters are divided equally between the Twin Cities and St. Cloud in 1990: forty-five percent journey to work in the eleven counties of the Twin Cities MSA, while half work in the three counties of the St. Cloud MSA.

Sherburne County is only one of the many places on the metropolitan fringe associated with more than one urban hinterland, illustrating the difficulty of delineating commuting fields in contemporary American settlement systems. By requiring that we designate a "core" in order to classify adjacent counties, the daily urban system concept hides the variation inherent in multicentered urban fields. As a consequence, commuting fields defined with this technique typically exhibit a great deal of overlap: most of the counties in southern Minnesota send at least five percent of their commuters to the seven-county Twin Cities area, for instance, but many also send more than five percent to nearby regional centers.

To achieve a more rigorous analysis of this complex system of spatial interaction, we employ a multivariate statistical technique, factor analysis, which offers the additional advantage that regions are, as far as possible, mutually exclusive and independent. By attempting to associate each county with only one commuting field, we eliminate many areas of overlap. Counties still correlating with more than one region, even with this restrictive criterion, thus provide the most compelling arguments in support of the hypothesis that commuting fields are becoming more interdependent.

In its simplest form, factor analysis is a technique for reducing a large data matrix to a smaller number of variables -- in this case, the task is to derive a small number of 'commuting fields' from a matrix of journey to work flows between all 120 counties in the study area. The methodological basis for factor analysis is in many respects similar to that of multiple linear

regression, in which one dependent variable is predicted by calibrating its relationship to several independent variables. Since commuting fields are best defined as sets of counties with similar distributions of work journeys, we may examine each of the 120 counties in turn, predicting the total flow of commuters to each by examining the other 119 counties. For each destination, then, the relationship is expressed as:

$$T_{ij} = A + B_1 T_{ia} + B_2 T_{ib} + B_3 T_{ic} + \dots + B_n T_{in}$$

Where  $i = 1$  to 120, and

$T_{ij}$	= Vector of work journeys to destination $j$ from all origins $i$ .
$A$	= Constant.
$B_1 \dots n$	= Regression coefficients.
$T_{ia}$	= Vector of work journeys to destination $a$ from all origins $i$ .

This approach is, of course, nothing more than the familiar gravity model used to calibrate the “trip distribution” component of the urban transportation planning process.<sup>10</sup> In this case, destinations are treated as *variables*, while origin counties are regarded as *cases* or *observations*. Each resulting correlation coefficient measures the degree to which a county’s commuter flows are correlated with the work journeys of all other counties in the study area. Thus a strong correlation between destinations suggests that they assemble their incoming trips from essentially the same set of origins, in roughly similar proportions. As such the procedure allows a rigorous and statistically comparable set of regionalizations, and is typically less prone to the ambiguities illustrated by Sherburne County’s commuter flows.

The simple regression model outlined above is only a rudimentary analogue to the procedure required to develop a statistically-based regionalization of commuter flows. Whereas regression typically is used to examine each destination separately, factor analysis allows all of these relationships to be modeled simultaneously, yielding a regionalization incorporating the

<sup>10</sup>See Meyer, M.D., and E.J. Miller (1984), *Urban Transportation Planning* (New York: McGraw-Hill).

combined effects of all counties in the study area. The results of the factor analysis consist of a set of (nonlinear) combinations of the original counties -- factors -- which may be regarded here as statistically-defined commuting fields. The degree to which a destination is associated with a particular field is measured by its *factor loading* on the respective factor, while an origin's association with a field is gauged by its *factor score*.<sup>11</sup>

Commuting fields delineated with this technique may differ substantially from those defined with daily urban system criteria, which often result in extremely broad areas of overlap. In the case of the Twin Cities, for instance, a number of counties send at least five percent of their commuters both to the eleven-county Minneapolis-St. Paul MSA and to the three-county St. Cloud MSA. Mapping the counties meeting these thresholds suggests a broad area of overlap, even though many of these counties send seventy or eighty percent of their workers to only one of the metro areas in question. In contrast, factor analysis may be performed in such a manner as to associate each county, as far as possible, with only one commuting field. With this more restrictive definition, any counties remaining statistically correlated with more than one field may be regarded as the areas where urban system overlap is most pronounced and significant.

The foregoing discussion illustrates the difficulties in analyzing complex and overlapping patterns of spatial interaction. Each approach has its own merits and limitations, of course, so our study presents three views of the work journey in Minnesota between 1960 and 1990. First, factor analysis is used to develop statistically-based commuting fields in the study area. Origin-destination matrices are constructed for each census year, each cell containing the number of commuters traveling between the respective origin and destination county. The prominent origins and destinations are then identified by inspection of the loadings and scores, and mapped to show

<sup>11</sup>Factor loadings report the correlation between the original *variables* and the new factors, and vary from -1 (perfectly inverse correlation) to +1 (perfect positive correlation). Factor scores measure the correlation between the original *observations* and the new factors, weighted by the actual numbers in the original data matrix (in this case, the total number of commuters from each origin).

individual settlement fields as they evolve (e.g., Figures 25, 26, and 27) and the interdependence and overlap between all of the fields (Figures 1 through 4).<sup>12</sup>

The second technique relies on the simplest variant of the daily urban system approach, defining a commuting field as the set of counties sending at least a specified percentage of their workers to a certain core. For the Twin Cities, all counties sending five percent or more of their commuters to the seven-county TCMA are included (Figure 9), while in other metropolitan areas the criterion is one percent sent to a single central county (Figures 30, 37, 45, and 52).

This second approach may be regarded as a measure of the significance of a commuter flow for the *origin*, and does not distinguish between large and small flows. In contrast, the third approach defines a field as the set of counties contributing at least one-half percent of all the workers in a given core area (the seven-county area for the Twin Cities, a single central county for all other fields). This latter approach thus measures the importance of a given flow for the *destination*.

In summary, we rely on three different ways of delineating commuter fields to sketch complementary views of Minnesota's evolving urban systems. Two of these approaches are variants on the daily urban system concept, and give easily-interpreted portraits of complex commuting patterns. Due to the limitations inherent in the DUS concept, however, we also employ factor analysis to test the hypothesis that Minnesota's urban systems are becoming more interdependent. Together, these three methods are the basis of our analysis of the journey to work in Minnesota and its relationships to various measures of population, employment, and housing.

<sup>12</sup>Maps showing all commuter fields (Figures 1 through 4) depict groups of counties with loadings and scores on respective factors exceeding a specified threshold. Maps showing individual fields (e.g., Figures 25, 26, and 27) were constructed as follows: first, prominent destinations and origins were identified by inspection of the factor loadings and scores; second, each destination was connected to the two counties from which it drew the largest number of commuters; and third, each origin was connected to the two counties to which it sent the largest number of commuters.

#### IV. COUNTY-TO-COUNTY COMMUTING IN MINNESOTA IN 1990

In 1990, county-to-county commuter flows in Minnesota reflected the interaction among eight urban systems (Fig. 1). The Twin Cities is blanketed by two commuting fields, one centered on the seven-county metropolitan area and extending eastward into Wisconsin, another focused on St. Cloud. These two fields overlap extensively, coalescing with separate commuting systems centered on Rochester and Mankato. Outside the well-developed settlement corridors of the southeast portion of the state, diffuse commuting fields surround Marshall, Fargo-Moorhead, Grand Forks, and Duluth-Superior.

The 1990 commuting patterns portray a succession of six overlapping fields stretching across the state from Grand Forks/East Grand Forks southeastward to Rochester and LaCrosse. These regions overlap extensively, both in outstate Minnesota where large rural counties are split between loosely-integrated regional trade center networks, and around Minneapolis-St. Paul where exurban counties straddle the boundaries between the Twin Cities and adjacent urban fields. Indeed, a broad arc of counties linked to more than one field stretches from Pine County, along the I-35 corridor north of St. Paul, to the entire tier of communities between Minneapolis and St. Cloud, to counties midway between the Twin Cities and Mankato and Rochester. In contrast to these areas of overlap, systems blanketing southwestern Minnesota and the Duluth-Superior metropolitan area remain comparatively isolated.

The contemporary picture of Minnesota's commuter flows represents the present stage in the evolution of the region's settlement fields, reflecting significant geographic and demographic trends of recent decades. Population and housing have dispersed from central cities to suburbs and beyond, while employment has sometimes followed people and purchasing power, other times leading the movement outward.

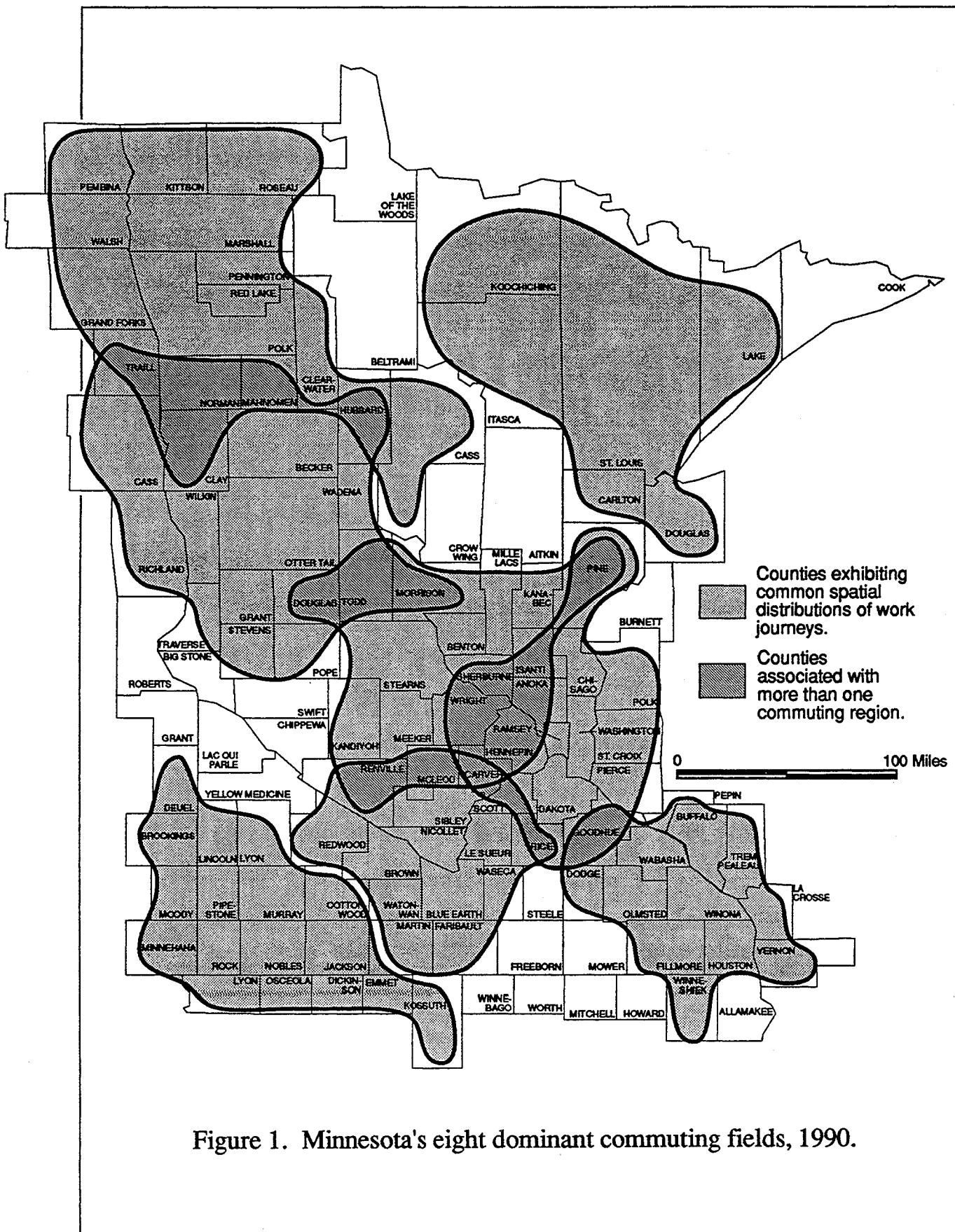


Figure 1. Minnesota's eight dominant commuting fields, 1990.

The emergence of multilayered commuting fields underscores particularly important questions for metropolitan planning in the Twin Cities, where population, housing, and employment have dispersed beyond the seven-county area since the establishment of the Metropolitan Council in the late 1960s. What is not known is whether the dispersal of the Twin Cities daily urban system is continuing at a *steady rate*, an *increasing rate*, or a *diminishing rate*.

## V. CHANGES IN COMMUTING FIELDS IN THE STUDY AREA BETWEEN 1960 AND 1990

To investigate trends in commuting in Minnesota and contiguous counties in adjacent states, we defined commuting fields for 1960, 1970, and 1980, comparing these with one another and with fields identified for 1990. Measures of change in commuting were then correlated with labor force participation and local business employment to examine aggregate relationships in the entire study area. Finally, the region's five dominant commuting fields were identified for further analysis in the next section of the report.

### A. COMMUTING IN 1960

In the years before the effects of large-scale federal highway construction rippled outward from metropolitan areas, Minnesota's settlement fields were characterized by two distinct types of commuter flows. Metropolitan areas were marked by well-defined journey-to-work corridors focused on the central cities and inner suburbs, while greater Minnesota's diffuse, loosely-integrated commuting fields extended across expansive rural areas. These two types of flows are evident in the map of commuting fields in 1960, showing a clearly-focused metropolitan system around the Twin Cities and sprawling outstate fields surrounding St. Cloud, Fargo-Moorhead, and Grand Forks (Fig. 2). Even in 1960, however, there are clear signs of an emerging alignment of overlapping fields from the northwest part of the state to the southeast.

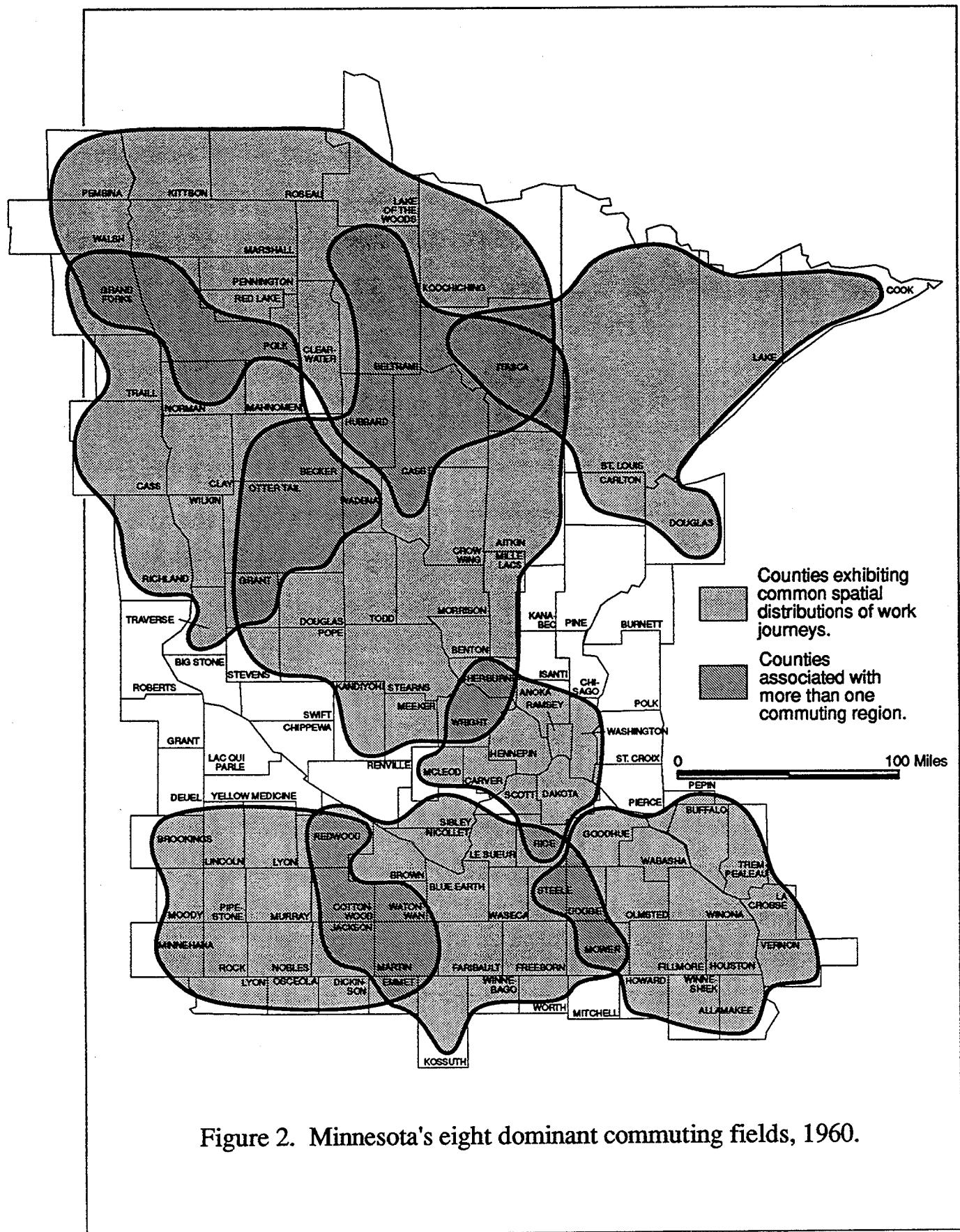


Figure 2. Minnesota's eight dominant commuting fields, 1960.

## B. COMMUTING IN 1970

The 1970 commuting map resembles the 1960 map, but with some conspicuous differences (Fig. 3). The Olmsted county commuting field has inched westward, perhaps due to the improvement in east-west highway travel as highway I90 was completed across the southern tier of Minnesota counties. West of Olmsted county, the nodality of Mower and Freeborn counties gives way to an emphasis on Blue Earth (Mankato) and Nicollet (St. Peter) counties. Meanwhile, the commuting field in the southwest corner of the state moved eastward all the way to Faribault (Blue Earth) county.

The Twin Cities field is largely unchanged, but it does extend slightly farther north into Isanti (Cambridge) county. One big change between 1960 and 1970 was the sharp contraction of the field around Stearns (St. Cloud) county. Elsewhere in Minnesota and adjacent counties, commuting fields associated with Cass and Clay counties (Fargo-Moorhead), with Polk (Grand Forks-E. Grand Forks) and Pennington (Thief River Falls) counties, and with Duluth-Superior and the Iron Range in northeastern Minnesota, remained in 1970 much as they were in 1960.

## C. COMMUTING IN 1980

By 1980, the same eight major commuting fields are defined by the intensity of daily commuting flows among sets of origin counties and destination counties, but important differences began to appear around the edges of the commuting fields (Fig. 4). The three southern commuting fields were largely unchanged although the field lying between the other two overlaps with them in ways that suggest movement east-west on I90. The Twin Cities-based field had spread westward to include McCleod county on highway US212, and southward into Steele (Owatonna) county on highway I35.

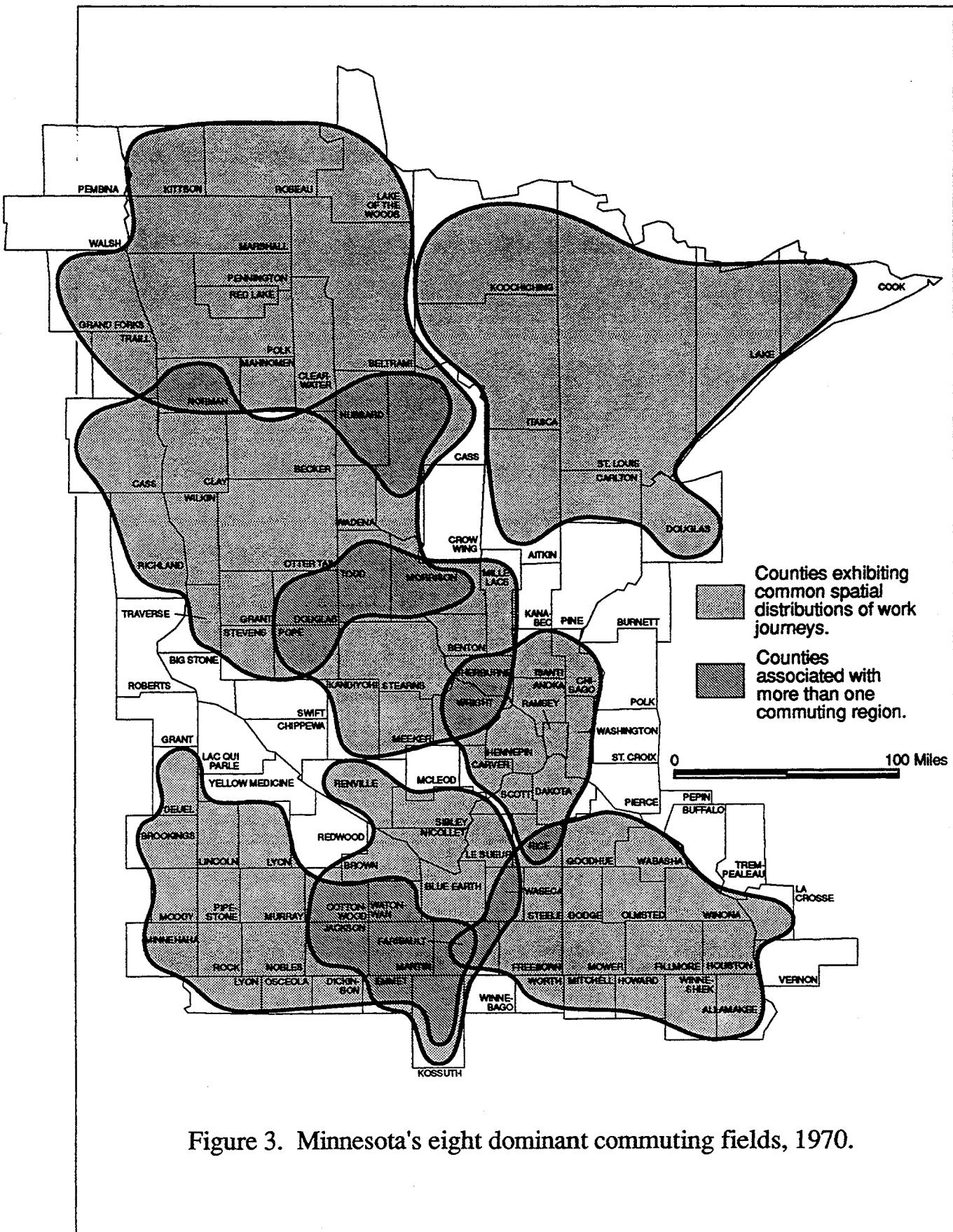


Figure 3. Minnesota's eight dominant commuting fields, 1970.

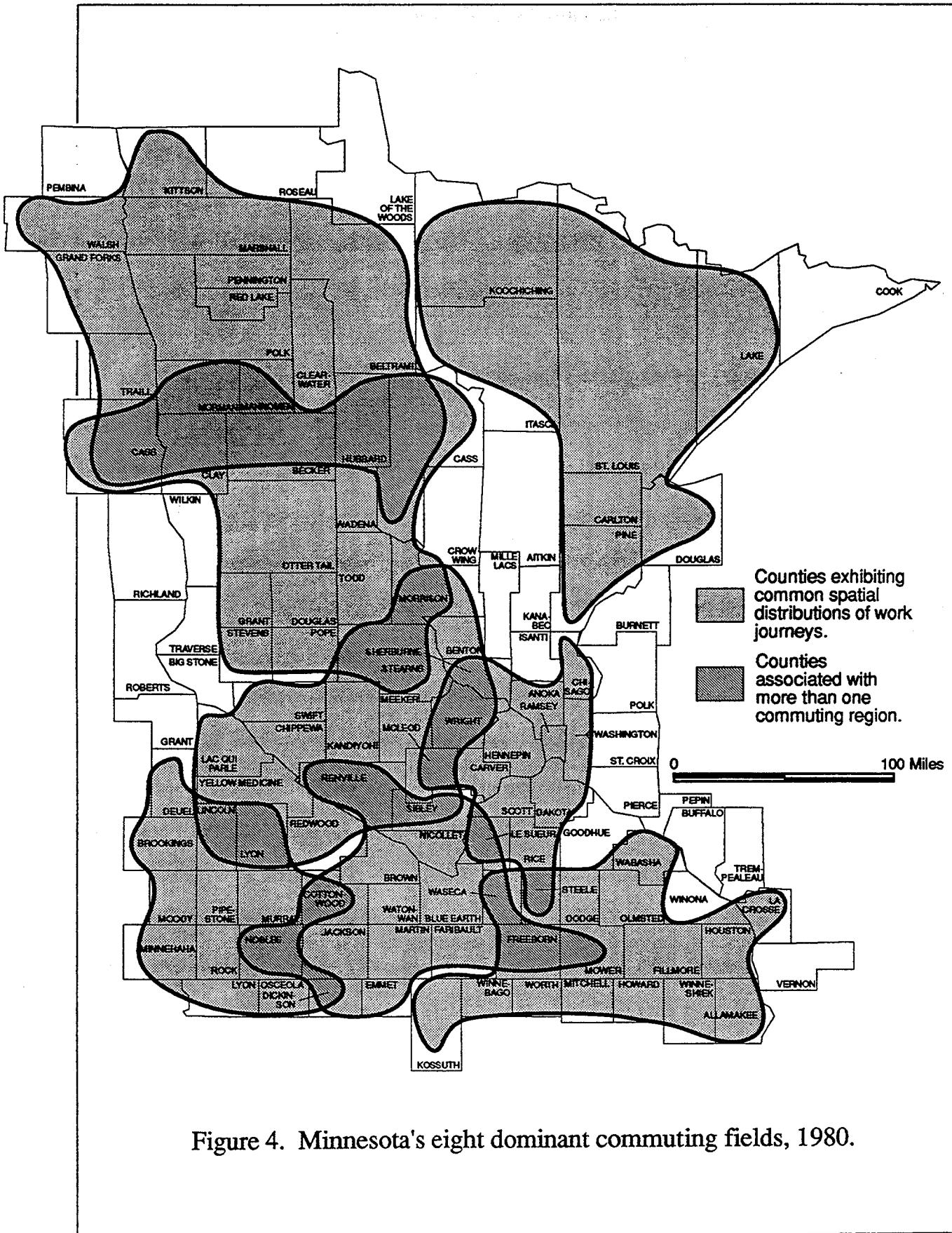


Figure 4. Minnesota's eight dominant commuting fields, 1980.

The Stearns (St. Cloud) county-centered commuting field appears to have loose linkages with areas to its southwest, but overlaps extensively with fields on all sides. Farther northwest, a variation of the 1970 field extended from the Fargo-Moorhead area, through Ottertail (Fergus Falls) county, and southeast into Stearns county. The northwest corner of the state was covered by the seventh field, which had substantial overlaps with the one to its south. Meanwhile, as the Duluth-Superior and Iron Range economy and population sagged, the commuting field in the northeast contracted.

#### D. CHANGE IN LABOR FORCE PARTICIPATION AND IN COMMUTING, 1970-1980

Between 1960 and 1990, besides improvements in highway facilities, other changes in Minnesota wielded influence on the size and shape of commuting fields. One was the sheer expansion of the labor force. Another was the general increase in labor force participation. These two upward trends were slightly correlated for the period 1980-90 (Fig. 5).

A few agricultural counties with small populations that were experiencing economic hard times or outmigration of young people in working ages (or both) saw labor force participation and total numbers of commuters actually drop, such as Traverse (Wheaton) county in extreme western Minnesota, or in Mitchell (northeast of Mason City) county, Iowa.

Some counties saw a significant increase in labor force participation, probably due to hard times, but not much of an increase in commuting, because of remoteness from major job centers (Lake of the Woods, Pembina ND). Some counties, on the other hand, had big increases in commuting without an exceptional increase in labor force participation rates. Most of these are counties within the Twin Cities and St. Cloud commuting orbits (Chisago, Sherburne, Washington, Wright, Dakota, Scott, and Isanti, among others).

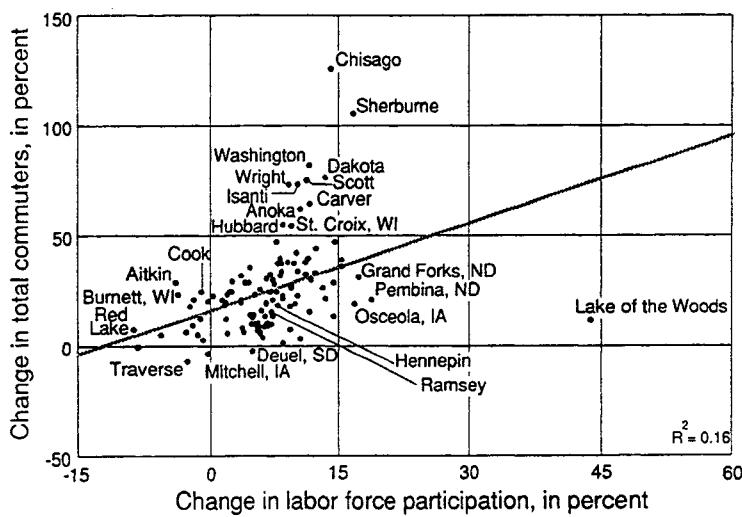


Figure 5. Change in total commuters by change in labor force participation, by county, 1970-80.

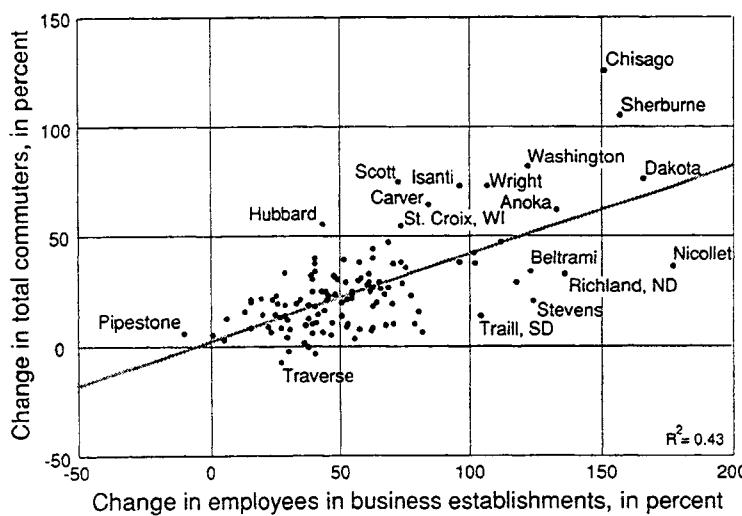


Figure 6. Change in total commuters by change in employees in business establishments, by county, 1970-80.

Still another class of outliers on the graph are counties with declining labor force participation, presumably due to outmigration, an aging population, and poor local economic conditions, in which labor force participation dropped while commuting rose modestly as local workers went farther afield for jobs (Cook -- in the Arrowhead region, Aitkin -- north of Mille Lacs on the Cuyuna Iron Range, and Red Lake).

#### E. CHANGE IN LOCAL BUSINESS EMPLOYMENT AND COMMUTING, 1970-1980

As the number of employees in businesses establishments in a county rises, the number of people living in that county who commute also rises (Fig 6). The correlation is high for two reasons. First, with more businesses within the county, there are more jobs available for local residents to commute to. Secondly, as local residents take up the new jobs, their disposable incomes attract additional businesses, supplying still more new job opportunities.

Conspicuously deviating from this correlation are counties on the rapidly expanding edges of major metro areas in which local consumer oriented businesses have not yet had a chance to multiply job opportunities as fast as households numbers have risen (Chisago, Sherburne, Washington, Scott, for example), and rural counties more distant from major job markets where local job opportunities rise, but the extra jobs evidently are disproportionately filled by people commuting from other counties (Nicollet, Beltrami, and Traverse, for example).

#### F. DOMINANT COMMUTING FIELDS IN THE STUDY AREA

Hennepin county was the largest net recipient of commuters in the Twin Cities area in 1990, with Ramsey county in second place (Fig. 7). Although most of the inter-county commuter flows in the state are associated with the Twin Cities area, there are nevertheless significant regional centers in outstate Minnesota with urban systems encompassing surrounding counties.

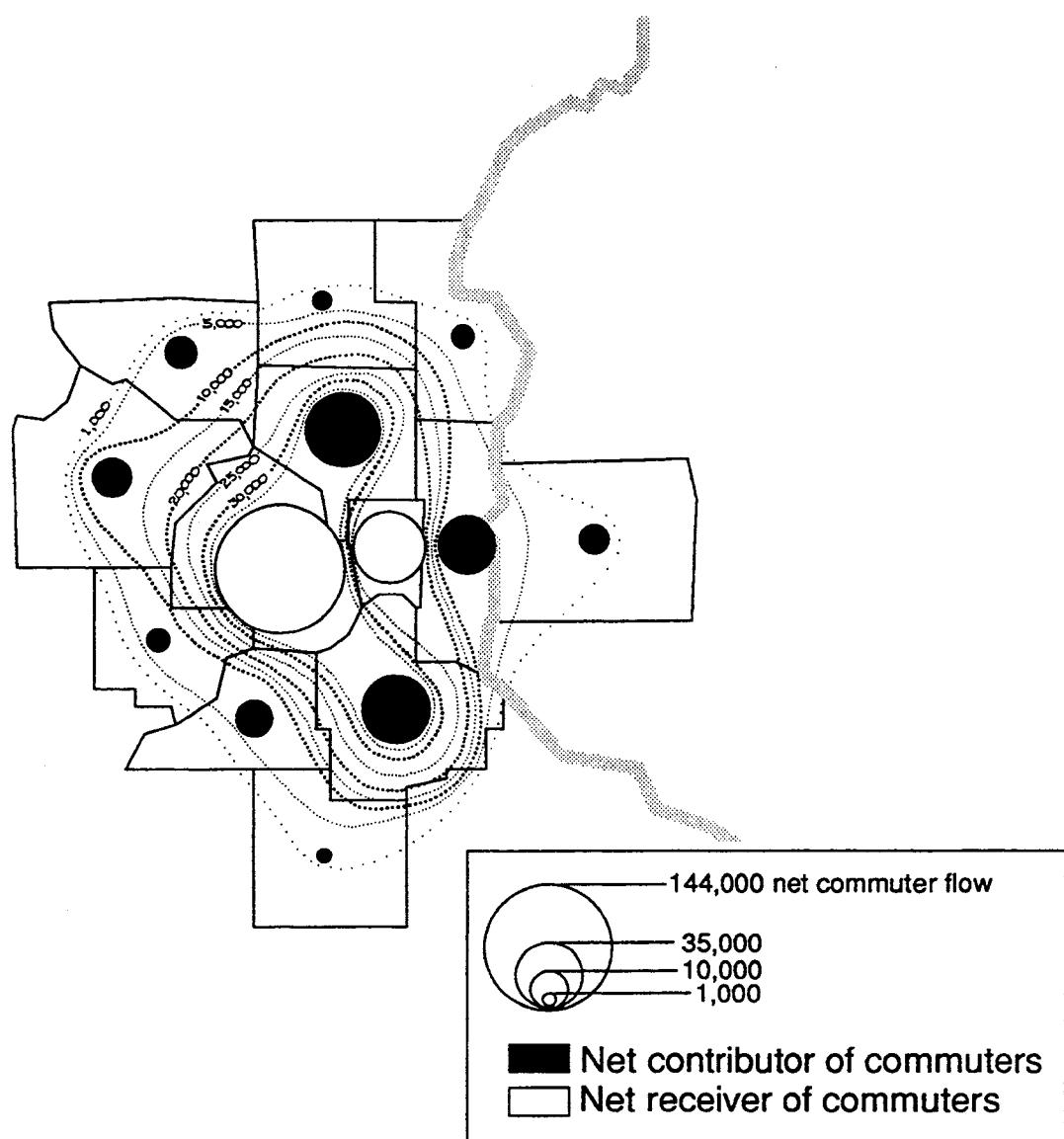


Figure 7. Commuters to Hennepin County (isolines) and contribution of each county to total intercounty commuting (circles), 1990.

In the following sections, we analyze changes in commuting patterns and demographic characteristics in the Twin Cities and four of these smaller systems: Duluth-Superior, St. Cloud, Rochester, and Mankato.

## VI. CHANGES IN THE REGION'S FIVE PRIMARY COMMUTING FIELDS BETWEEN 1970 AND 1990

Central and southern Minnesota is blanketed by five urban systems that surround and overlap portions of the Twin Cities commuting field: Duluth-Superior, St. Cloud, Rochester, and Mankato, in addition to the Twin Cities field itself. To gain a fuller understanding of the evolving linkages between the Twin Cities and counties straddling the boundaries between metropolitan influence, we examine changes in demographic and commuting characteristics in these fields between 1970 and 1990. We address the following questions, examining each of the commuting fields in turn:

- What is the geographical extent of the fields?
- How have the fields changed in recent decades?
- How are the changes related to employment, population, and housing?
- How have changes in individual fields contributed to the overlapping and integration of commuting fields?
- Over time, as commuting fields have expanded, can we tell if the rates of expansion are increasing? stabilizing? or decreasing?

### A. CHANGES IN THE TWIN CITIES COMMUTING FIELD, 1970-1990

Only ten counties contributed one-half percent or more of the commuting trips that ended in the seven county Twin Cities metro area in 1990 (Fig. 8). They include the Metro Council's seven county area itself, plus Chisago, Wright, and St. Croix (Wisconsin).

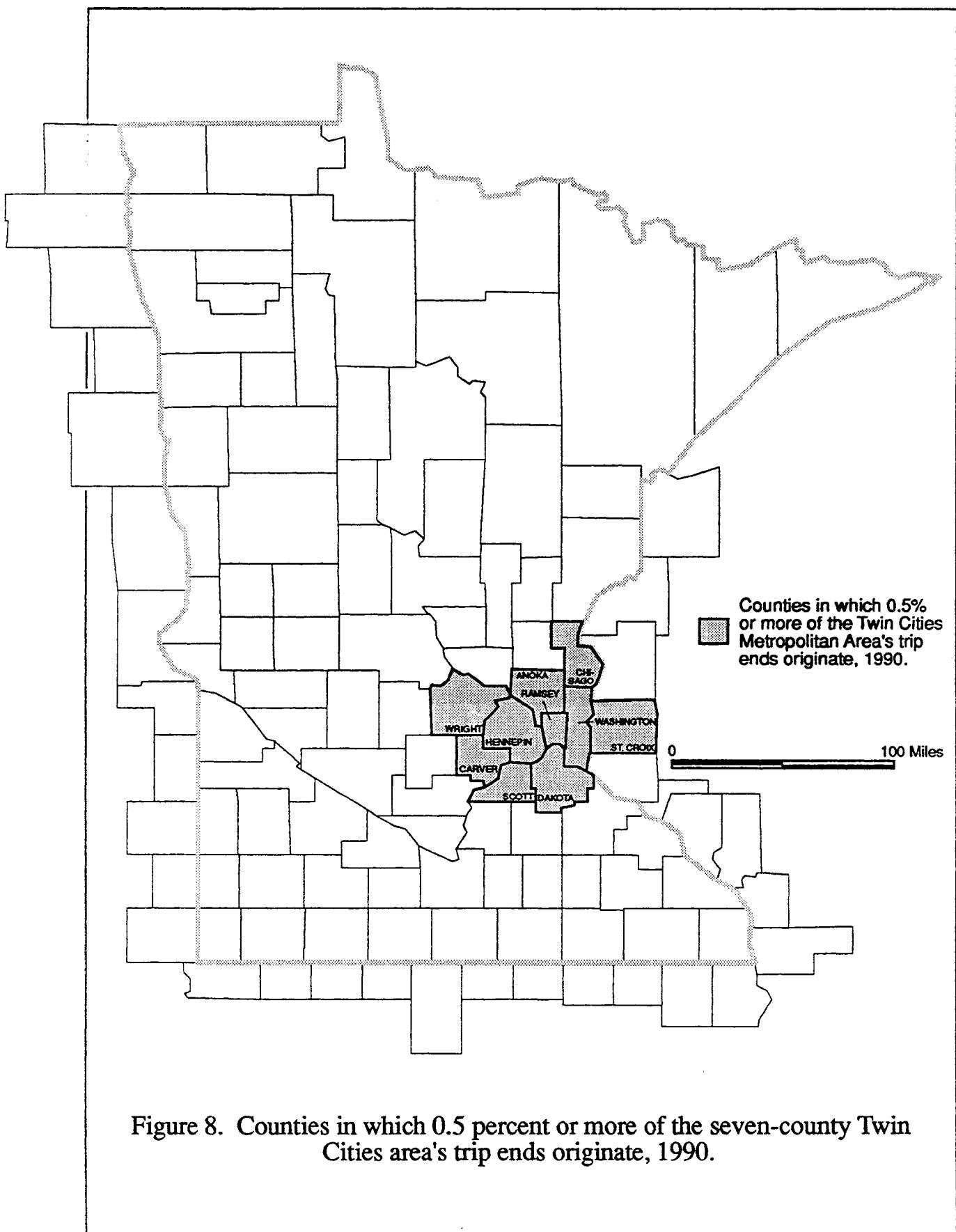


Figure 8. Counties in which 0.5 percent or more of the seven-county Twin Cities area's trip ends originate, 1990.

If we examine the picture from the point of view of the sending counties, we identify a wider commuting field of nineteen counties that sent at least five percent of their commuters to the seven county Twin Cities area in 1990 (Fig. 9). The field extends north to include Mille Lacs, Kanabec and Pine counties; west to include Wright, McLeod and Sibley; and south to include LeSueur, Rice, and Goodhue.

The importance of a sending county to the Twin Cities labor market, and the importance of the Twin Cities to the sending county's workers, are related but quite different variables. Between 1970 and 1980, these variables changed in different ways (Fig. 10). Counties of Type A contributed increasing proportions of the total number of workers in the Twin Cities, and at the same time, commuters to the Twin Cities from those counties formed an increasing share of workers living in them.

In counties of Type D, both measures dropped in the 1970s. That is, they became relatively less important as contributors to the Twin Cities worker total as their shares dropped. At the same time, the proportion of people living in these counties who traveled to the Twin Cities labor market dropped as a share of all commuters. The share could drop because some commuters shifted to jobs in other job markets, or because job opportunities increased locally, employing more local residents, and driving down the percentage of all workers who left the county for the Twin Cities, or any of a combination of increased or decreases in flows to different destinations.

There seem to be no conspicuous cases of Types B or C, although some counties are on the boundary. Hennepin and Ramsey accounted for a smaller share of Twin Cities trip ends at the end of the decade than at the beginning, while Anoka, Scott, Washington, and Chisago had rising shares (horizontal axis). In terms of the share of their residents going to work in the Twin Cities job market (vertical axis), there was no change for any of these counties.

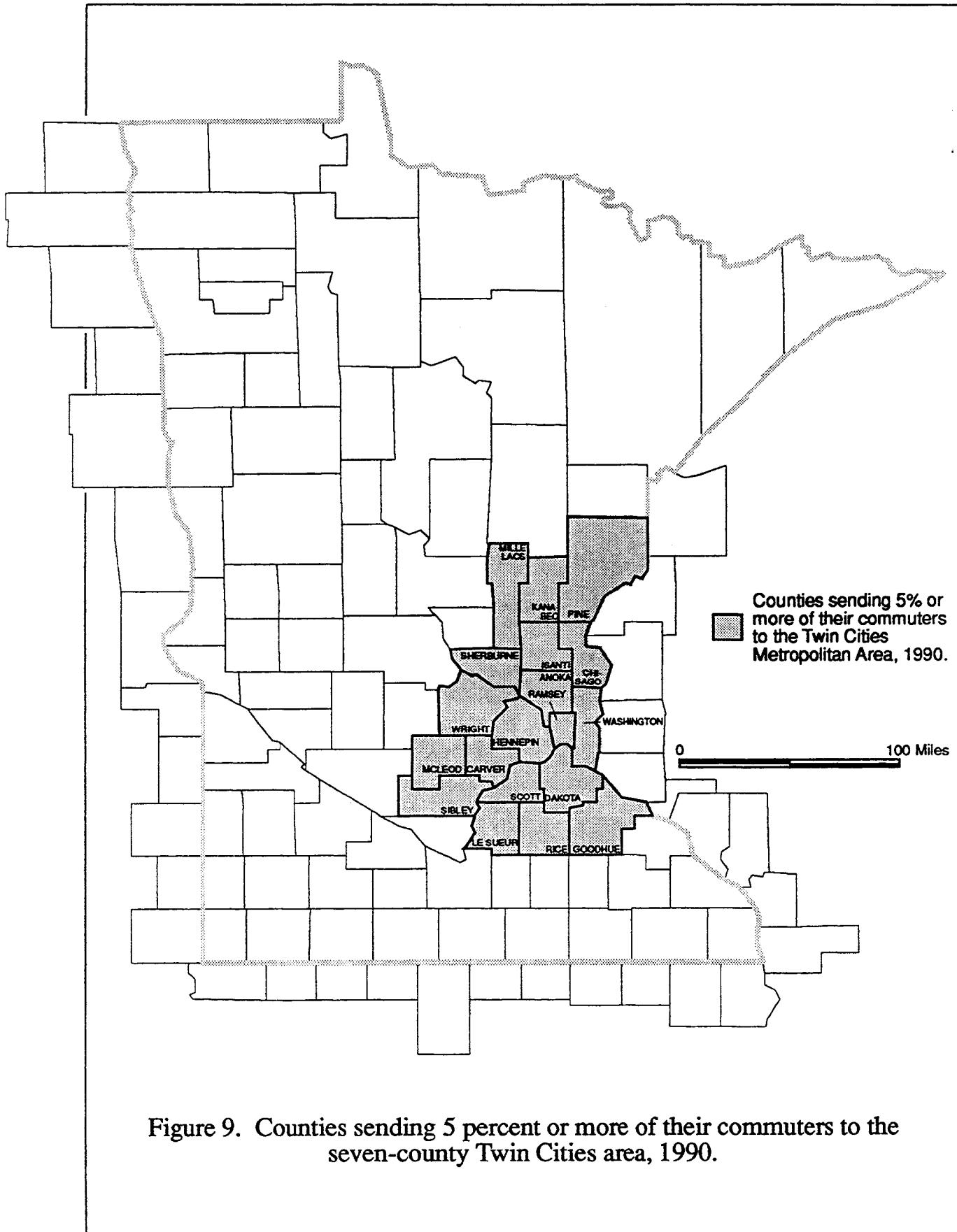


Figure 9. Counties sending 5 percent or more of their commuters to the seven-county Twin Cities area, 1990.

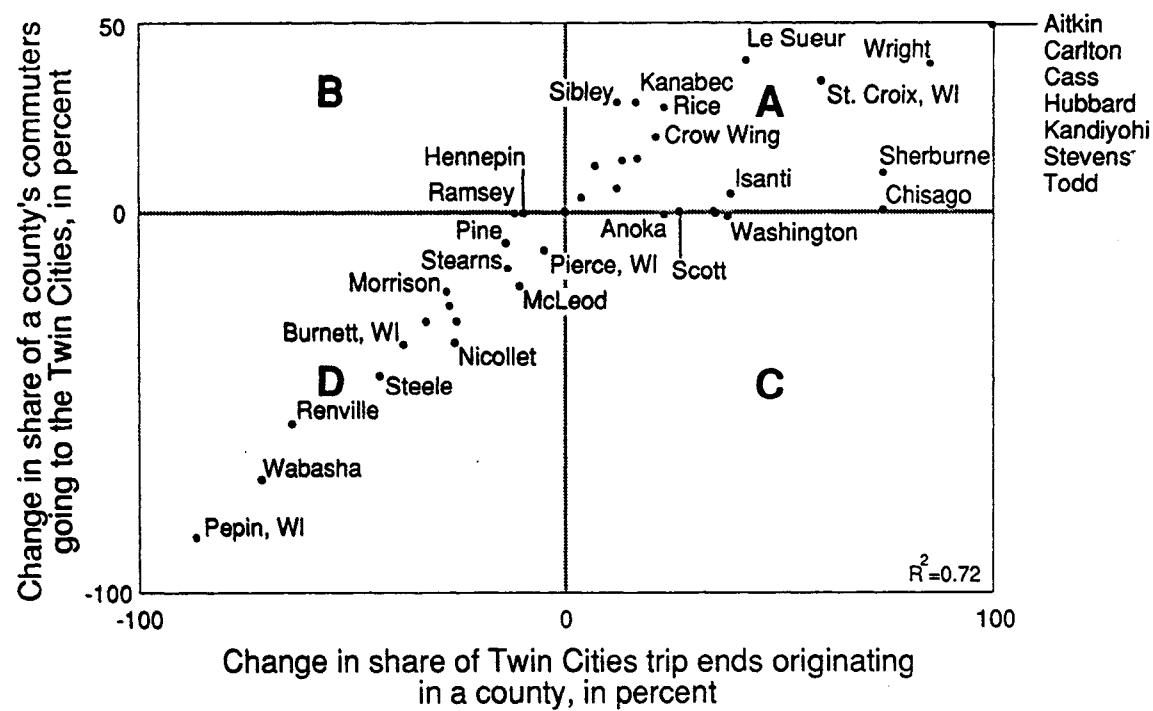


Figure 10. Change in share of Twin Cities trip ends originating in a county by change in share of a county's commuters going to the Twin Cities, 1970-80.

Some outlying counties showed significant relative increases in their participation in the Twin Cities commuting field: Aitkin, Cass, Kandiyohi, Carlton, Hubbard, and a few others. If a small share doubles, that means an increase of 100 percent, even if few workers are involved.

The array of counties on the scatter diagram (Fig. 10) can be portrayed cartographically (Fig. 11). Counties of Type A, with both shares rising, are identified with solid circles. In counties of Type A, the counties are becoming more important to the Twin Cities at the same time the Twin Cities job market is becoming more important to the sending counties. This group includes new entries, especially north of the Twin Cities and west of Duluth, plus selected counties on the fringes of commuting fields adjacent to the Twin Cities field.

In counties of Type D, the counties are becoming relatively less important as providers of workers to the seven county Twin Cities job market, and at the same time, that market is diminishing in relative importance for workers from the sending counties. In the cases around the edges, it seems likely that these Type D counties are sending more workers to alternative destinations -- Olmsted (Rochester), Nicollet and Blue Earth (Mankato and St. Peter), Stearns, Benton, and Sherburne (St. Cloud), Winona (Rochester, LaCrosse), and so forth. The declines posted by Hennepin and Ramsey counties are due to rapid increases in other counties sending workers to the Twin Cities, which has the effect of reducing the shares of these two sources.

#### 1. Change in Commuting to the Twin Cities and Growth in County Populations, 1970-1980

When the working age population of counties in the Twin Cities commuting field rose more than about 25 percent in the 1970s, there was a general tendency for them to account for larger shares of the workers commuting to jobs in the Twin Cities (Fig 12). When working age population growth fell short of 25 percent, the county's share of total workers with commuting trip ends in the Twin Cities generally declined.

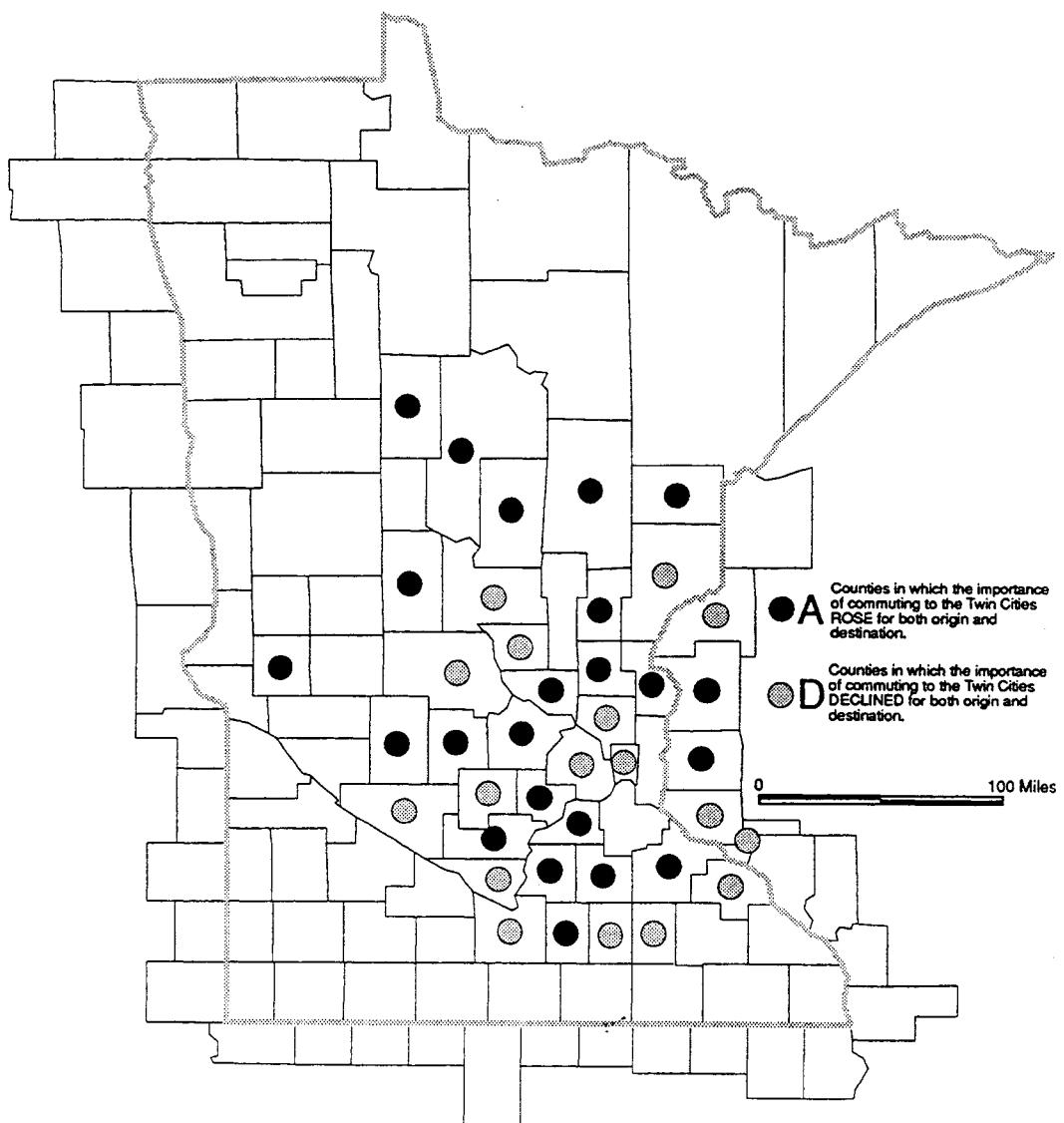


Figure 11. Counties for which Twin Cities commuting rose or declined in importance for both origin and destination, 1970-80.

Counties that had population increases but *reduced* shares of Twin Cities commuting trip ends tended to be on the margins of the Twin Cities commuting field, with other job centers nearby them -- Burnett WI, Benton, Steele, Renville, Wabasha, and Pepin WI. At the other extreme, counties with population increases and significantly *expanded* shares of commuting trip ends in the Twin Cities, also tended to be remote from the Twin Cities, either in poor areas, and lacking suitable alternative employment opportunities nearby -- Aitkin, Stevens (Morris), Carlton (Cloquet), Cass (Walker), Hubbard (Park Rapids), or on convenient commuting routes into the Twin Cities labor market -- Kandiyohi (Willmar, on US 12), Todd (served by I94 and US10), LeSueur (on U.S. 169), and St. Croix WI (on I94).

## 2. Change in Commuting to the Twin Cities and Growth in County Housing Stocks, 1970-1980

Another major indicator of change is change in the number of occupied housing units, 1970-1980 (Fig. 13). Patterns are similar to those related to population change (Fig. 12). As the number of occupied housing units in a county rose during the 1970s, there was a general increase in the share of its commuting trips that ended in the seven county Twin Cities area. Trip end shares dropped as number of occupied housing units rose in cases where counties were remote from the Twin Cities (for example, Pepin WI, Burnett WI), where alternative expanding job opportunities lay nearby (such as Stearns, Benton, or Wabasha), or possibly where working age migrants left the county in the face of local economic difficulties (Renville).

Sometimes the number of occupied housing units in a county increased moderately, but the share of Twin Cities trip ends rose sharply above what was expected from the correlation. This result seemed to occur when small percentages doubled on the edges of the commuting field in counties experiencing economic difficulties, and in fast growing counties close to the Twin Cities (Sibley, LeSueur, St. Croix, Chisago, Sherburne, and Wright).

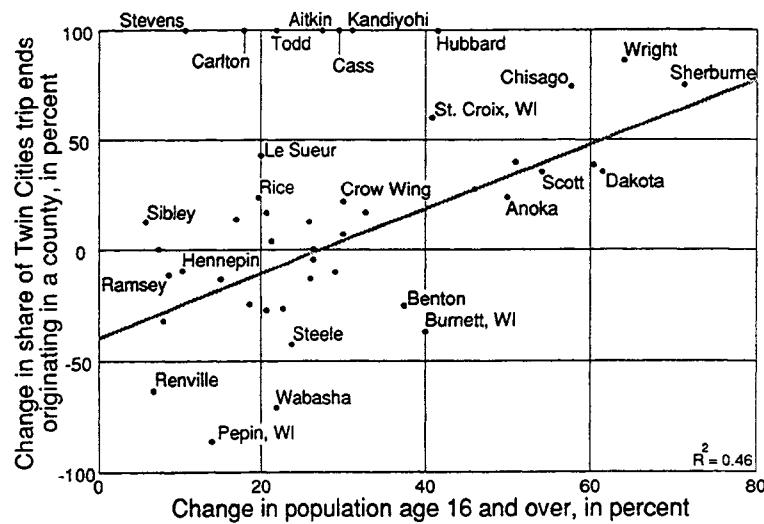


Figure 12. Change in share of Twin Cities trip ends by change in population age 16 and over, by county, 1970-80.

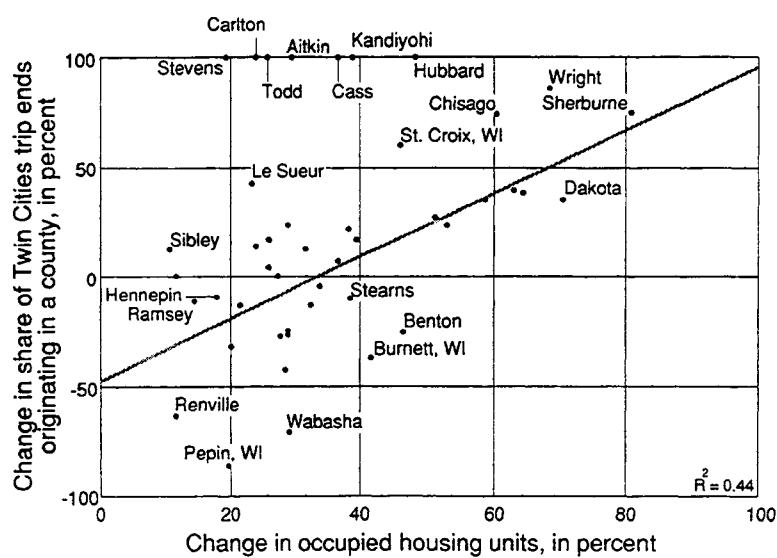


Figure 13. Change in share of Twin Cities trip ends by change in occupied housing units, by county, 1970-80.

### 3. Change in Commuting to the Twin Cities and Growth in the Number of Businesses, 1970-1980

As development occurs in the immediate suburban counties, their shares of Twin Cities area trip ends rise. As development proceeds, new businesses follow purchasing power into the suburban counties and new businesses spring up to provide local goods and services to the new residential developments. Local business growth then redirects commuters to local destinations. One variable triggers increases in the other, and vice-versa.

When change in number of business establishments in the 1970s is compared with change in share of Twin Cities trip ends originating in counties, a moderate correlation appears (Fig. 14). Several overlapping patterns are present in the array. In some peripheral counties, business may be expanding, but share of trip ends is declining (Pepin WI, Renville, Wabasha, Steele, Burnett WI Benton, and so forth). In those places, commuting to the Twin Cities has failed to keep pace with total commuting to the Twin Cities. This failure to keep pace can be due to local stagnation relative to other places, or growth in commuting to other destinations.

At the top of the chart are plotted counties with greater or lesser records of business expansion -- the "new entries" with abruptly rising shares of total Twin Cities commuting trip ends. Some are remote counties whose small percentages rose enough to propel them to the top of the chart. Other counties are well within the suburban and exurban commuting range of large numbers of workers to the Twin Cities (LeSueur, Isanti, Scott, Washington, Chisago, Sherburne, and so forth).

### 4. DIFFERENCES WITHIN THE TWIN CITIES COMMUTING FIELD

Between 1970 and 1980, commuting flows to Hennepin and Ramsey counties were realigned. Some counties in the Twin Cities commuting field saw their shares of Hennepin-bound

commuters rise; others had their shares fall. Meanwhile, counties in the Twin Cities field underwent changes in their shares commuting to Ramsey county; some shares rose while others fell (Fig. 15). Aitkin county, for example, had its Hennepin-bound share rise by over 100 percent, while the share of its commuters going to Ramsey county expanded by an equally high rate. At the lower left hand corner of the chart, Pepin county WI had both its Hennepin and its Ramsey shares drop sharply.

Counties that saw the proportion of their commuters headed to Ramsey county increase in the 1970s while the Hennepin-bound share dropped, are plotted in the quadrant labeled (R) (Fig. 15). These are the counties in the Twin Cities commuting field that, in relative terms, became more aligned with Ramsey county during the decade. With the exception of Goodhue, the counties involved are remote from Ramsey county and the numbers of commuters are small.

Counties that saw their Hennepin-bound share rise while their Ramsey county-bound share declined, are plotted in quadrant (H) (Fig. 15). These are places that in relative terms became more tightly tied to the Hennepin county orbit during the decade. Most of them are located on the edge of the Twin Cities commuting field and involve small flows, but a few are well within easy commuting range of the Twin Cities suburbs -- Sibley, Dakota, Wright, Sherburne, Pine, and Pierce WI.

In seven counties the share of commuters to both Hennepin and Ramsey counties rose in the 1970s (Fig. 16). There were fifteen counties in which the shares to Hennepin and Ramsey counties declined in the 1970s. In the southern portion of the Twin Cities commuting field, the counties with declining shares seem to contain or be located near one of the region's outlying job centers (Mankato, Rochester, Owatonna, Albert Lea).

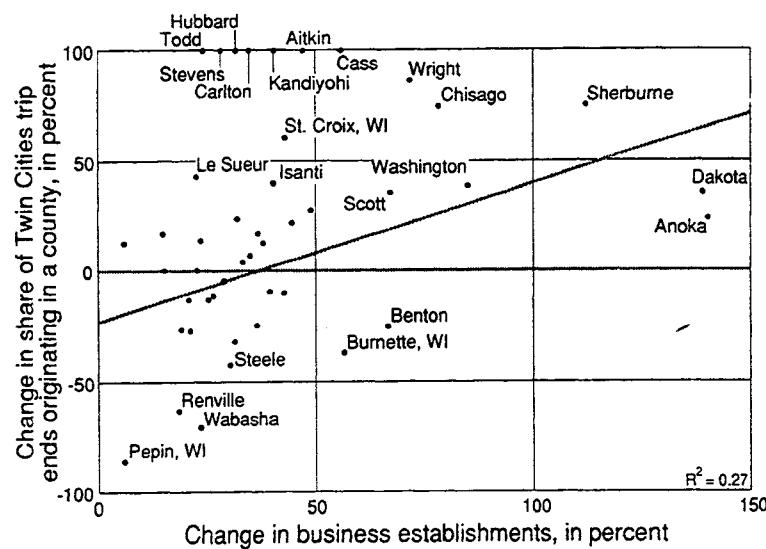


Figure 14. Change in share of Twin Cities trip ends by change in business establishments, by county, 1970-80.

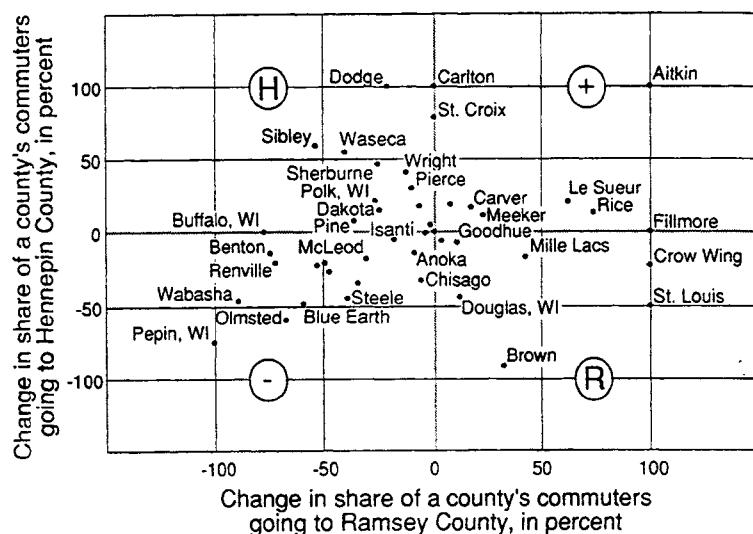


Figure 15. Change in share of a county's commuters going to Hennepin County by change in share going to Ramsey County, by county, 1970-80.

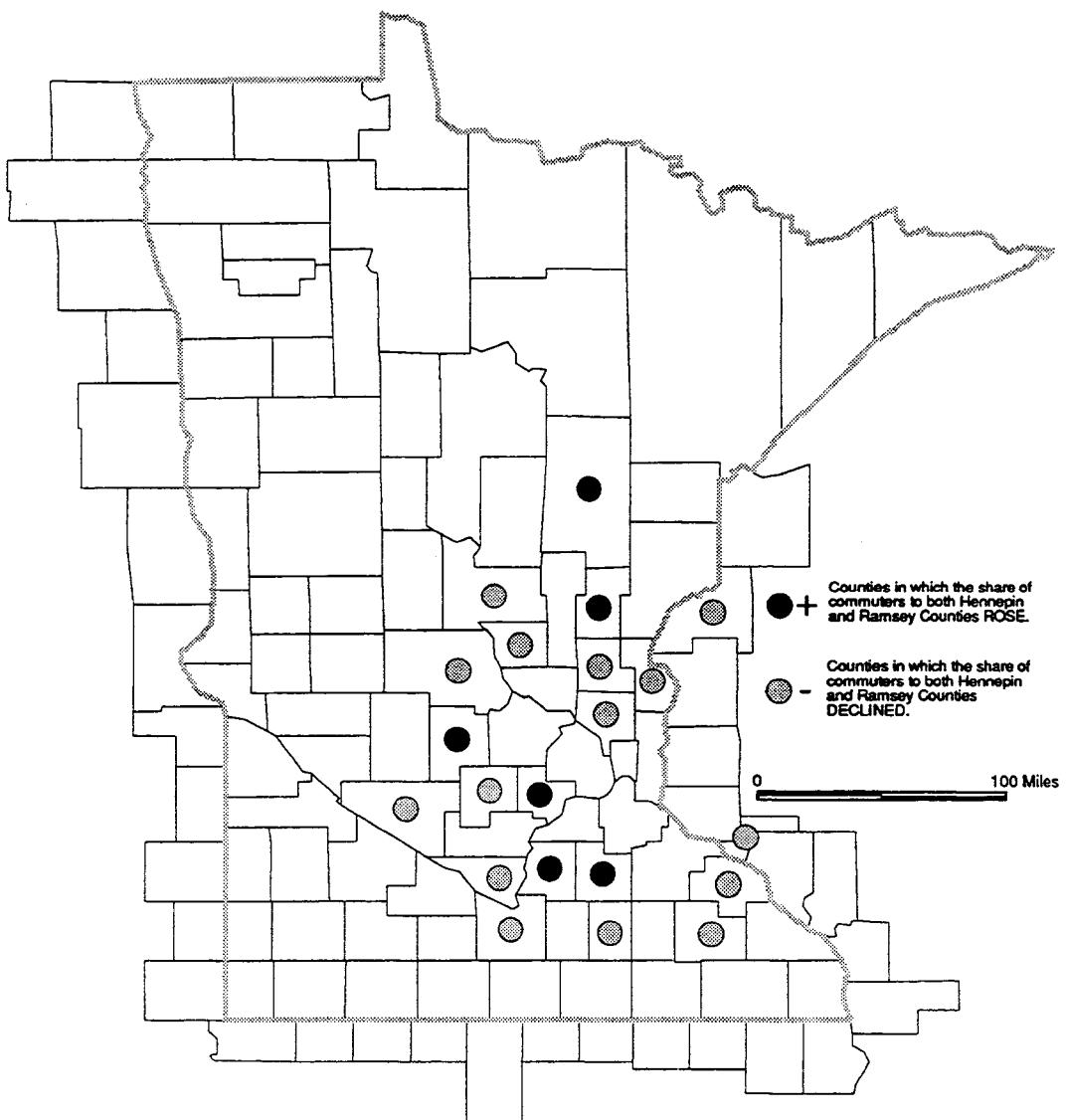


Figure 16. Counties sending increase shares of their commuters to both Hennepin and Ramsey counties, and counties sending decreased shares to both, 1970-80.

In the northwest sector of the Twin Cities commuting field, Stearns, Benton, and Morrison counties had declining shares to the Twin Cities, but this decline is presumably due to their proximity to St. Cloud. Immediately north of Hennepin and Ramsey counties, Anoka, Isanti, and Chisago counties also had declining shares to Hennepin and Ramsey counties, but this drop is almost certainly due to the expansion of employment within those counties themselves, which absorbed larger shares of local workers commuting to local jobs.

Ten counties saw their share of commuters to Hennepin rise as the share to Ramsey dropped (Fig. 17). The solid circles on the map indicate counties that enhanced, in relative terms, their ties with Hennepin as their relative ties to Ramsey declined. These ten surround Hennepin, and include Ramsey itself. A few increased their relative ties to Ramsey, notably Goodhue and Washington. Outliers involve such small flows that shifts in relative terms are unimportant.

a. Changes in Commuting to Hennepin County, 1970-1980. Two things were happening in the 1980s as flows to Hennepin county were rearranged. Counties sending commuters to Hennepin adjusted their mix of outbound flows among the various destinations (vertical axis, Fig. 18). At the same time, and for some of the same reasons, Hennepin drew its incoming commuters from a mix of origins that differed in 1980 from 1970 (horizontal axis, Fig. 18). The percentage changes over the decade are closely correlated, but deviations from the best fitting line tell a story.

Below and to the right of the line are counties accounting for an increasing share of Hennepin's trip ends (Sherburne, Wright, Dakota, Scott, Chicago, Washington, etc.), yet the fraction of those sending counties' trips headed for Hennepin was less than expected, probably because they were growing while sending proportionately more of their trips to themselves and to nearby suburban job opportunities.

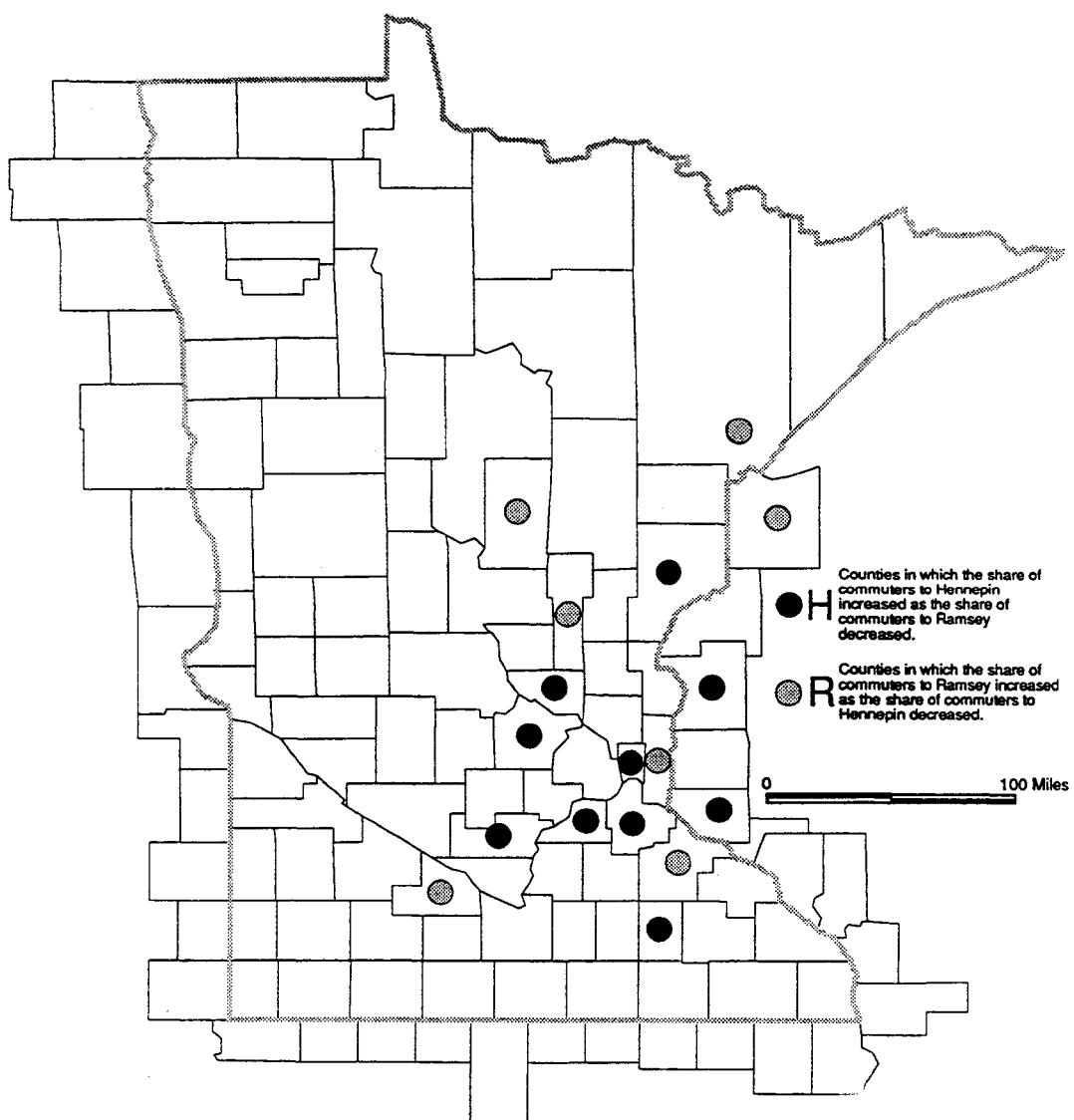


Figure 17. Counties sending increased shares of their commuters to Hennepin County and decreased shares to Ramsey County; counties sending increased shares to Ramsey County and decreased shares to Hennepin County, 1970-80.

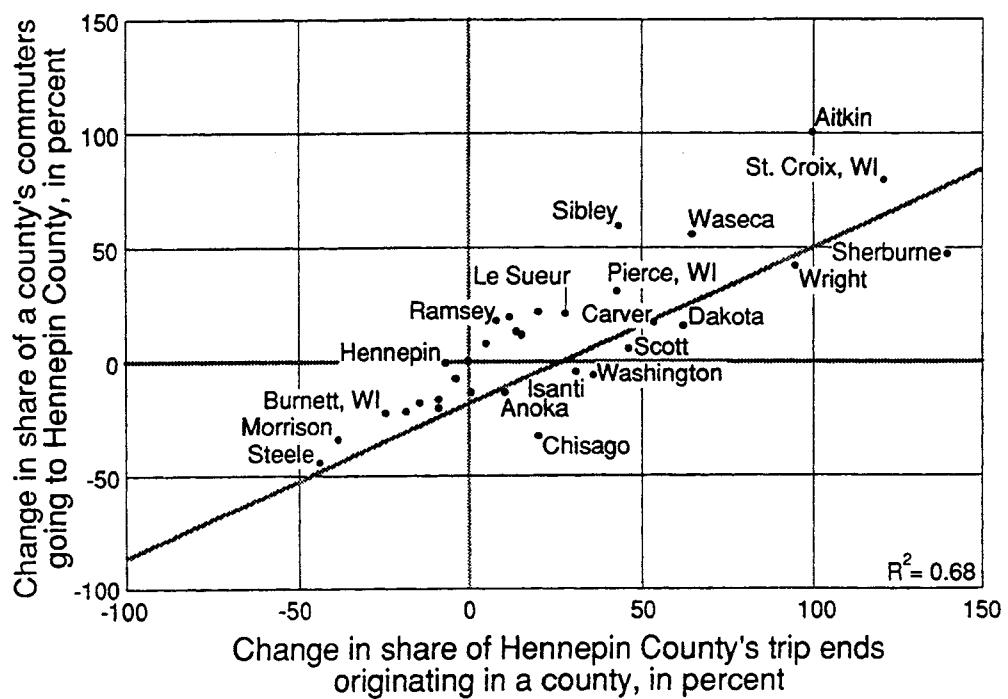


Figure 18. Change in share of a county's commuters going to Hennepin County by change in share of Hennepin County's trip ends originating in a county, 1970-80.

Above the line, among counties with an increasing share of Hennepin trip ends, are places like Aitkin, St. Croix, Waseca, Pierce, LeSueur -- origins that are sending proportionately more commuters to Hennepin, possibly ex-urbanites moving out and commuting back in, plus old residents drawn into the Twin Cities job market.

In the lower left hand quadrant of the chart are counties with declining shares going to Hennepin, and accounting for shrinking shares of trips ending in Hennepin (Burnett, Morrison, Steele). In these cases, trips are proportionately heading to other destinations, or are experiencing declining numbers of commuters of all kinds, or both.

Some of the change in Hennepin's commuting flows can be traced to change in total commuting during the 1970s (Fig. 19). As the number of total commuters in the Twin Cities commuting field rose in the 1970s, the share of each counties' commuters who went to Hennepin changed also. Most of the time the proportion going to Hennepin rose, but in a few cases the share dropped (lower left hand quadrant, Fig. 19). Sometimes the share dropped because of strong growth in nearby employment opportunities, for example Morrison and Stearns (St. Cloud), or Steele (Rochester and other job opportunities around Owatonna). The share of Hennepin commuters going to Hennepin dropped probably because of disproportionate gains in job opportunities in other nearby counties.

In general, the greater the increase in total commuters in a county, the greater the share of those trips that ended in Hennepin. Chisago and Sherburne had the largest percentage increase in total commuters -- over 100 percent. Compared with the best fitting line, however, Chisago (farther away from Hennepin) sent a disproportionately small increase to Hennepin. It faced a range of alternative destinations for its rapidly expanding numbers of commuters. Sherburne, on the other hand, saw its share of commuters heading to Hennepin increase almost 150 percent, but

then Sherburne county lies close to the areas of Hennepin where employment opportunities were expanding.

Labor force participation rates were up during the 1970s in almost all counties in the Twin Cities commuting field, with only four exceptions -- Carlton (Cloquet), Aitkin, Kanabec (Mora), and Burnett WI (Siren) (Fig. 20). There was little correlation between the increase in labor force participation and the change in share of Hennepin's trip ends.

A better predictor of increasing share of Hennepin trip ends in the 1970s was a county's increase in occupied housing units. As a county's occupied housing units rose, its share of Hennepin's trip ends also rose (Fig. 21). Counties well above the best fitting line are places that had major increases in occupied housing units, along with disproportionately large increases in their shares of Hennepin's trip ends. They are fast growing, but apparently lack nearby or intervening job opportunities sufficient to absorb the commuting generated by the local growth and capable of diverting a major share of the flows to Hennepin.

As a county grows in population and number of occupied housing units, it also increases its local employment. Growth is a circular process. Local business expansion attracts residents, but residents attract local businesses selling them goods and services (Fig. 22). Since there is an obvious and expected correlation between the change in the number of occupied housing units in a county and the change in employees in business establishments in a county, it is not surprising that Fig. 21 and Fig. 22 look much alike.

b. Changes in Commuting to Ramsey County, 1970-1980. There is a good correlation between change in share of Ramsey county trip ends originating in a county (horizontal axis, Fig. 23) and change in share of a county's commuters going to Ramsey county (vertical axis). Counties

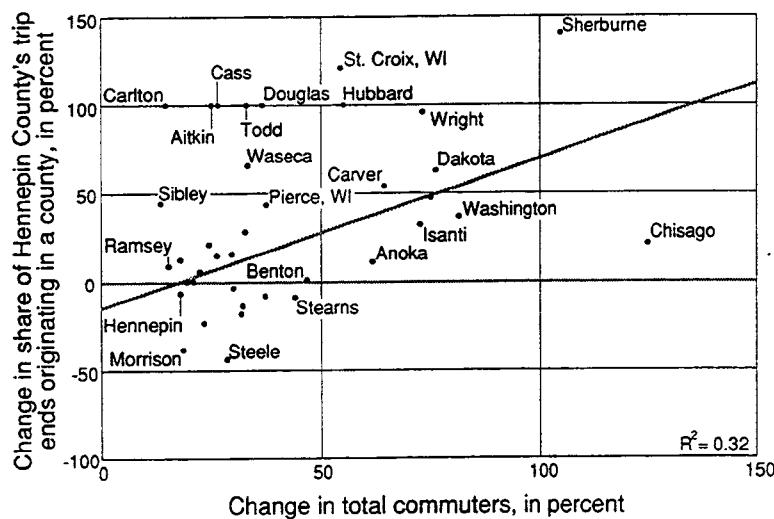


Figure 19. Change in share of Hennepin County's trip ends originating in a county by change in total commuters, by county, 1970-80.

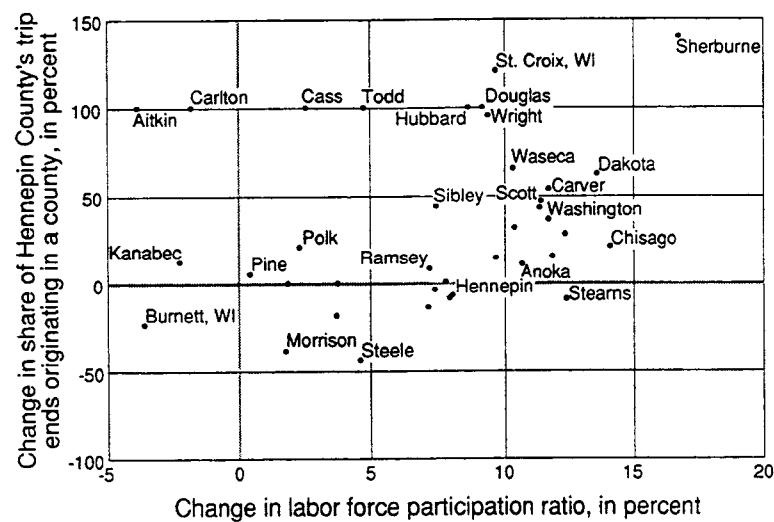


Figure 20. Change in share of Hennepin County's trip ends originating in a county by change in labor force participation, by county, 1970-80.

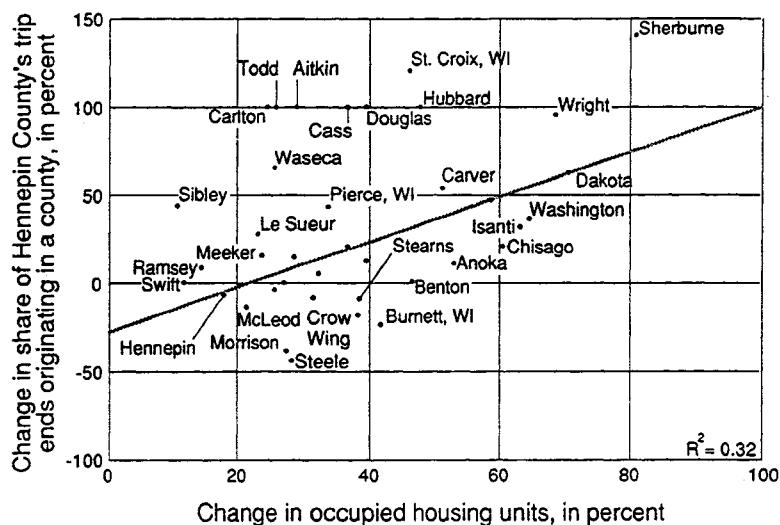


Figure 21. Change in share of Hennepin County's trip ends originating in a county by change in occupied housing units, by county, 1970-80.

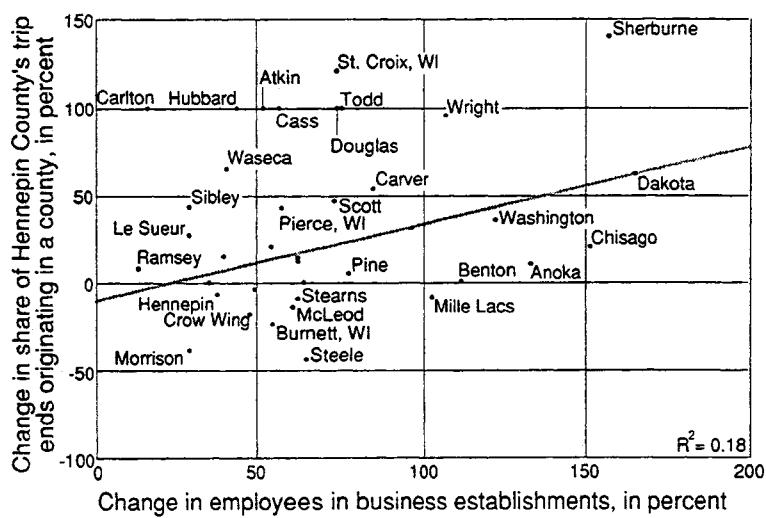


Figure 22. Change in share of Hennepin County's trip ends originating in a county by change in employees in business establishments, by county, 1970-80.

are growing at different rates while sending their mix of commuters to a steadily changing set of destinations. Meanwhile, Ramsey county, as a job destination, competes with nearby counties as a magnet for commuters. One set of counties had an increasing share of Ramsey county trip ends and also sent an expanded share of commuters to Ramsey (upper right quadrant, Fig. 23). These include fast growing counties within the Twin Cities area (Washington, Carver) as well as more remote counties offering residential amenities but with limited local job opportunities (Aitkin, Rice, Mille Lacs).

For a second set of counties (lower right quadrant) the share of Ramsey trip ends rose, but the shares from the origin counties going to Ramsey dropped (Dakota, Scott, Wright, Sherburne, Anoka). This outcome likely occurs because origin counties are growing rapidly, and therefore able to account for higher shares of Ramsey's trip ends, but at the same time they have increasing numbers of job destinations available for their commuters within or near them and increasing shares of their commuters are absorbed by those closer jobs.

A third set of counties saw their shares decline on both measures (lower left quadrant, Fig. 23). Both Hennepin and Ramsey itself are included in this set as they diverted larger shares of their commuter trips to non-Ramsey destinations. Burnett WI (Grantsburg, Siren), Polk WI(St. Croix Falls), Benton (Sauk Rapids), and Pine (Hinckley, Sandstone) are small counties with significant expanding intervening job opportunities lying between them and Ramsey.

Another view of Ramsey county's changing commuting relationships with sending counties compares change in labor force participation ratios with change in share of Ramsey's trip ends originating in a county (Fig. 24). As a county's labor force participation ratio rises -- and more workers are available, the county's share of Ramsey trip ends generally rises. It is not a high correlation, but the relation seems apparent. Changes in labor force participation ratios seem

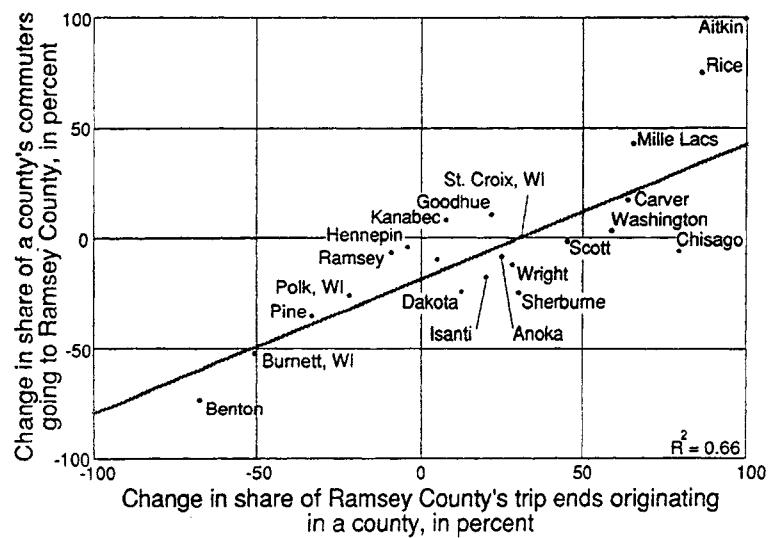


Figure 23. Change in share of a county's commuters going to Ramsey County by change in share of Ramsey County's trip ends originating in a county, 1970-80.

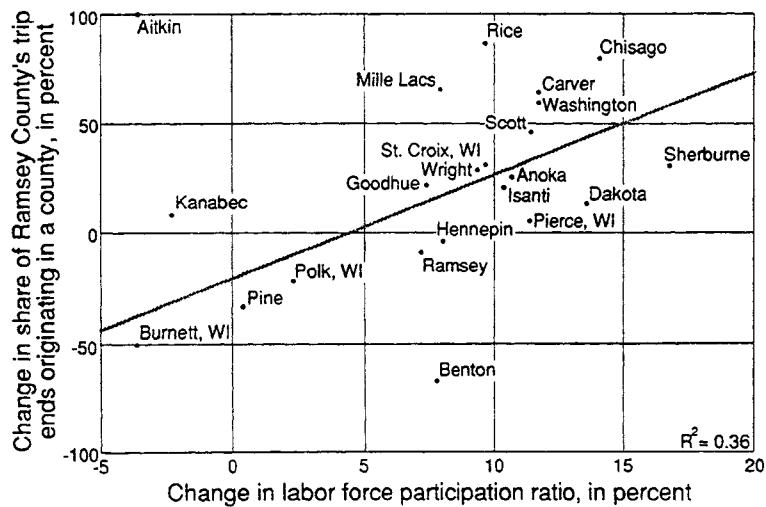


Figure 24. Change in share of Ramsey County's trip ends originating in a county by change in labor force participation, by county, 1970-80.

below average or negative mainly in counties experiencing significant outmigration of working age population, or in lake and resort counties receiving significant number of retirees.

### 5. The Evolving Twin Cities Commuting Field, 1970-1990

The geographic and demographic changes outlined above combined to produce significant changes in the commuting field surrounding Minneapolis and St. Paul. Our analysis relies on a statistically-based regionalization of inter-county commuter flows to evaluate the changes observable between 1970 and 1990.<sup>13</sup>

In 1970, the commuting field centered on the Twin Cities remained comparatively centralized, dominated by Hennepin, Ramsey, and Dakota counties (Fig. 25). Yet a number of outlying communities were already linked to the metropolitan area by this time, and the commuting patterns of Wright, Sherburne, Isanti, and Chisago counties were becoming more similar to those of the seven-county TCMA.

Ten years later, the 1980 Twin Cities commuting field defined the same way had expanded -- but at the same time that other fields in the study area have also changed (Fig 26). The result is that some counties are added to the Twin Cities field, but one is lost. On the north side, Isanti drops out, not because it no longer sent and received commuters within the Twin Cities commuting field, but because in terms of significance it had relatively less prominence as an origin than it had in 1970. Meanwhile, McLeod (Hutchinson on Highway US212) county joins the Twin Cities field on the west, LeSueur joins to the southwest, and Steele (Owatonna) is added south of Rice county on highway I35).

<sup>13</sup>For details on the statistical procedures, see Section III above, and the Appendix at the end of the report; details on the construction of the figures appears above, Section III, footnote 12.

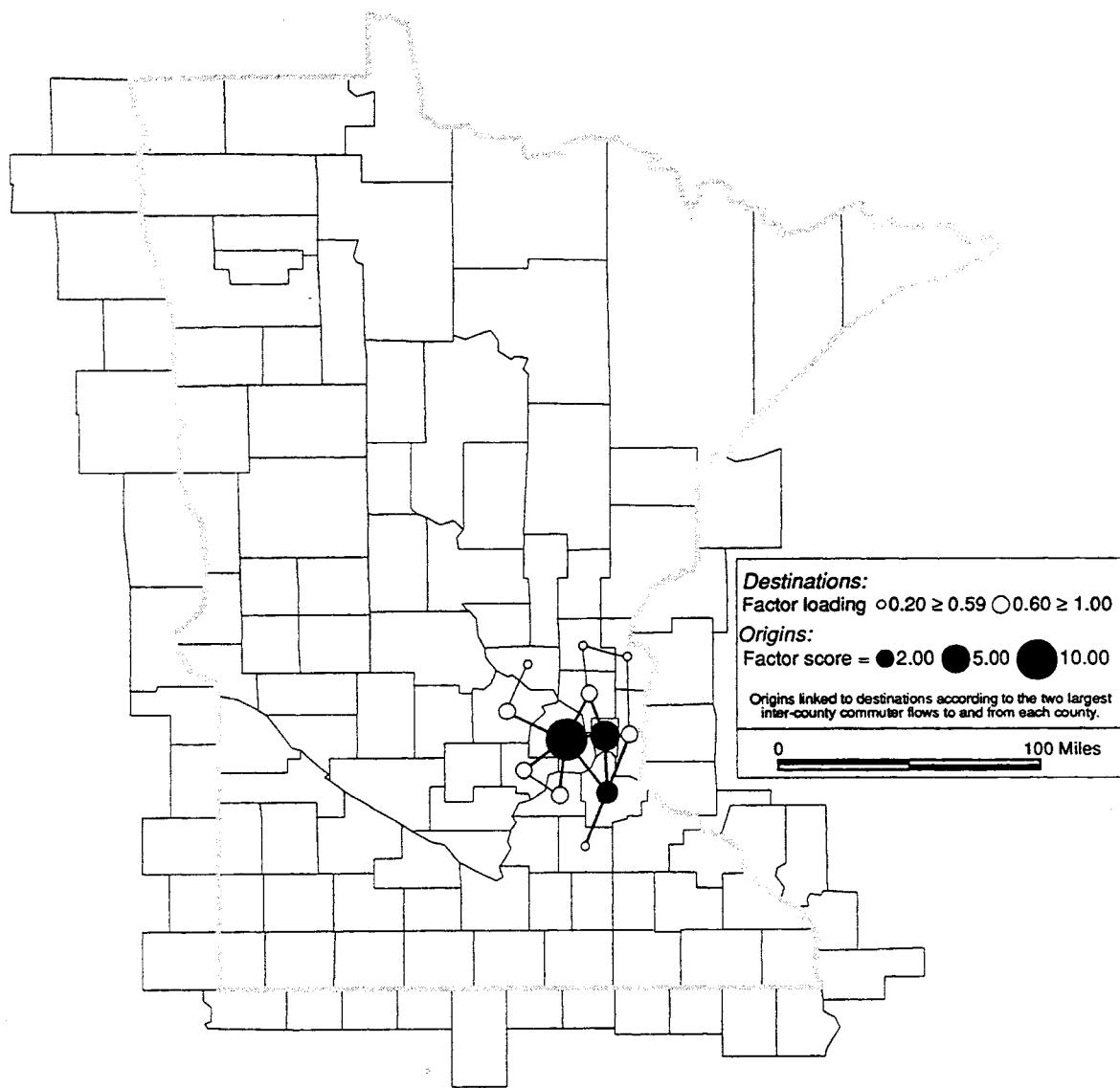
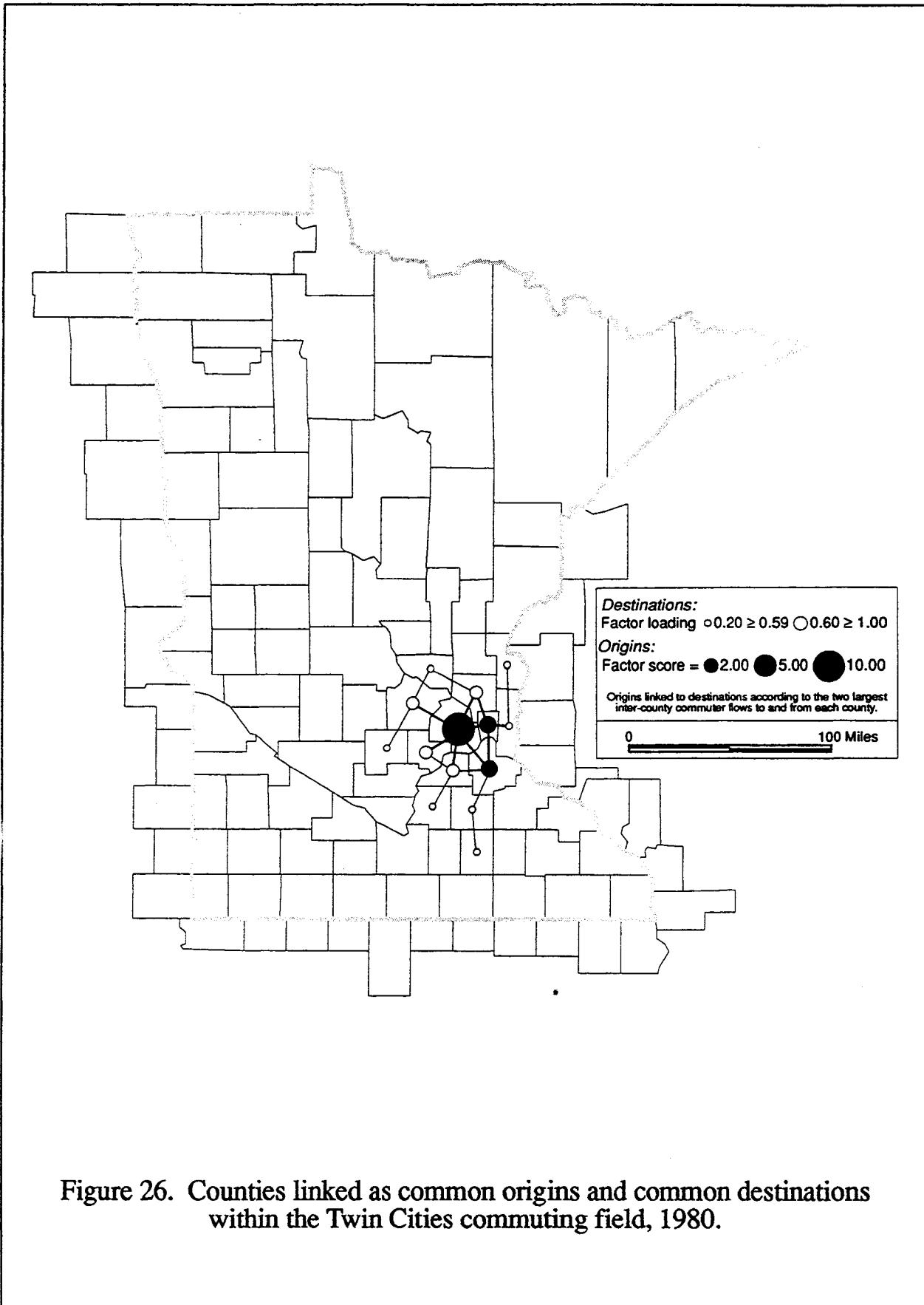


Figure 25. Counties linked as common origins and common destinations within the Twin Cities commuting field, 1970.



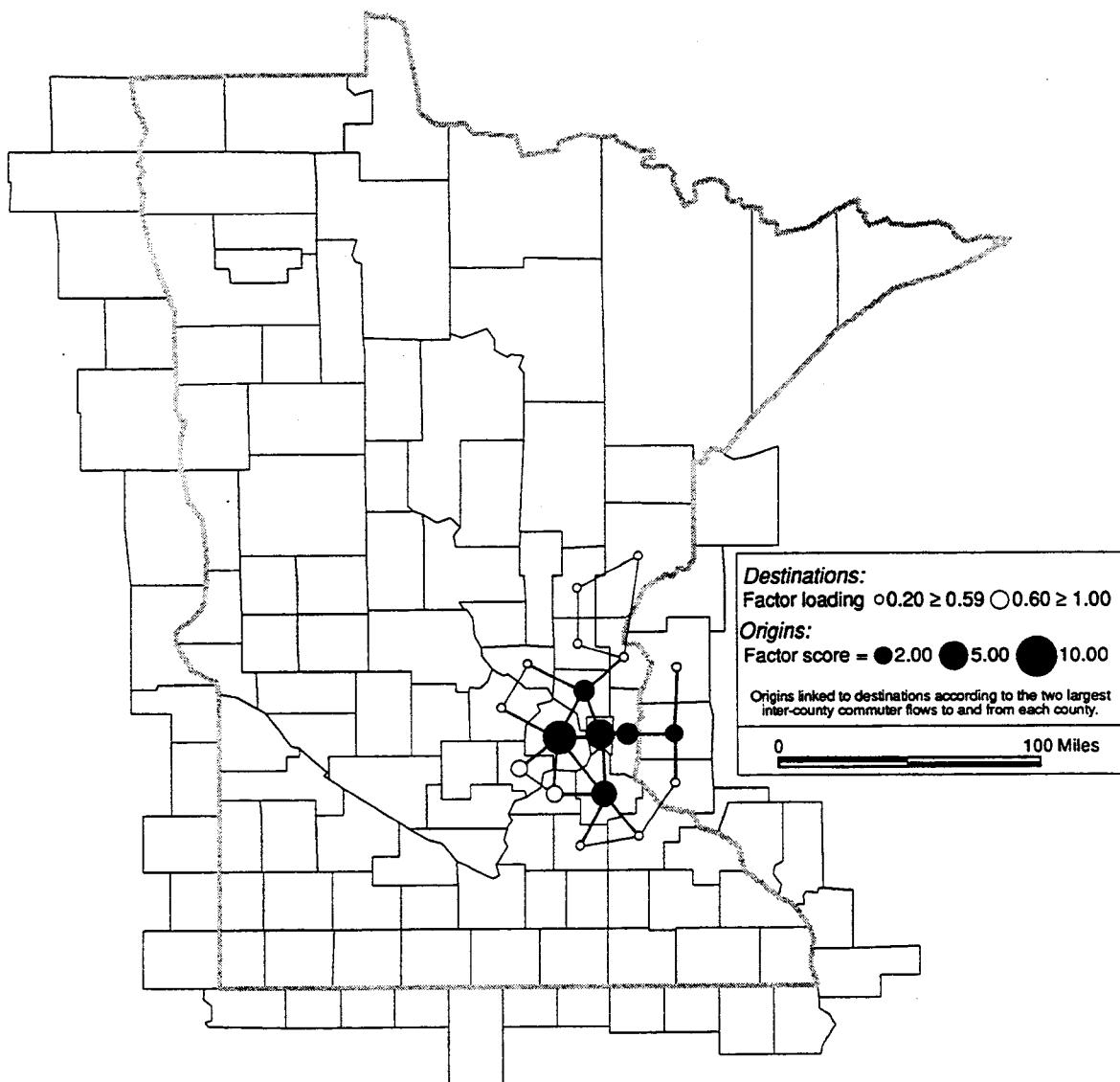


Figure 27. Counties linked as common origins and common destinations within the Twin Cities commuting field, 1990.

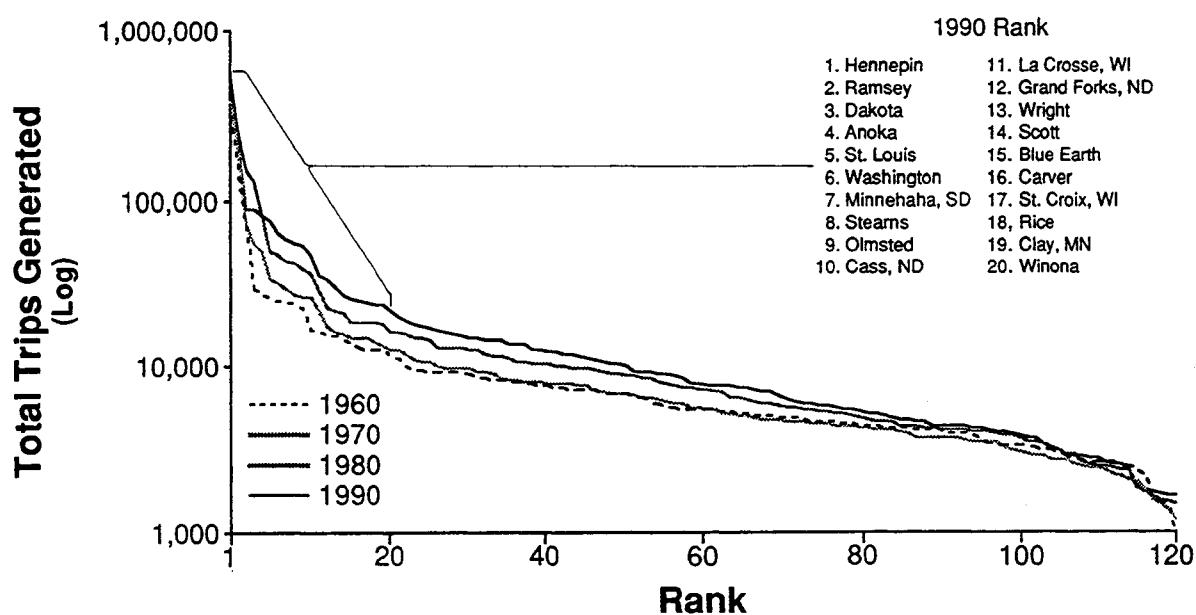


Figure 28. Counties in study area ranked by total commuting trips generated, 1960-90.

The 1990 commuting data reveal a further geographical broadening of the Twin Cities field (Fig. 27). East of the St. Croix River, St. Croix WI (Hudson), Polk (St. Croix Falls), and Pierce WI (River Falls, Prescott, Ellsworth) counties are added. Southeast of Dakota county, Goodhue (Red Wing) is added. McLeod, still sending and receiving commuters, fails to meet 1990 thresholds defined within a larger and stronger commuting field. On the northwest side of the metro area, Wright and Sherburne remain integral elements of the Twin Cities commuting field. On the north, Pine and Kanabec emerge as part of the Twin Cities field, undoubtedly a partial result of the strong Twin Cities job market and steady improvement of highway facilities north of the Twin Cities in the 1970s and 1980s.

In the decades since 1960 the same counties have consistently generated the most commuting trips, dominating the state's settlement system in terms of the movement of goods, information, and people. In relative terms, however, the hierarchy has realigned itself as Hennepin County's position atop the hierarchy has eroded slightly (Fig. 28). Reflecting the decentralization of economic activity outward from metropolitan cores, commuter flows have diffused down the county hierarchy.

#### B. CHANGES IN THE DULUTH-SUPERIOR COMMUTING FIELD, 1970-1990

The Duluth-Superior metro area is the largest urban agglomeration in northeastern Minnesota, and Duluth in St. Louis county is the largest city in the region. Five counties contributed .5 percent or more of St. Louis county's trip ends in 1990 (Fig. 29). They were St. Louis itself (Duluth, Hibbing, Virginia, Mesabi Range towns), Lake (Two Harbor, Silver Bay), Itasca (Grand Rapids), Carlton (Cloquet), and Douglas WI (Superior). These are the origins that are most important to St. Louis county.

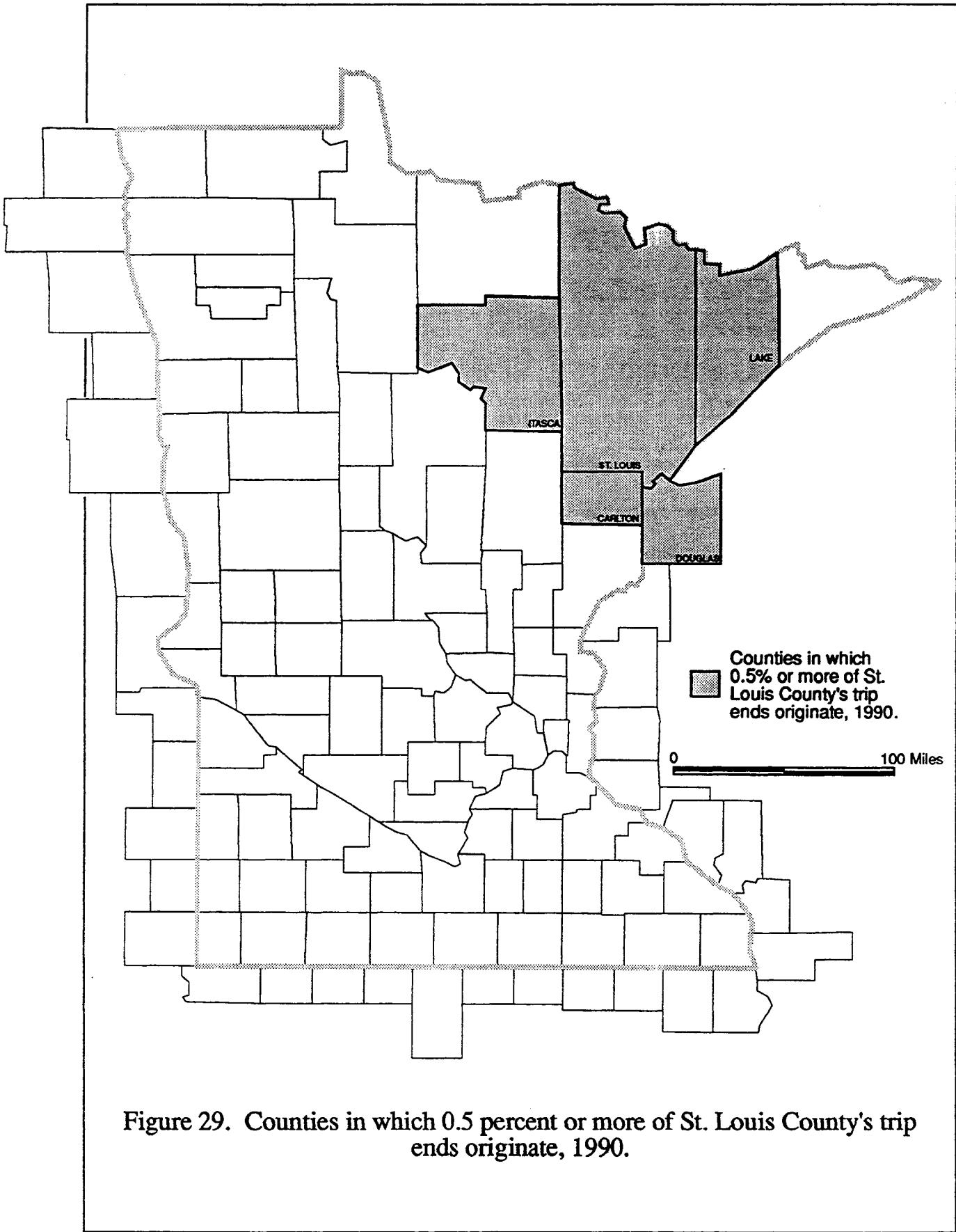


Figure 29. Counties in which 0.5 percent or more of St. Louis County's trip ends originate, 1990.

From the viewpoint of the sending counties, we identify these five counties plus two others that sent one percent or more of their commuters to St. Louis county in 1990 -- Cook county (Grand Marais, Lutsen) in the Arrowhead region, and Pine county on highway I35 south of Duluth (Fig. 30). This commuting area spans a large and sparsely populated territory. The distance from western Itasca county to the eastern end of Cook county is more than 200 miles; north-south distances are similar.

The change in share of St. Louis county trip ends originating in a county and the change in a county's commuters going to St. Louis county are almost perfectly correlated for the period 1970-80 (Fig. 31). This outcome is almost certainly due to the fact that the Duluth-Iron Range cities are the most significant employment nodes in the entire region. When employment opportunities in St. Louis county rise relative to local opportunities, counties sending commuters to St. Louis county send a larger share of their workers to St. Louis county (Pine, Hubbard (Park Rapids), Carlton). But when the St. Louis county economy stagnates, or local job opportunities improve relative to those in St. Louis county, then workers commute shorter distances and both measures decline (Cook, Koochiching, Lake).

Another source of change in commuting within the St. Louis county commuting area is the change in a county's occupied housing units, which is moderately correlated with the share of St. Louis county trip ends originating in a county (Fig. 32). In other words, as the number of occupied housing units in a county rises, the county on the average accounts for a greater share of St. Louis county trip ends, 1970-80. Places not conforming well to this generalization are Cook and Pine.

Cook, along the North Shore in the Arrowhead region, presumably had an increasing number of local jobs for people in its additional occupied housing units, making it less urgent for local workers to commute to St. Louis county, or else a substantial fraction of the additional occupied units were built to accommodate retirees and others not in the labor force. Pine county

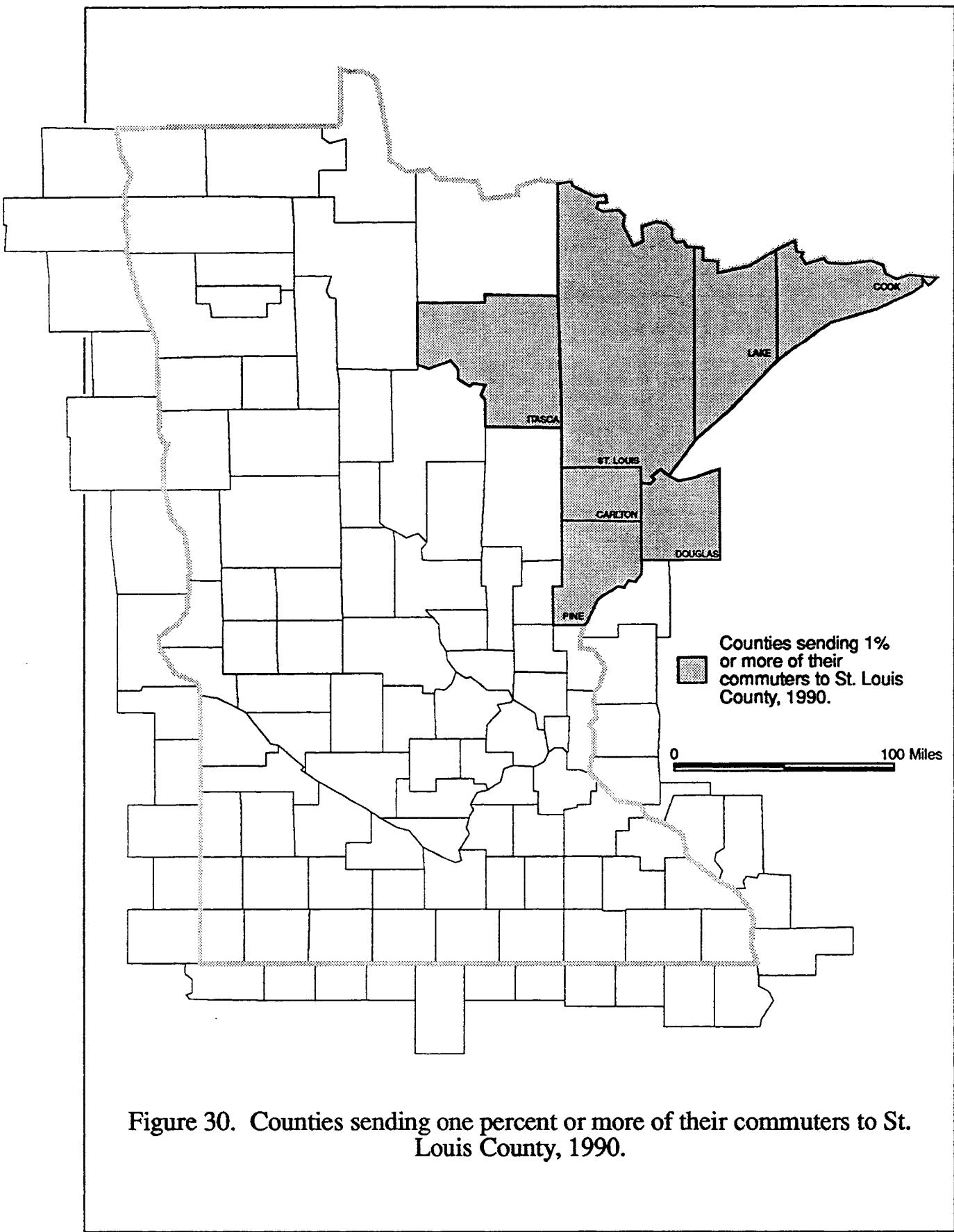


Figure 30. Counties sending one percent or more of their commuters to St. Louis County, 1990.

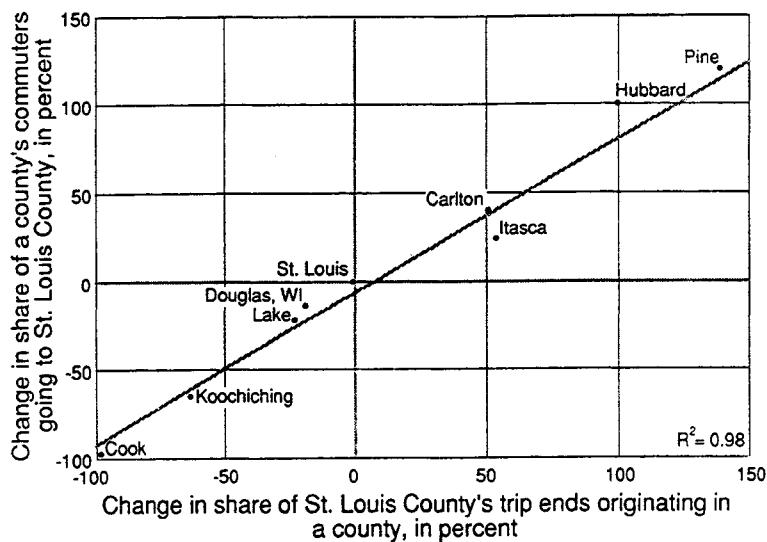


Figure 31. Change in share of a county's commuters going to St. Louis County by change in share of St. Louis County's trip ends originating in a county, 1970-80.

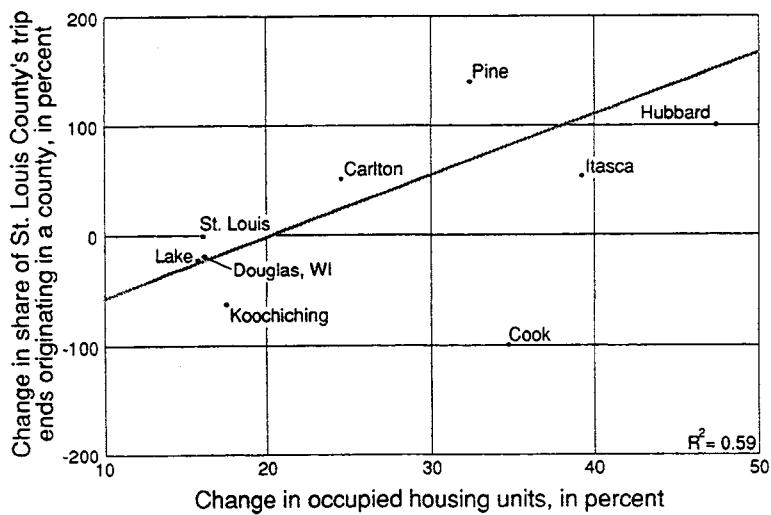


Figure 32. Change in share of St. Louis County's trip ends originating in a county by change in occupied housing units, by county, 1970-80.

south of Duluth on highway I35 had a significant number of additional occupied housing units but evidently lacked a corresponding expansion of local job opportunities, so commuting to St. Louis county increased disproportionately.

In 1970, the eight counties of northeastern Minnesota were knit together into a commuting field centered on St. Louis (Duluth) county. The method of factor analysis identified the most prominent origins and destinations in the commuting field (Fig. 33).

(1) St. Louis county is the most prominent origin. (2) St. Louis, along with seven other nearby counties, are the important destinations in the St. Louis county-centered commuting area. (3) Each of the origins is linked with its two most important destinations. (4) Then, each destination is linked with the two most important origins sending commuters to it. If a county had already been linked in the previous step, no additional linkage is noted in this step. Finally (5), heavy lines are used to link the important origin with the important destinations. The result is a graph that portrays the main linkages in the Duluth-St. Louis county commuting field. All the outlying counties have strong ties with St. Louis county, and in a few cases (Cook-Lake; Koochiching-Itasca; Itasca-Aitkin) the counties have significant links with one another.

The 1980 map reveals a few changes (Fig. 34). Cook in the far northeast, and Aitkin on the southwest dropped out of the network, and the link between Carlton, immediately southwest of Duluth, and Douglas WI (Superior) shows up as relatively more important in 1980 than in 1970.

In the 1990 map of the Duluth-St. Louis county commuting field, the only major difference from 1980 is that Pine county drops out (Fig. 35). As the Twin Cities economy has strengthened compared with the Northeastern Minnesota economy centered on Duluth-Superior and the Iron Range towns of St. Louis county, Pine county has apparently become less northeast oriented and

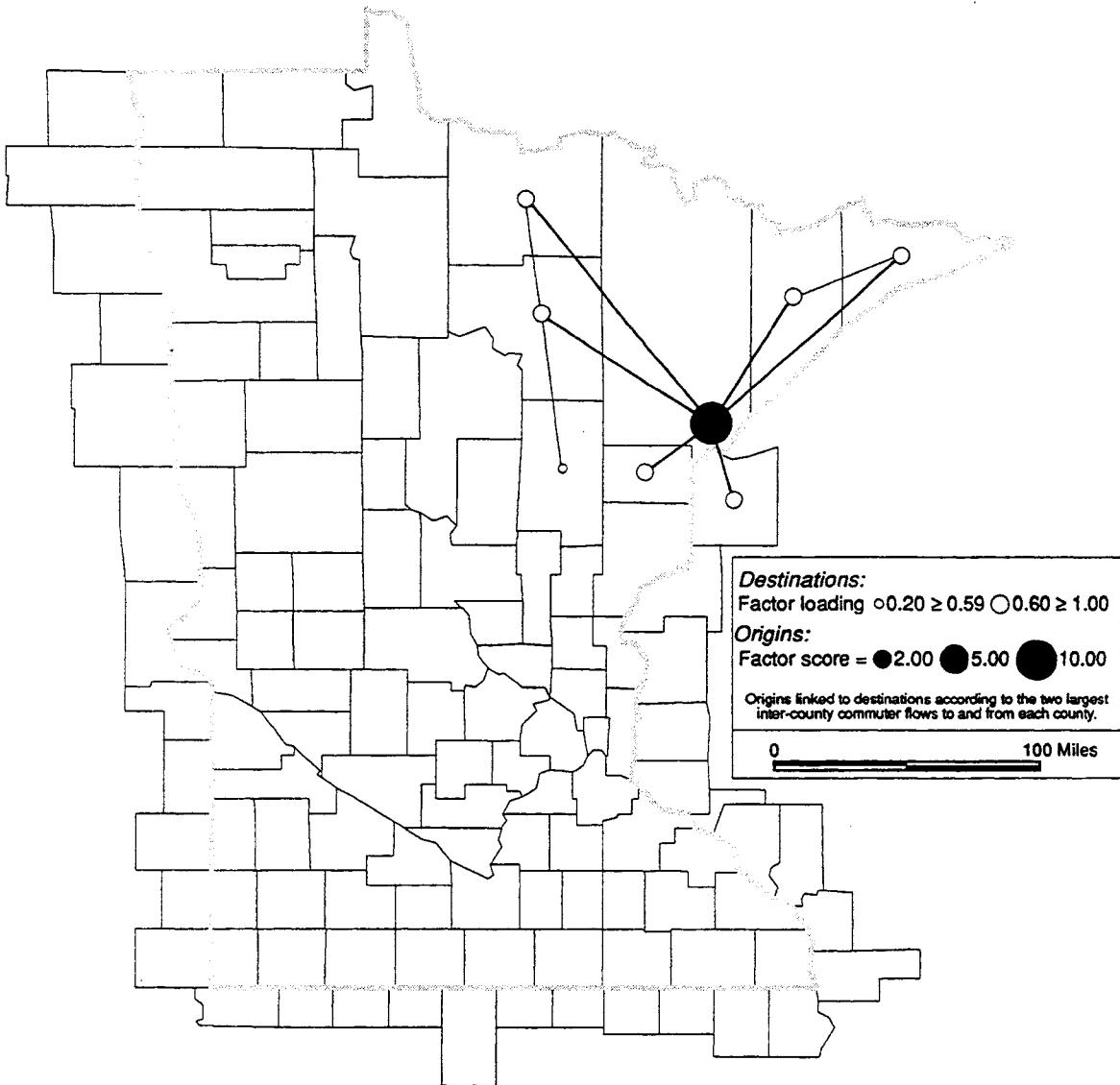


Figure 33. Counties linked as common origins and common destinations within the Duluth commuting field, 1970.

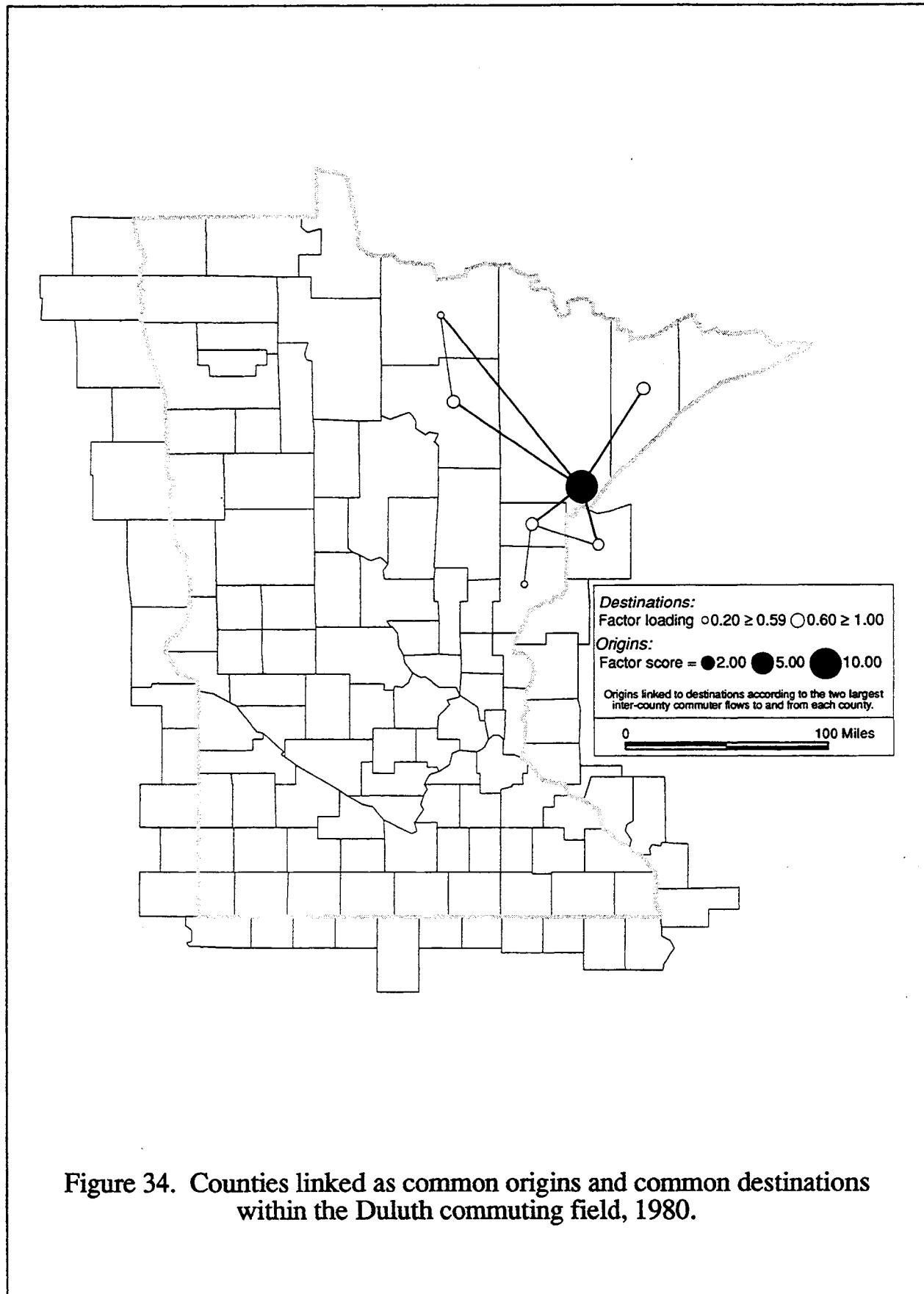


Figure 34. Counties linked as common origins and common destinations within the Duluth commuting field, 1980.

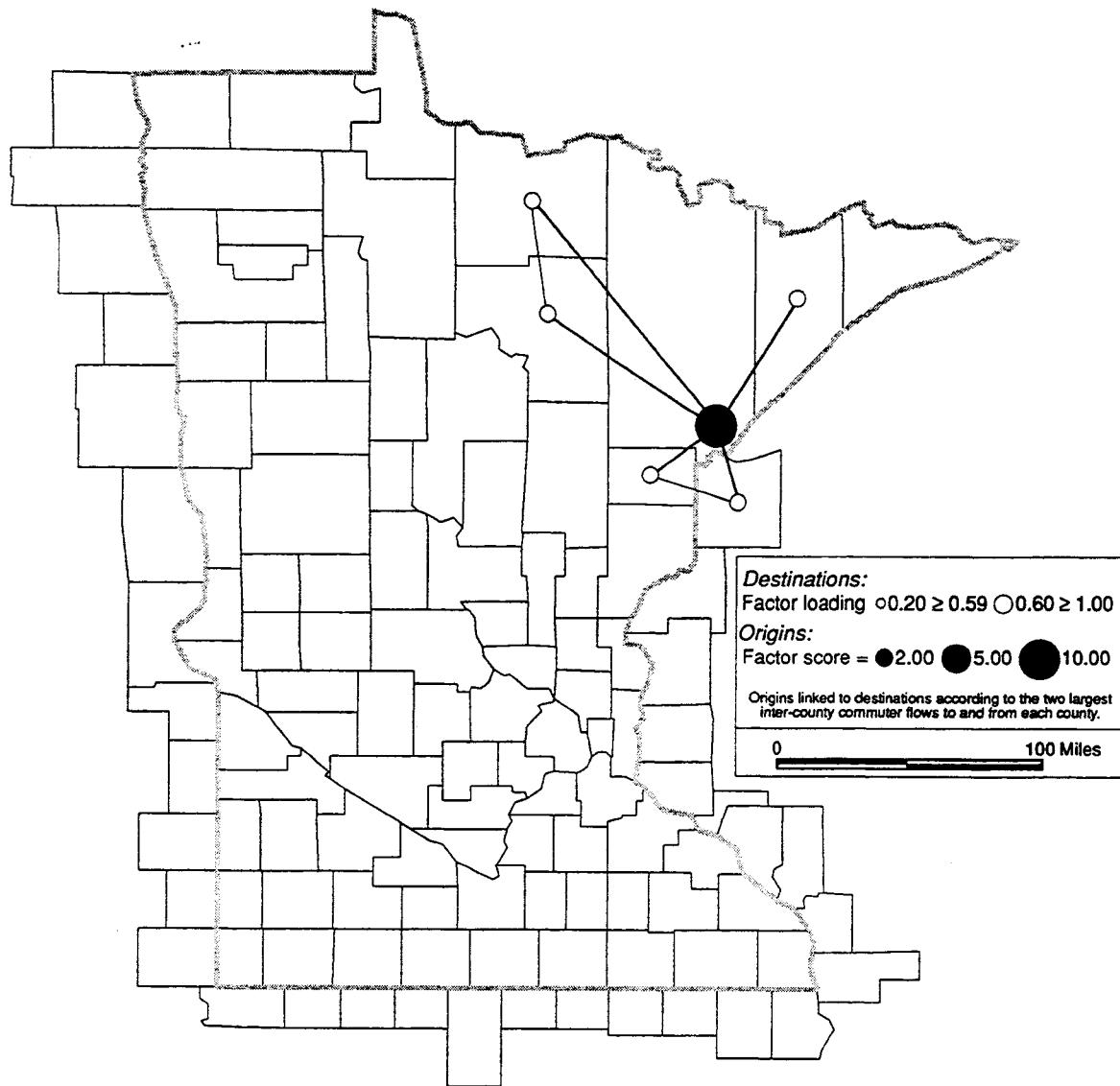


Figure 35. Counties linked as common origins and common destinations within the Duluth commuting field, 1990.

more tightly linked with the economy of the Twin Cities. The restructuring of the Duluth and the Twin Cities commuting fields are consistent with this reorientation.

### C. CHANGES IN THE ST. CLOUD COMMUTING FIELD, 1970-1990

In 1990, Stearns (St. Cloud) county dominated a nine-county commuting area north and west of Hennepin (Fig. 36). Counties that contributed .5 percent or more of Stearns county's 1990 trip ends included Hennepin on the southeastern edge; Wright (Buffalo), Meeker (Litchfield), and Kandiyohi (Willmar) to the south; Stearns; and Todd (Long Prairie), Morrison (Little Falls), Benton (Sauk Rapids), and Sherburne (Elk River) on the north and east. Highways US10, I94, and US12 provide convenient commuting routes northwest-southeast within the region. Additional routes connect outlying areas directly with Stearns county and St. Cloud.

The map of counties sending one percent or more of their commuters to Stearns county (Fig. 37) displays essentially the same pattern as the previous map (Fig. 36) with three exceptions. On the southeast edge, Hennepin drops out because although Hennepin is important to Stearns as a source for trip ends, Stearns in relative terms is unimportant to Hennepin as an employment destination for Hennepin commuters.

A second difference is on the west end of the commuting area, where Douglas (Alexandria) and Pope counties send one percent or more of their commuters to Stearns. Finally, Mille Lacs on the northeast edge of the commuting area also sends one percent or more to Stearns county.

The change between 1970 and 1980 in share of Stearns county trip ends originating in a county, and the change in share of a county's commuters going to Stearns county are almost perfectly correlated (Fig. 38). During the decade, the most dramatic increase on both measures was for Mille Lacs county. At the other extreme, Douglas and Meeker experienced sharp declines.

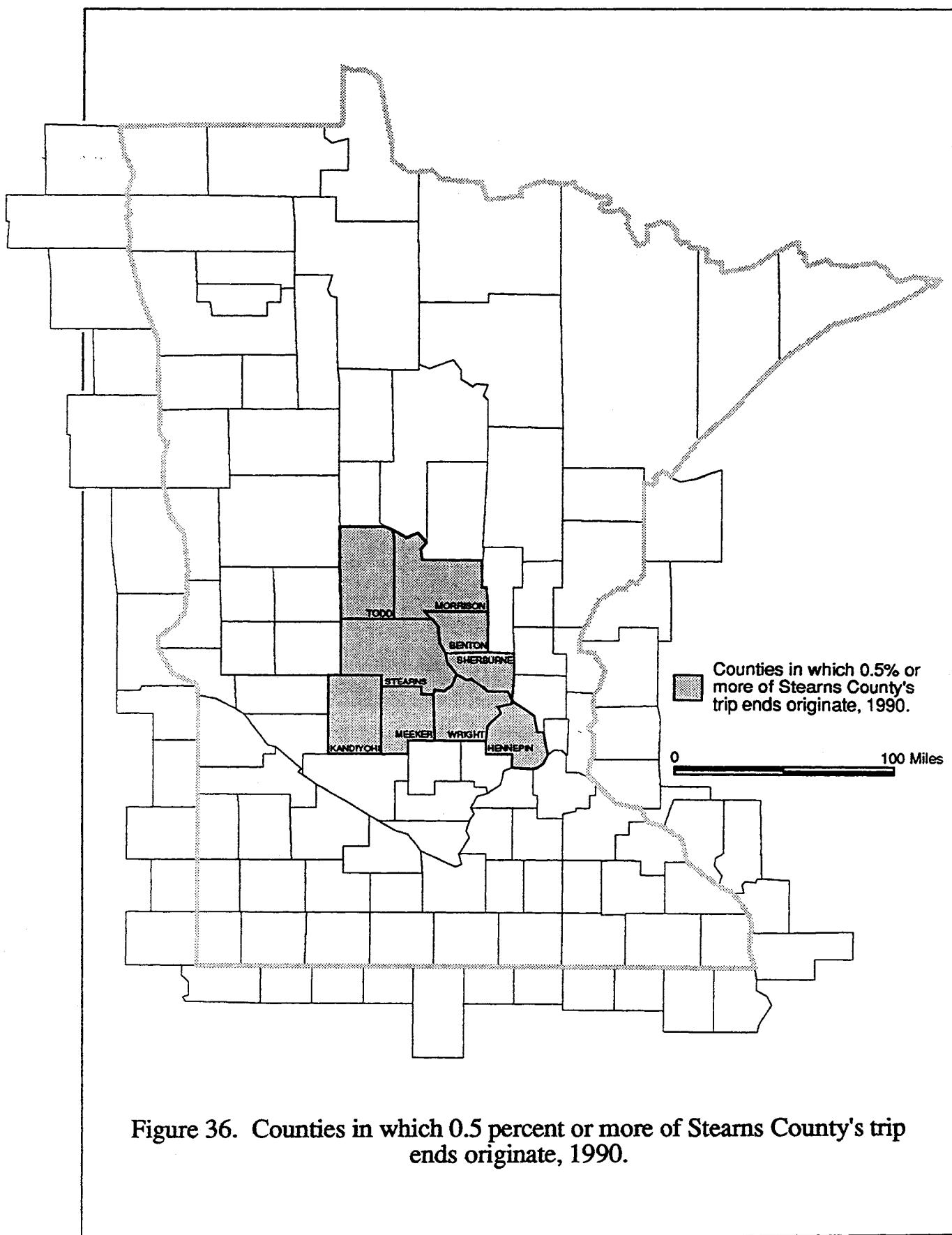


Figure 36. Counties in which 0.5 percent or more of Stearns County's trip ends originate, 1990.

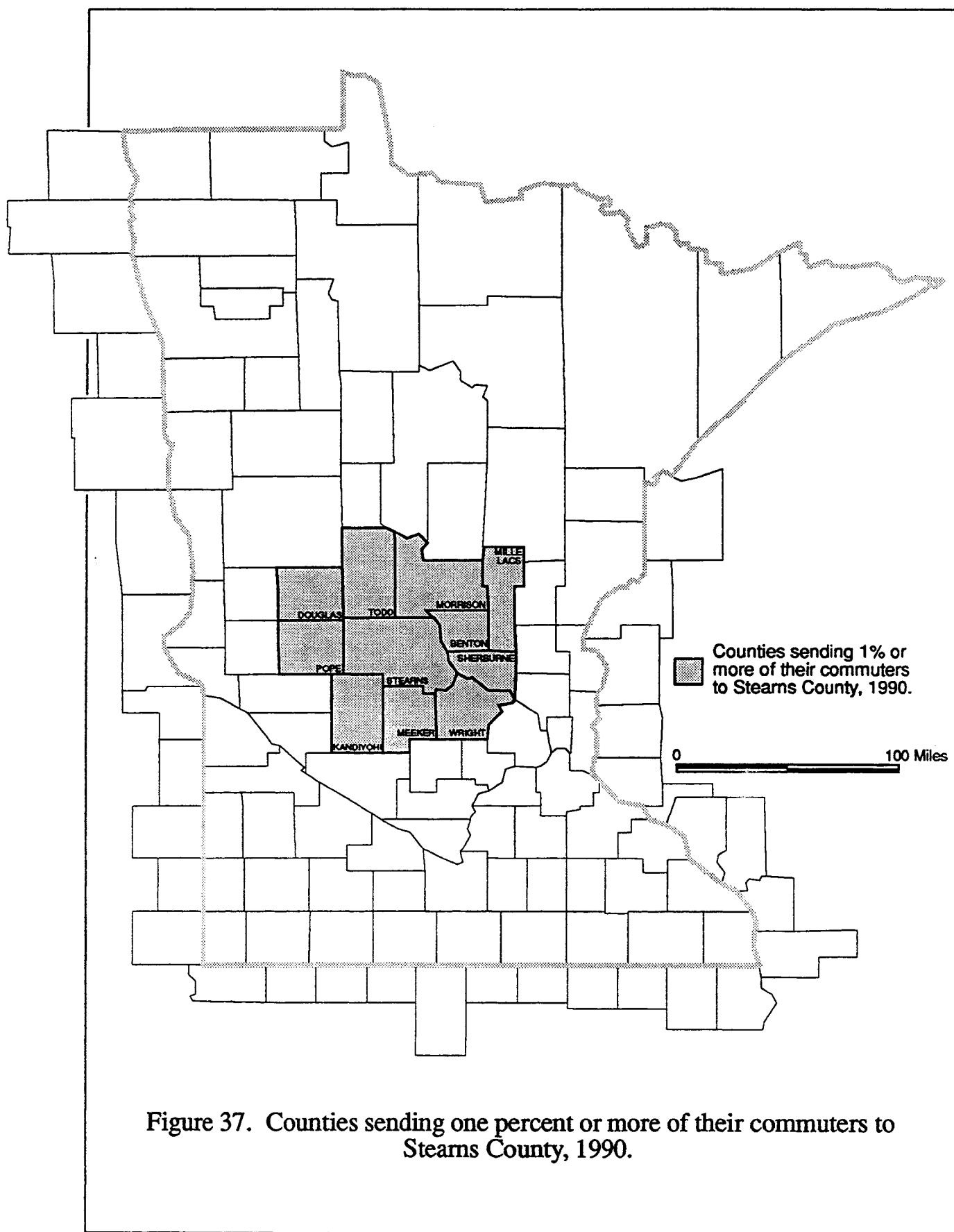


Figure 37. Counties sending one percent or more of their commuters to Stearns County, 1990.

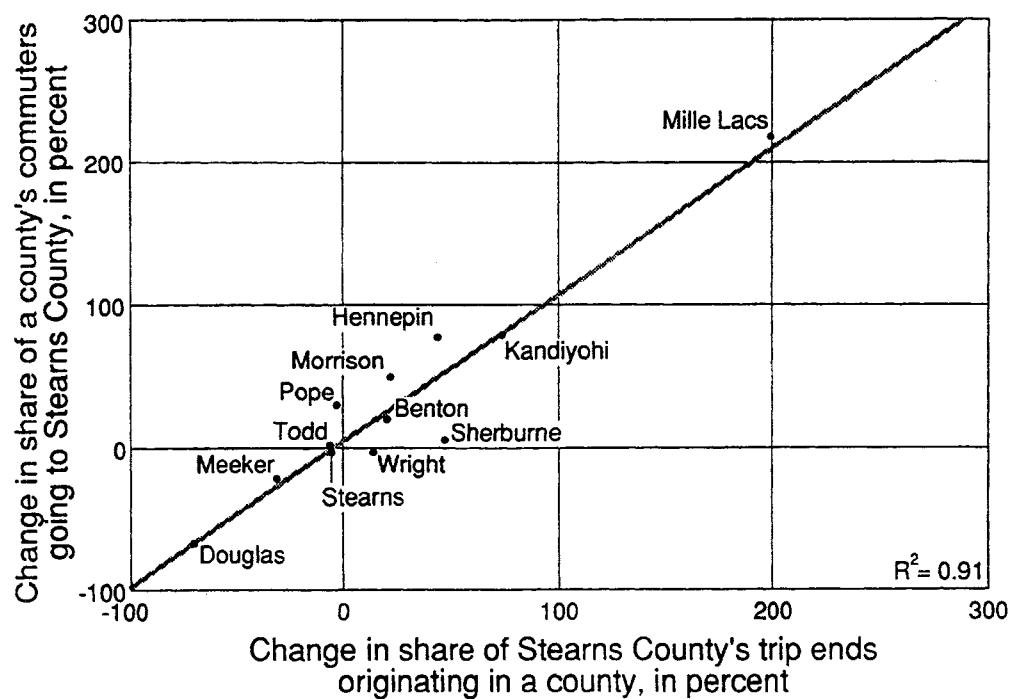


Figure 38. Change in share of a county's commuters going to Stearns County by change in share of Stearns County trip ends originating in a county, 1970-80.

Douglas county is as close to the Fargo-Moorhead area as it is to St. Cloud, and some of its decline may be traceable to a reorienting of commuting toward Fargo. Commuters in Meeker county are as close to the Twin Cities western suburbs using highway US12 as they are to St. Cloud on highway MN15, and there are many more job opportunities for Meeker county commuters in the Twin Cities than there are in the St. Cloud area.

A comparison of change in total commuters by county with change in share of Stearns county's trip ends originating in a county displays no correlation, but it does reveal facts accounting for changes in the St. Cloud commuting field in the 1970s (Fig. 39). For one thing, changes in the linkage between Stearns and the counties of Douglas, Meeker, Kandiyohi, and Mille Lacs cannot be traced to change in the total number of commuters from these counties since they are similar on this measure. Furthermore, Hennepin, Morrison, Benton, Sherburne, and several others accounted for similar increases in shares of Stearns county trip ends in 1980 than in 1970, but they had widely varied increases in total commuters.

Change in occupied housing units in a county is contrasted with change in share of Stearns county trip ends originating in a county to determine whether the two measures are correlated (Fig. 40). If they were, the correlation would suggest that differential county growth in the St. Cloud area commuting field, as reported by changes in occupied housing, might account for changes in Stearns county trip ends. Unfortunately, like Fig. 39, there is no correlation. In fact, the array of observations in Fig. 40 closely resembles that of Fig. 39.

The patterns in both figures have to do with (1) the varying sizes of alternative employment centers; (2) the changing ease of highway commuting as roads improved in the 1970s; and (3) varying rates of expansion of metropolitan economies competing for workers. In this competition, the Twin Cities had the major locational advantage right up to the back doors of competing centers

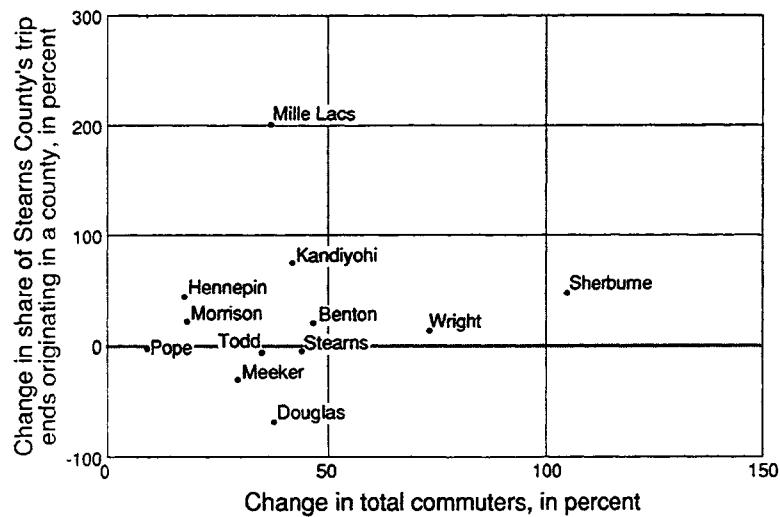


Figure 39. Change in share of Stearns County's trip ends originating in a county by change in total commuters, by county, 1970-80.

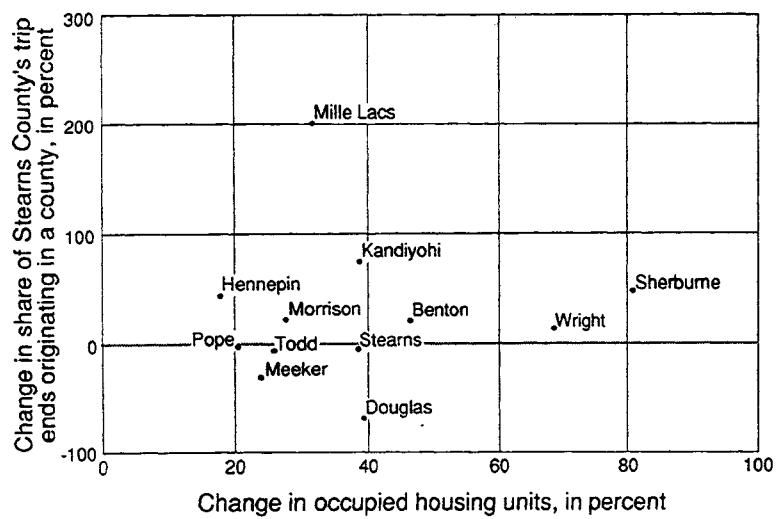


Figure 40. Change in share of Stearns County's trip ends originating in a county by change in occupied housing units, by county, 1970-80.

-- Duluth, St. Cloud, Mankato, Rochester. But on the far sides of these lower-order competitors, the competitor had the advantage over the Twin Cities.

Major origins within the 1970 St. Cloud commuting field were Stearns, Todd, Benton, and Sherburne counties (solid circles, Fig. 41). Important destinations (besides the four origins, which are also destinations) are Douglas and Pope on the west; Morrison and Mille Lacs on the north and northeast; and Wright, Meeker, and Kandiyohi on the south (open circles, Fig 41).

During the 1970s, a major reconfiguration of the St. Cloud commuting field occurred (Fig. 42). This reorganization occurred as Minnesota's other commuting fields were themselves undergoing elaboration and reorientation. In the procedures we used, all the commuting fields are defined simultaneously.

Prominent origins in the 1980 St. Cloud-based commuting field are Stearns, Kandiyohi (Willmar) to the southwest, Chippewa (Montivideo) southwest of Kandiyohi, Yellow Medicine (Granite Falls) southwest of Chippewa to the Minnesota border, Renville (Olivia, Bird Island), and McLeod (Hutchinson) (Fig. 42). The St. Cloud commuting field in 1980 seemed to dominate counties north of Mankato, northwest of the Twin Cities, and southwest of Stearns. By 1990, the St. Cloud commuting field had resumed a reasonably compact shape but had extended its influence over an area wider than that of 1970 (Fig. 43).

The major origins in the 1990 St. Cloud commuting field were Stearns and Sherburne, followed by Benton, Wright, and Hennepin. Origins tied into the St. Cloud field lay northeast as far as Pine, Kanabec and Isanti; northwest to Douglas (Alexandria); and south to Renville, and McLeod (Fig. 43). Compared with 1970, the St. Cloud commuting field in 1990 was larger, stronger, spatially more extensive, and increasingly overlapping the Twin Cities field.

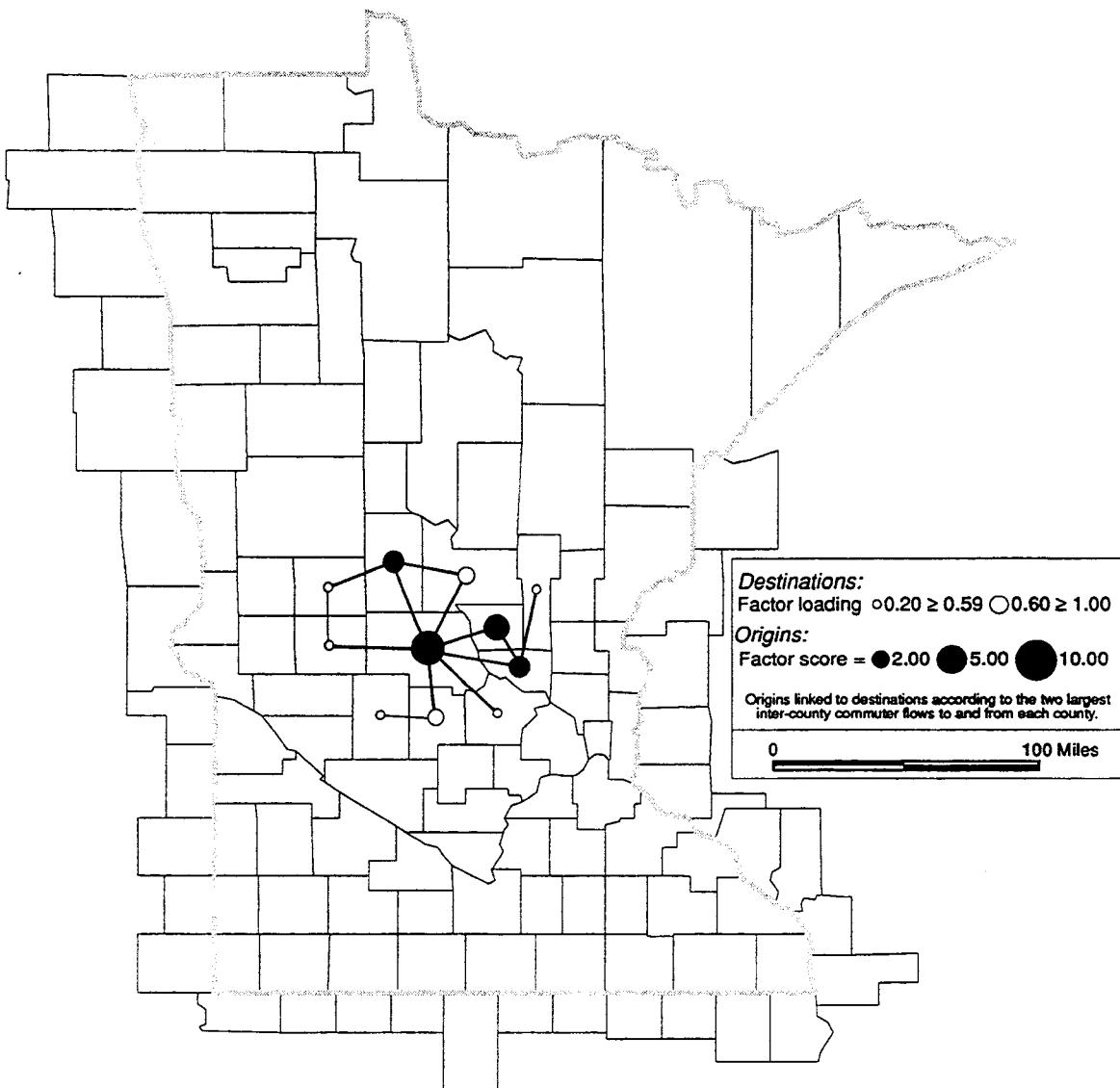


Figure 41. Counties linked as common origins and destinations within the St. Cloud commuting field, 1970.

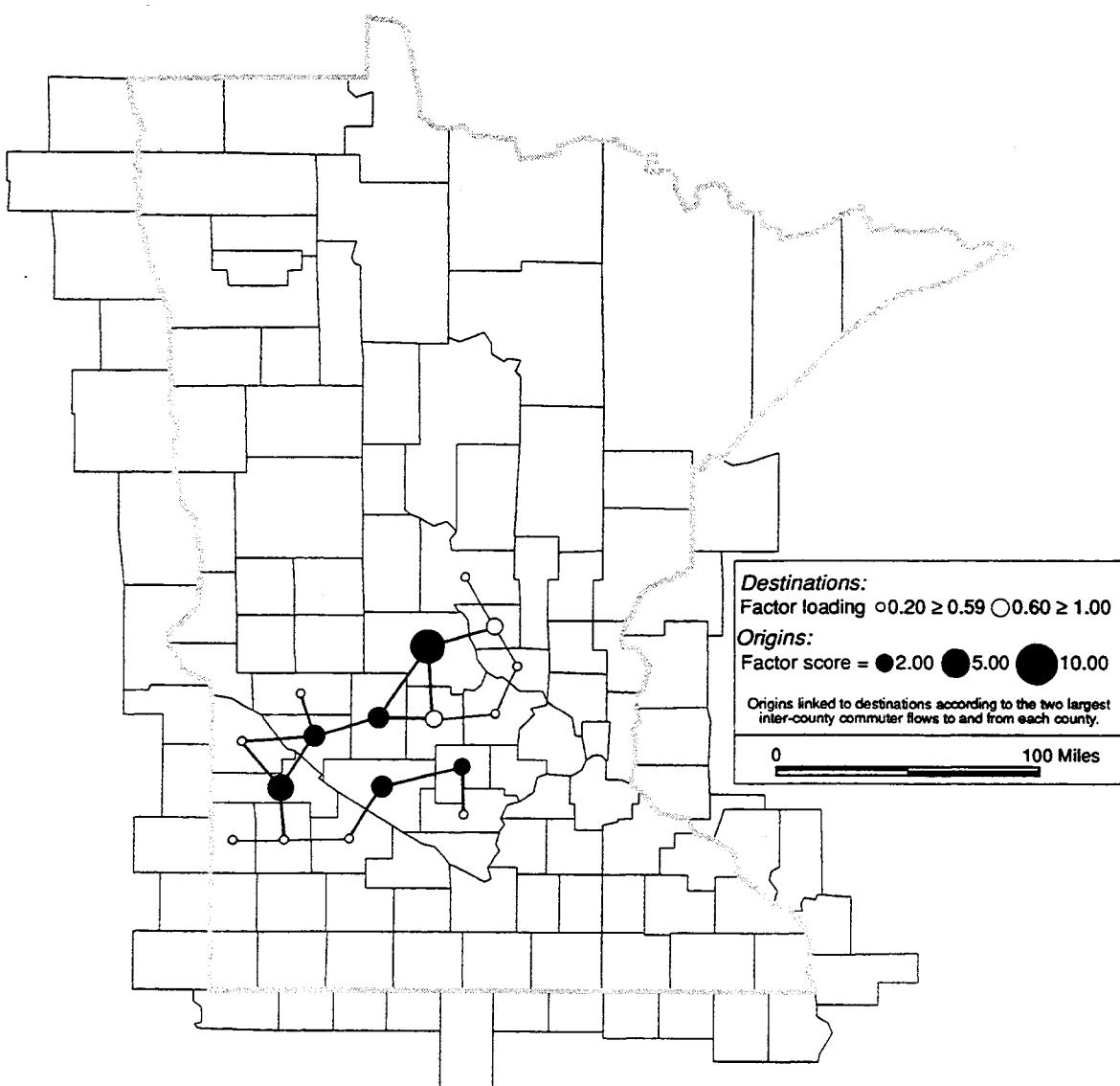


Figure 42. Counties linked as common origins and destinations within the St. Cloud commuting field, 1980.

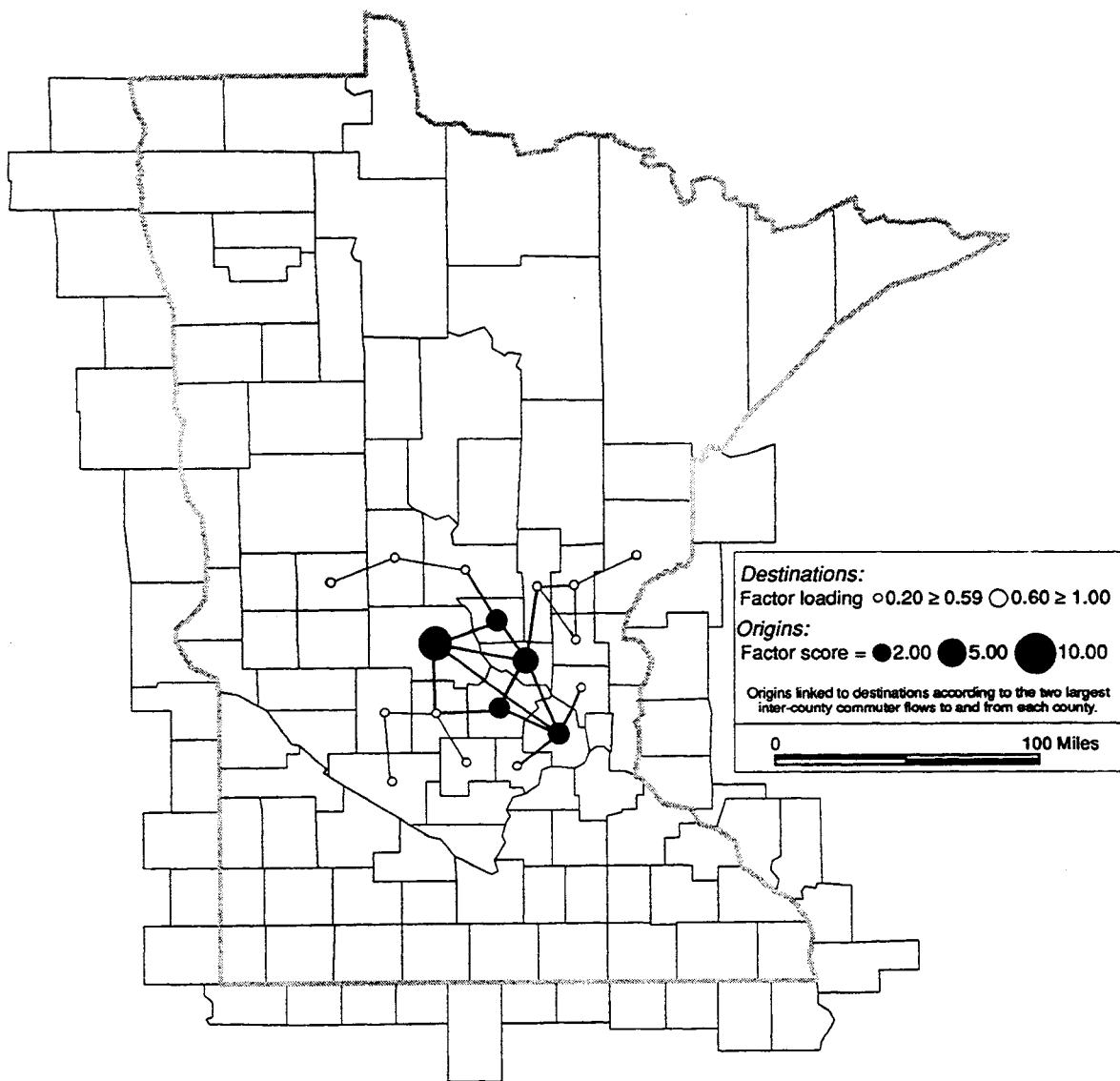


Figure 43. Counties linked as common origins and common destinations within the St. Cloud commuting field, 1990.

#### D. CHANGES IN THE ROCHESTER COMMUTING FIELD, 1970-1990

In 1990, the Rochester and Olmsted county commuting field dominated the southeastern corner of Minnesota (Fig. 44). Counties in which .5 percent or more of Olmsted county's trip ends originated included Olmsted itself and the ring of six counties contiguous to Olmsted -- Winona, Fillmore (Preston), Mower (Austin), Dodge, Goodhue (Red Wing), and Wabasha.

Counties sending one percent or more of their commuters to Olmsted county in 1990 were the same seven, plus Steele (Owatonna) west of Dodge and Olmsted counties on US14, and Howard county just across the Iowa border south of Rochester on highway US63 (Fig. 45).

Within the Rochester commuting field during the 1970s, the change in share of Olmsted county trip ends originating in a county and the change in share of a county's commuters going to Olmsted county are closely correlated (Fig. 46). Rochester and Olmsted county were the dominant job center in the southeastern corner of Minnesota in the 1970s, and as employment levels in the county rose the links with counties in its commuter field intensified.

The change in number of occupied housing units in the 1970s was modestly correlated with the change in share of Olmsted county's trip ends originating in a county (Fig 47). Olmsted county itself was the outlier in this comparison. Although the county had a healthy increase in occupied housing units, its share of trip ends to itself declined slightly, but that was undoubtedly due to the fact that much of the growth of the Rochester area job market was being taken up by commuters from the other counties. Olmsted had trouble maintaining its share, despite the fact of significant absolute growth in population and housing during the decade.,

The commuting field centered on Rochester formed a sharply focused network when 1970 origins and destinations are connected (Fig. 48). Ten counties are significant origins in 1970 (solid

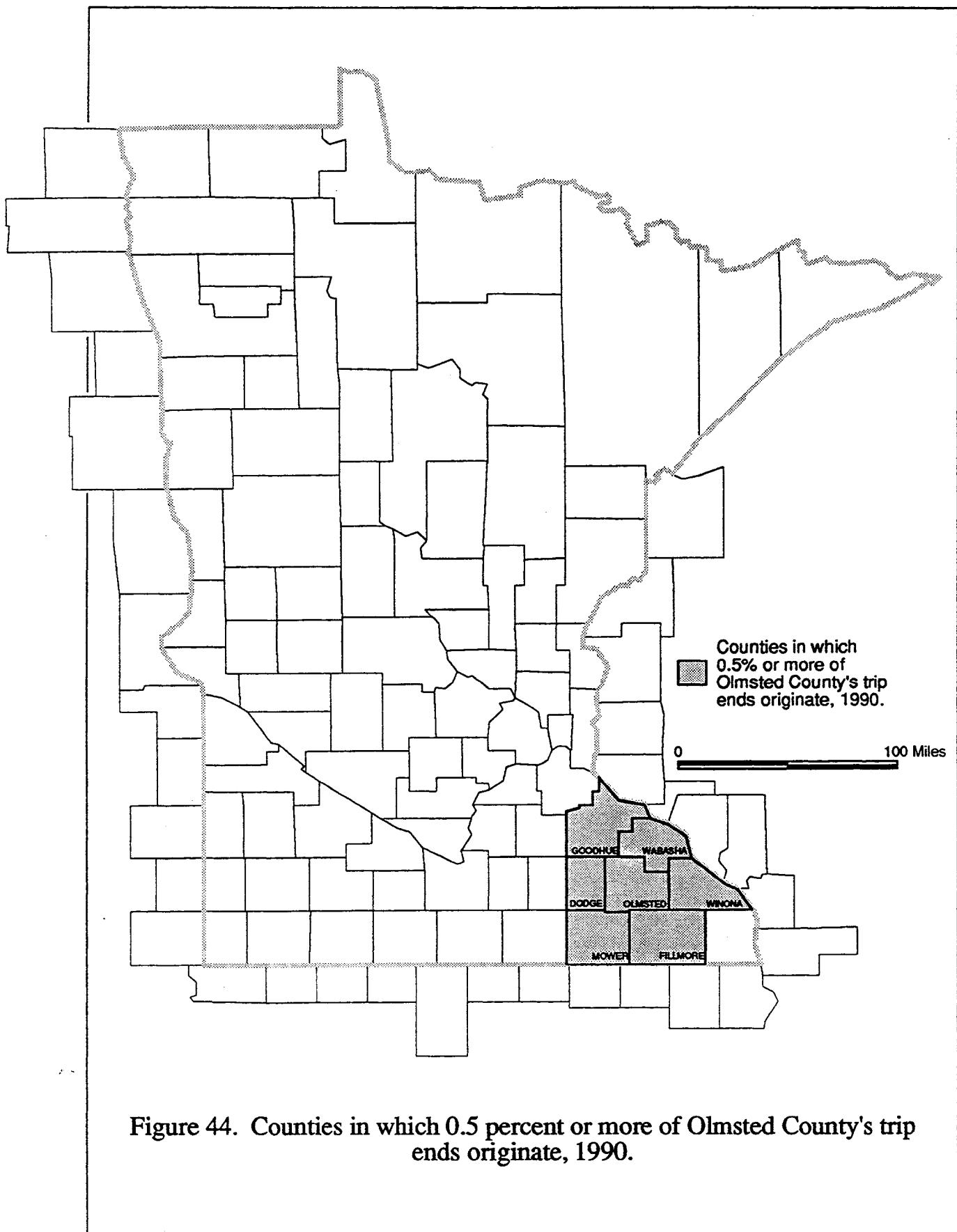


Figure 44. Counties in which 0.5 percent or more of Olmsted County's trip ends originate, 1990.

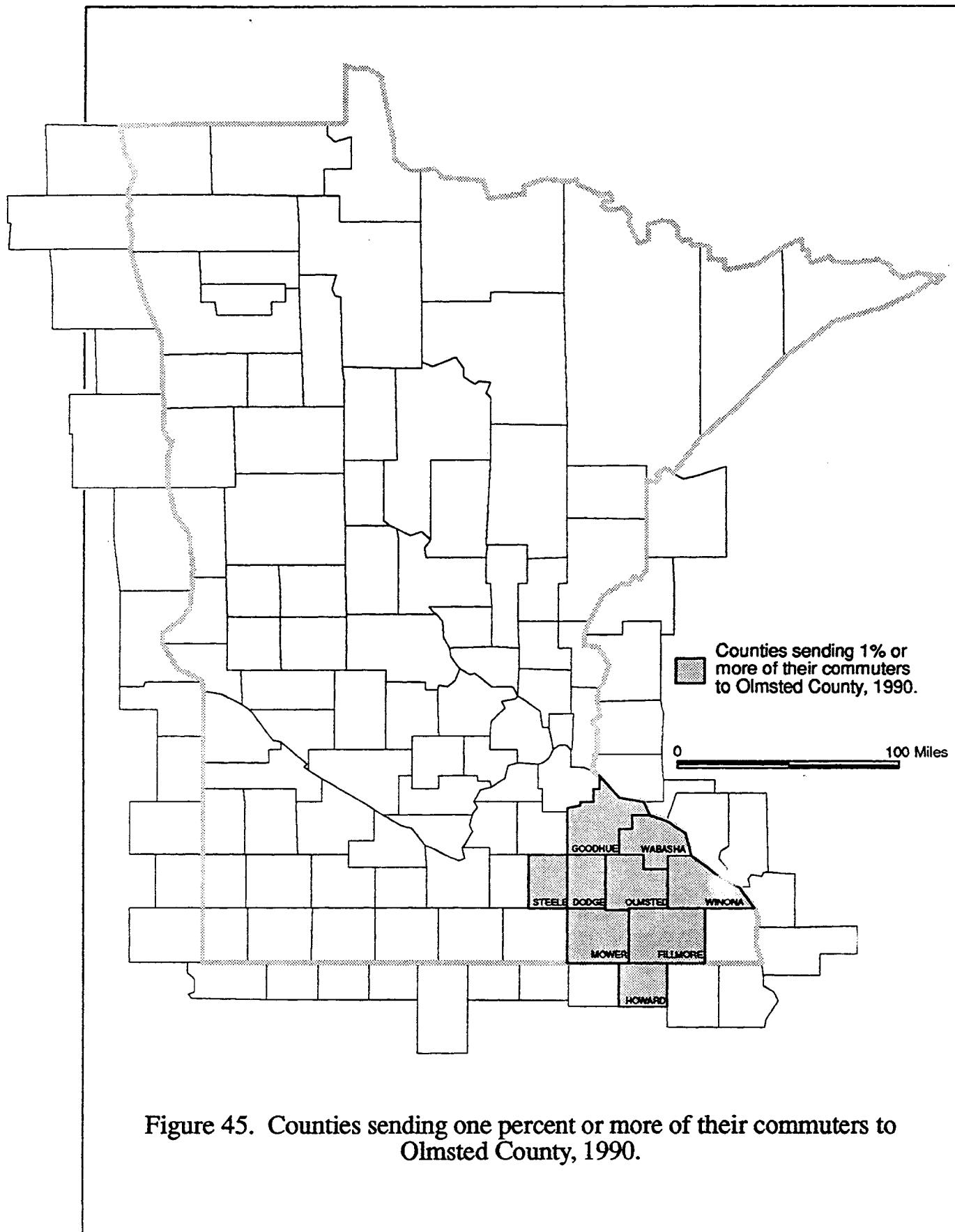


Figure 45. Counties sending one percent or more of their commuters to Olmsted County, 1990.

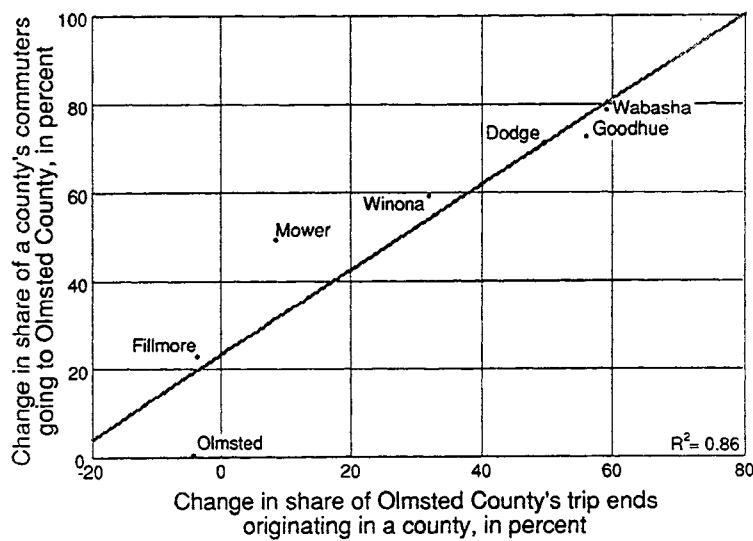


Figure 46. Change in share of a county's commuters going to Olmsted County by change in share of Olmsted County's trip ends originating in a county, 1970-1980.

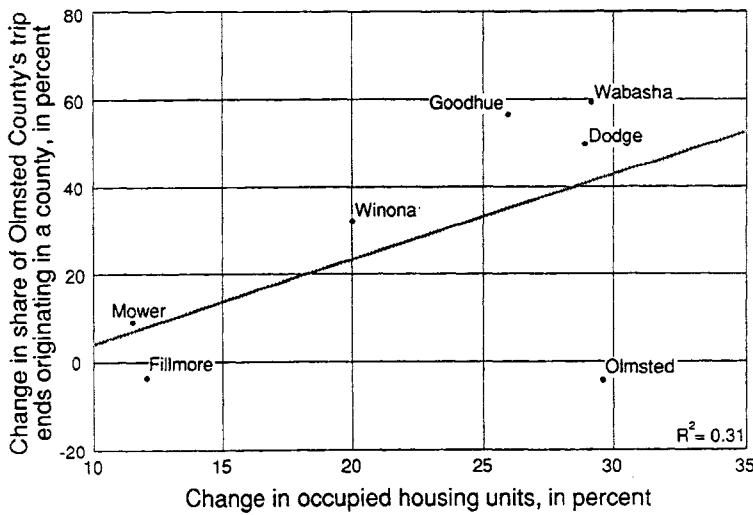


Figure 47. Change in share of Olmsted County's trip ends originating in a county by change in occupied housing units, by county, 1970-80.

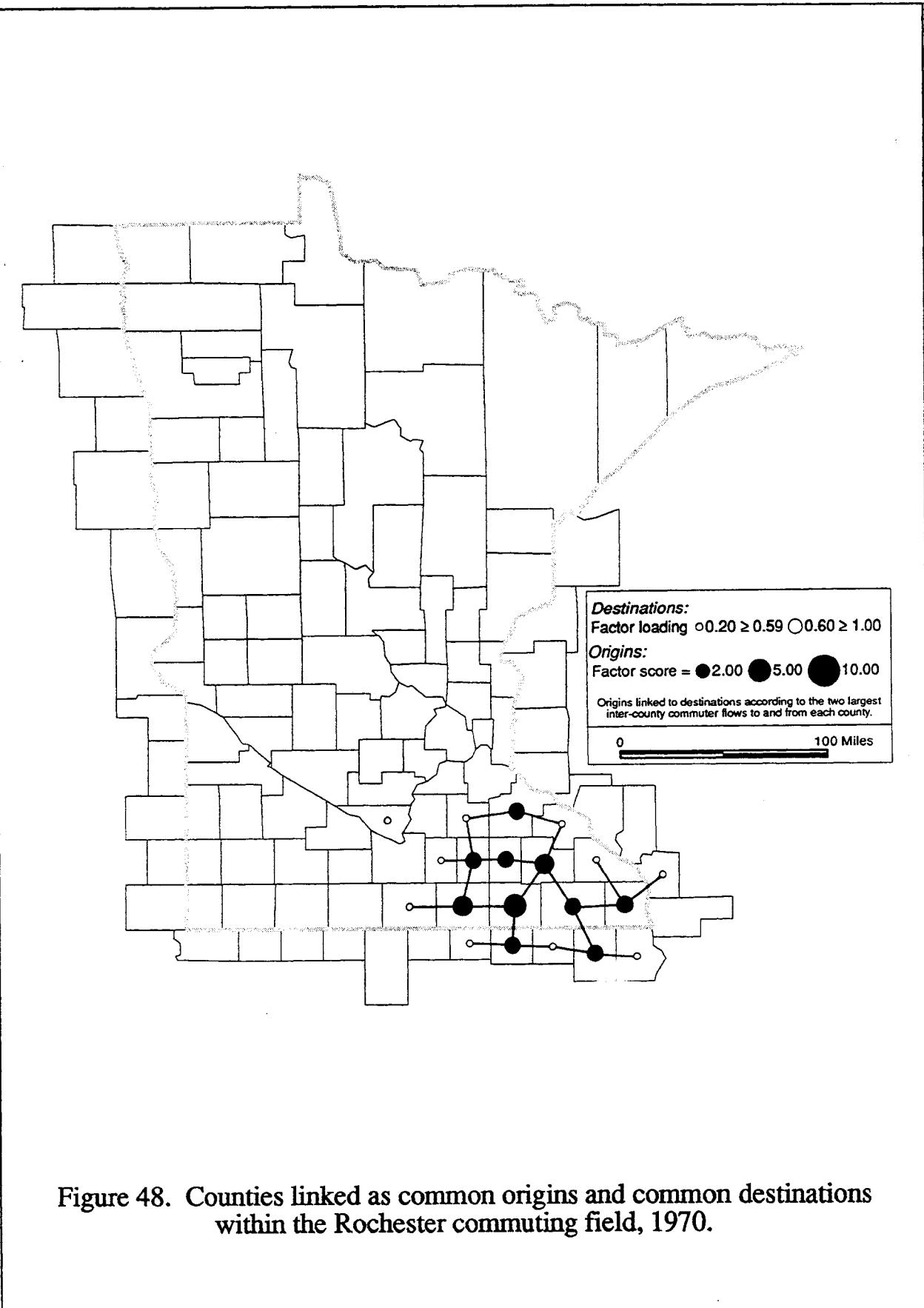


Figure 48. Counties linked as common origins and common destinations within the Rochester commuting field, 1970.

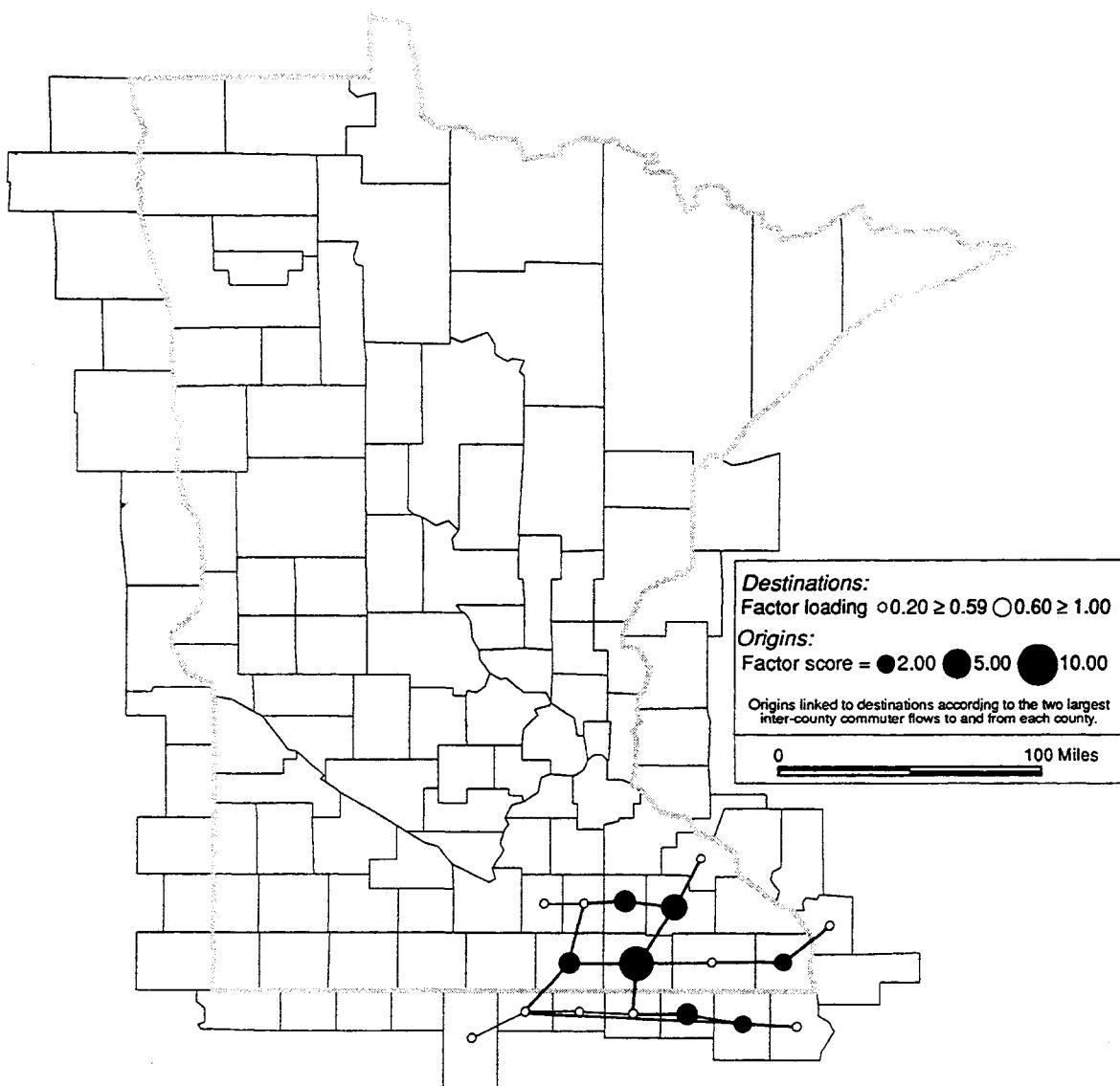


Figure 49. Counties linked as common origins and common destinations within the Rochester commuting field, 1980.

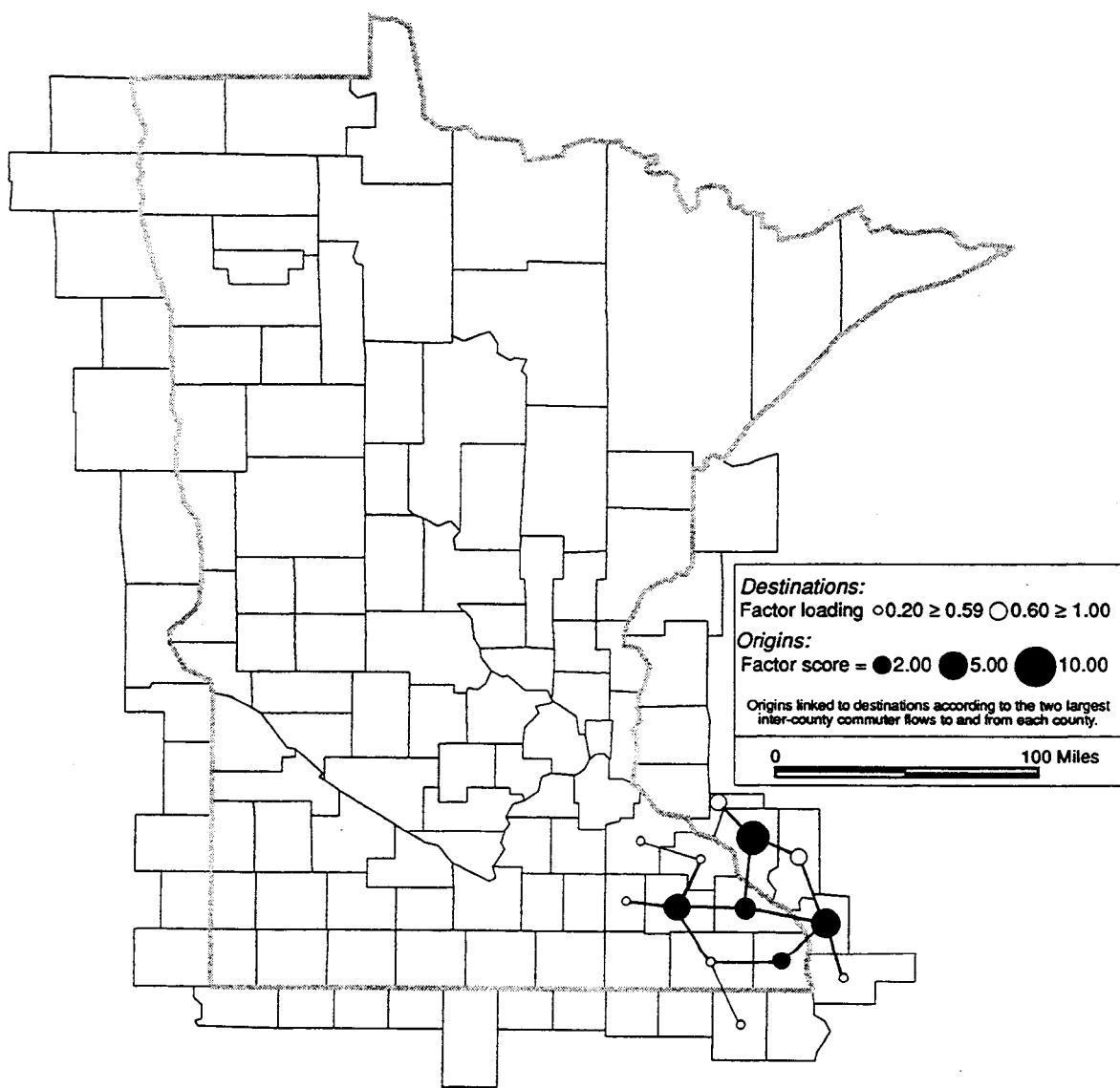


Figure 50. Counties linked as common origins and common destinations within the Rochester commuting field, 1990.

circles), and were the important destinations, along with the ten prominent origins, which also were significant destinations. The field included five counties along the northern edge of Iowa -- Worth, Mitchell, Howard, Winneshiek, and Allamakee; and LaCrosse county in Wisconsin.

By the end of the 1970s, the Rochester commuting field had lost some of its northern exposure, but had penetrated more widely into northern Iowa (Fig. 49). Goodhue, Rice and Winona counties drop out on the north; Faribault is added on the west; and Kossuth IA (Algona) and Winnebago IA (Forest City) are added along the top tier of counties in Iowa.

By 1990, presumably as a result of penetration of the Twin Cities influence southward and the relative increase of the Twin Cities metro economy compared with Rochester's metro economy, the major origin and destination counties linked within the Rochester commuting field have shifted eastward into Wisconsin, while the Iowa linkages have diminished in relative terms even if they have not declined absolutely (Fig 50). In Wisconsin, from north to south, the counties within the Rochester commuting field are Pepin, Buffalo, Trempealeau, LaCrosse, and Vernon. In Iowa, only Winneshiek remains among the prominent destinations.

#### E. CHANGES IN THE MANKATO COMMUTING FIELD, 1970-1990

The 1990 commuting field around Mankato and Blue Earth county, defined by counties from which .5 percent or more of Blue Earth county's trip ends originate, formed a compact group of seven counties including Nicollet (St. Peter) on the north; Brown (New Ulm) on the west; Watonwan (St. James) to the southwest; Blue Earth itself with Faribault directly south; and Waseca and LeSeuer to the east (Fig. 51). The Mankato commuting field competes with Rochester farther east, the Twin Cities to the northeast, and the St. Cloud commuting field to the north.

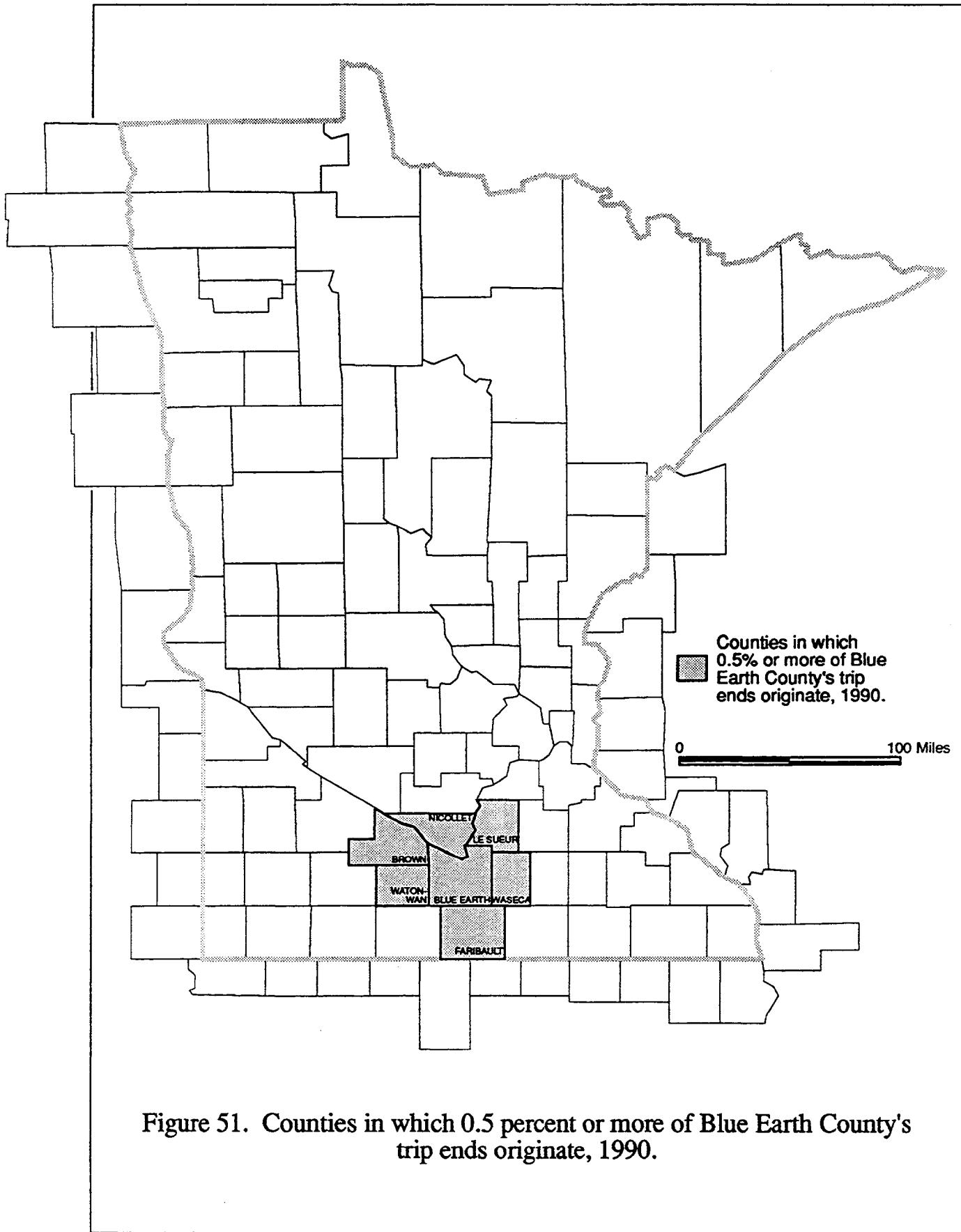


Figure 51. Counties in which 0.5 percent or more of Blue Earth County's trip ends originate, 1990.

If the field is defined as counties sending one percent or more of their commuters to Blue Earth county in 1990, the field is the same, with the addition of Sibley (Winthrop, Gaylord) county north of Nicollet county (Fig. 52).

Like the Rochester commuting field, when the change in share of Blue Earth county's trip ends originating in a county is compared with change in share of a county's commuters going to Blue Earth county, 1970-80, the correlation is almost perfect (Fig. 53). The two numbers move together almost exactly, suggesting that as the Mankato metropolitan area's economy expanded in the 1970s, the county's linkages with its surrounding counties intensified in a consistent way. There were no outliers in the statistical relationship.

The changes in the number of occupied housing units in the 1970s had a moderate correlation with a county's share of Blue Earth county's trip ends. Counties with only moderate expansion in their occupied housing inventories -- heavily agricultural counties such as Watonwan, Brown, and Faribault, for example, saw their share drop or rise only modestly (Fig. 54). Fast growing LeSeuer county, on the edge of both the Twin Cities commuting field and the Mankato commuting field, saw its share rise well above average.

Counties linked as common origins and destinations within the 1970 Mankato commuting field included the dominant origins of Nicollet (St. Peter), followed by Blue Earth itself (Mankato), then Martin (Fairmont), Waseca, and Sibley counties (solid circles, Fig. 55). The major destinations (besides the major origins, which are also important destinations) were Brown, plus eight others, including Kossuth (Algona) and Emmet (Estherville) in Iowa (open circles, Fig. 55).

During the 1970s, the Mankato commuting field changed somewhat by extending east-west along the southern tier of Minnesota counties, which by then were well served by the completed highway I90. Major origins in 1980 included the counties of Jackson, Martin (Fairmont), and

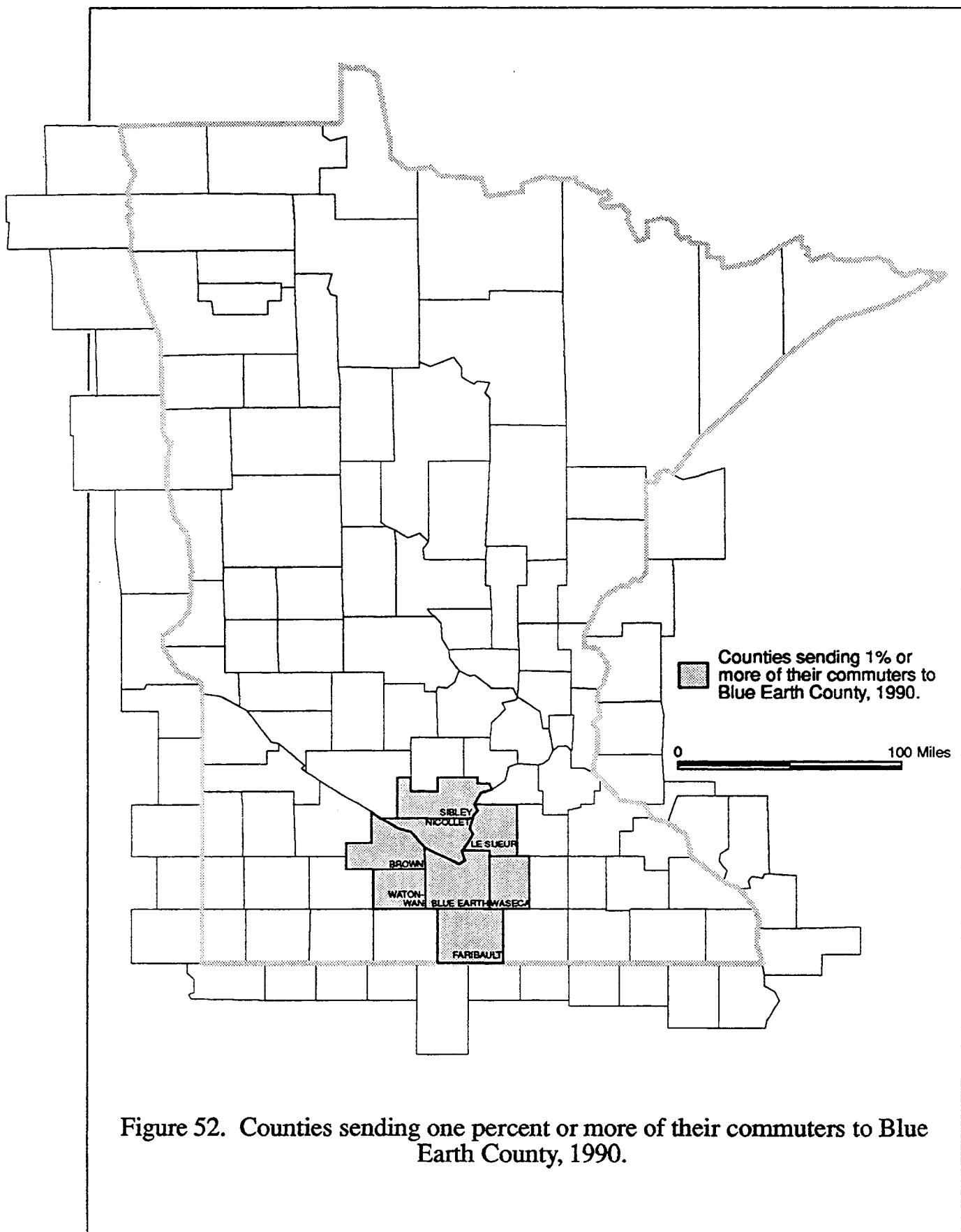


Figure 52. Counties sending one percent or more of their commuters to Blue Earth County, 1990.

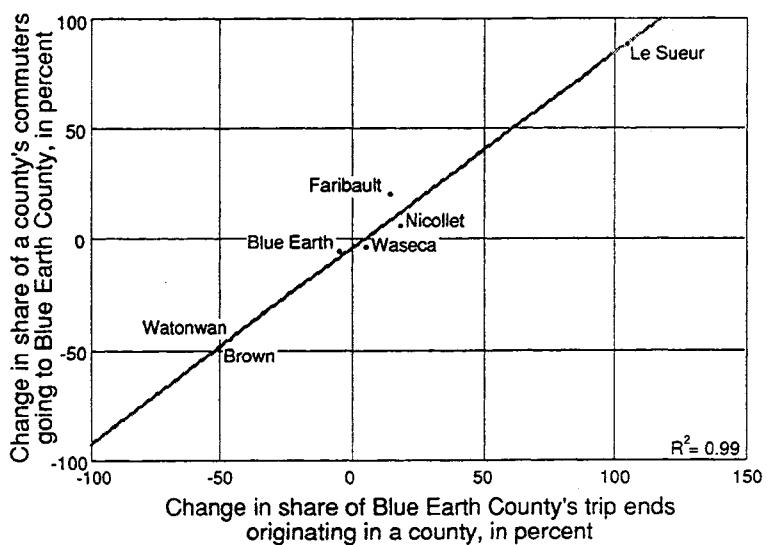


Figure 53. Change in share of a county's commuters going to Blue Earth County by change in share of Blue Earth County's trip ends originating in a county, 1970-80.

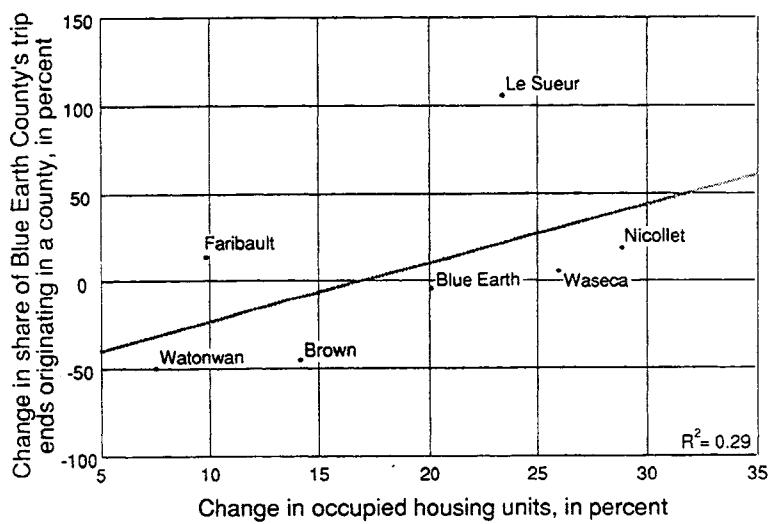


Figure 54. Change in share of Blue Earth County's trip ends originating in a county by change in occupied housing units, 1970-80.

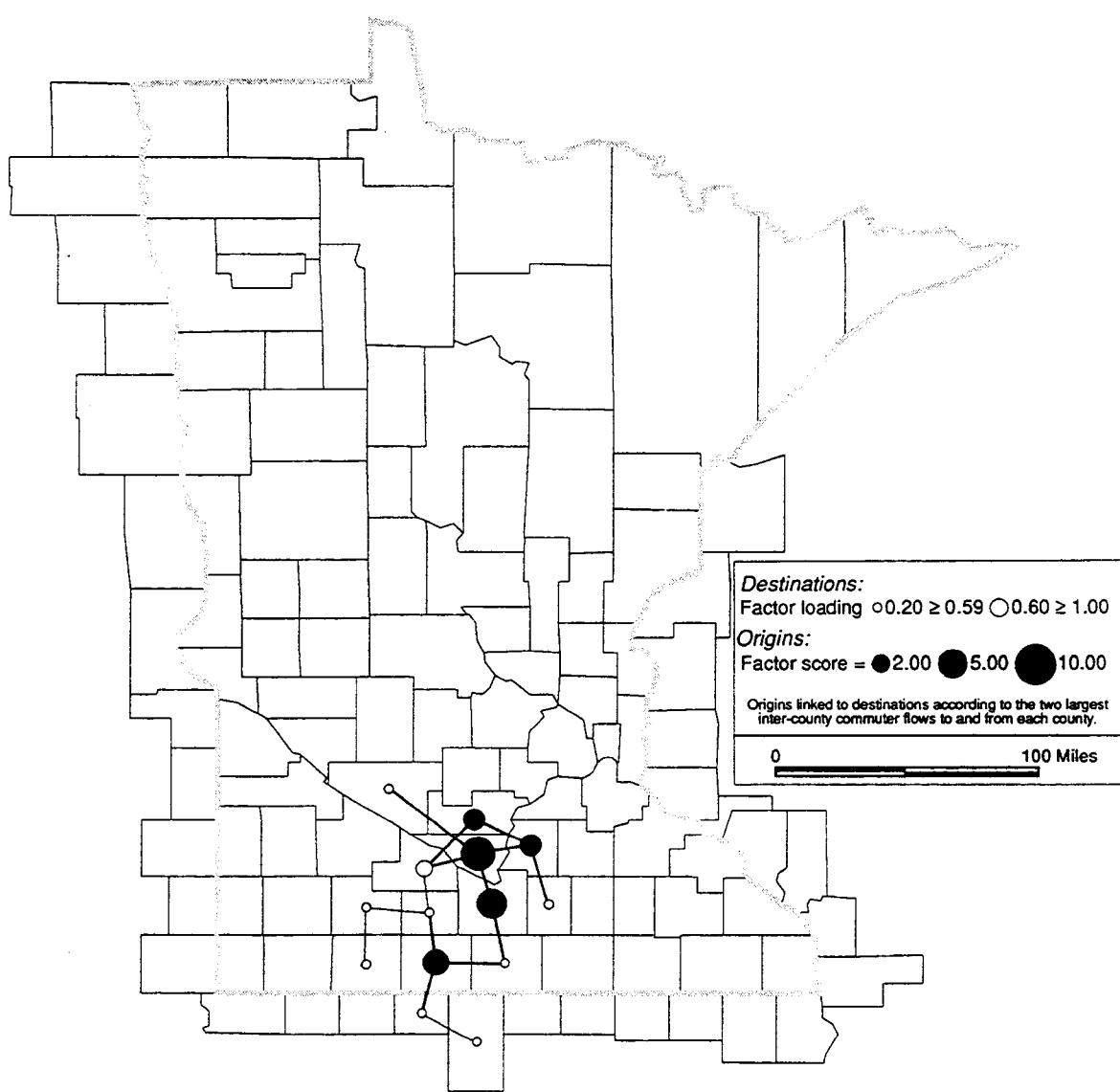


Figure 55. Counties linked as common origins and common destinations within the Mankato commuting field, 1970.

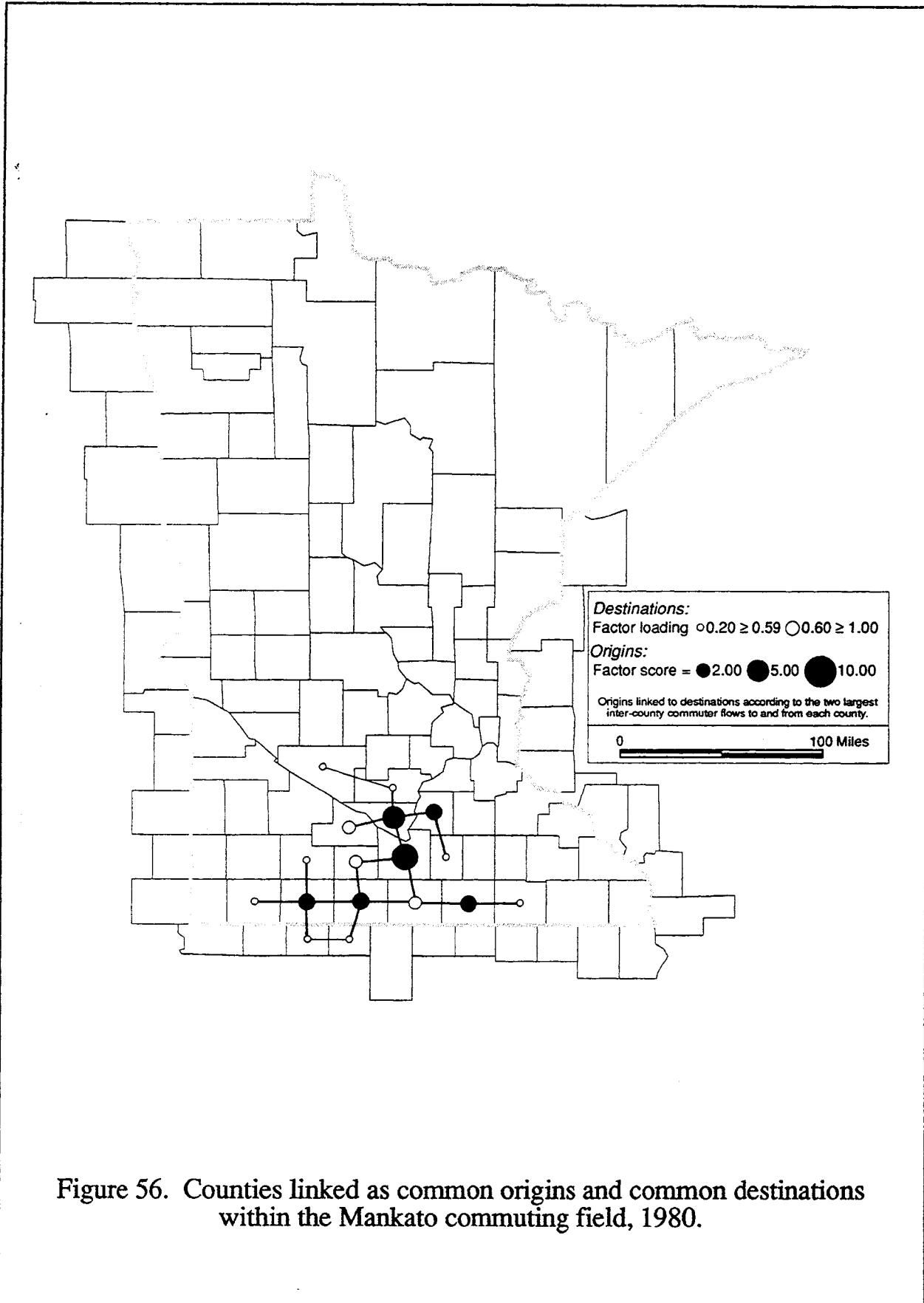


Figure 56. Counties linked as common origins and common destinations within the Mankato commuting field, 1980.

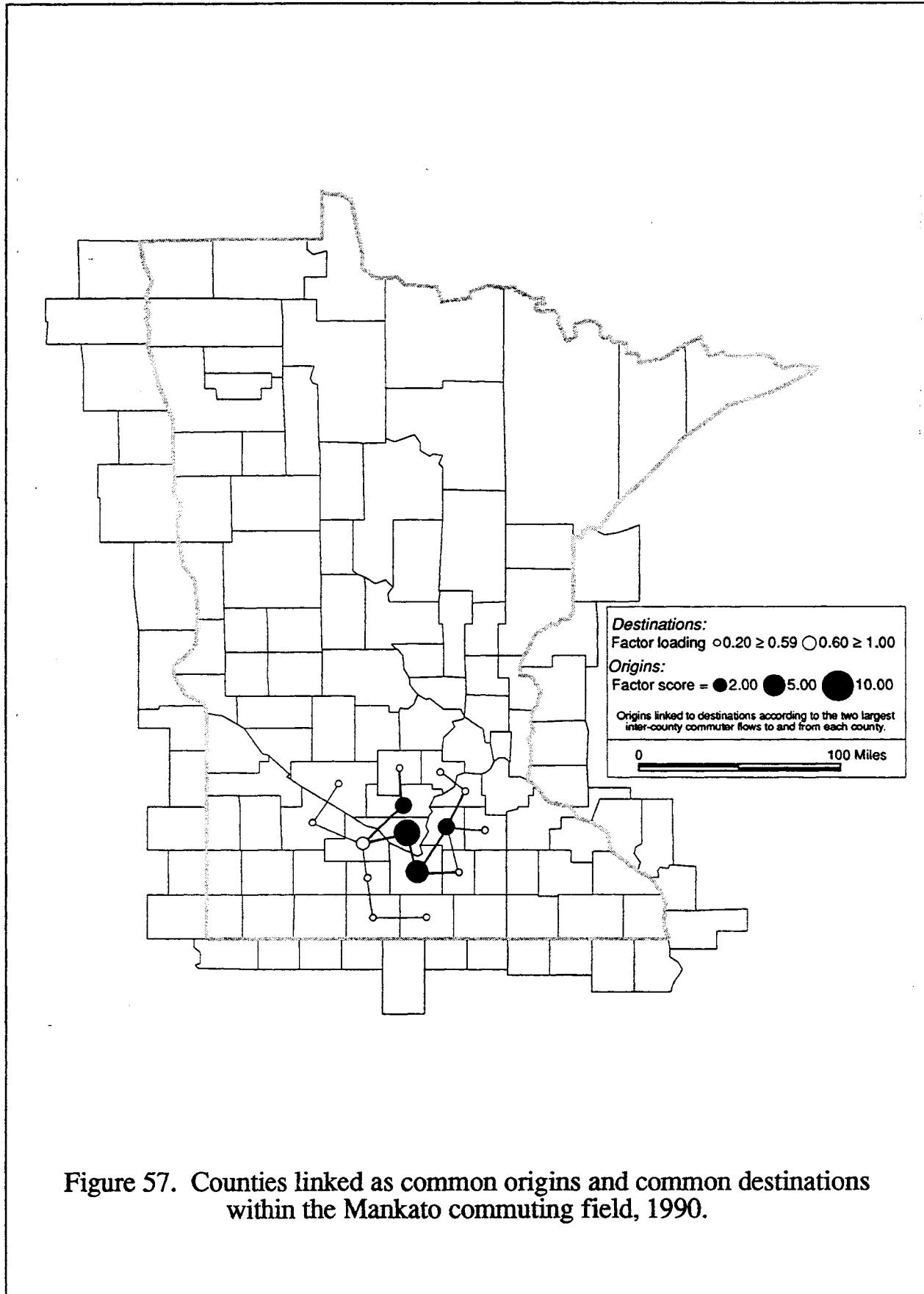


Figure 57. Counties linked as common origins and common destinations within the Mankato commuting field, 1990.

Faribault (Blue Earth) along the southern tier of Minnesota counties; Blue Earth and Nicollet counties; and LeSeuer county. The major origins were also major destinations. They, together with other prominent destinations, defined the expanded reach of the Mankato commuting field by 1980. It extended northwest into Renville county, west to Brown (New Ulm), southwest to Nobles (Worthington) in Minnesota, plus Dickinson and Emmet in northern Iowa, and east to Mower (Austin) county (Fig. 56).

By 1990, the Mankato field had tightened so that only four major origins emerged -- Blue Earth, Nicollet, Sibley and Waseca counties (Fig. 57). Destinations in addition to the major origins are the counties contiguous to the four major origins, plus Redwood county west of Brown. This result does not imply an absolute decline in the strength of the Mankato-Blue Earth county economy, or its ability to attract and send commuters to jobs within its labor market. It does mean, though, that when the counties of the Mankato commuting field are analyzed within the context of all 120 counties in the study area, their importance diminished during the 1980s as other components -- most notably, the Twin Cities and St. Cloud areas -- advanced vigorously.

## VII. CONCLUSIONS

Minnesota's present settlement system is the result of previous generations of growth and change, and commuter flows among the state's counties provide insightful snapshots through several decades of metropolitan evolution. While the patterns associated with each city signify unique local conditions, overarching trends throughout the region have resulted in decentralized, overlapping commuting fields which scarcely resemble the daily urban systems of the 1950s and 1960s.

These trends have been especially important in the greater Twin Cities area, where commuting has expanded far beyond the seven-county jurisdiction of the Metropolitan Council. At

the time of the Council's creation in 1967, the *built-up* Twin Cities region fit comfortably within the seven-county area, and the *daily urban system* focused on the Twin Cities functioned almost entirely within the seven counties.

By 1990, the decentralization of population, employment, and housing combined with the increased ease of transportation to create a vastly more complicated and interconnected web of commuter flows. The observable evidence of these changes may be summarized briefly:

- Within the study area, consisting of Minnesota's 87 counties plus the 33 contiguous counties in adjacent states, only seven percent of all work journeys crossed a county boundary in 1960; more than 18 percent did so in 1990.
- The number of commuters entering the seven-county Twin Cities area from surrounding tiers of counties catapulted from fewer than 10,000 in 1960 to more than 70,000 in 1990.
- The number of commuters *entering* the seven-county area from the first tier of surrounding counties multiplied nearly nine times between 1960 and 1990 (from fewer than 8,000 to more than 60,000). The rate of increase is diminishing, but the total number of commuters is considerable.
- The number of commuters *leaving* the seven-county area for the first tier of surrounding counties increased from fewer than 2,000 in 1960 to more than 10,000 in 1990. The rate of increase is diminishing, and in 1990 the number of outward commuters is about a sixth of the number of journeys inward to the seven-county core.
- When county-to-county flows over the period 1960 to 1990 are examined simultaneously, the patterns reveal the development of a complicated set of overlapping commuting fields covering much of southeastern Minnesota. The field centering on the Twin Cities features significant overlaps with those focused on St. Cloud, Rochester, and Mankato.

These findings support the proposition that the functioning daily urban system focused on the greater Twin Cities area extends well beyond the seven county area. The extent of today's commuting fields underscores the question whether the jurisdiction of the Metropolitan Council should expand to include counties with which the core is intimately connected on a daily basis.

While the growth in inter-county commuting has gradually diminished between 1960 and 1990 (suggesting that flows around the Twin Cities may be settling down to a new equilibrium) the emerging settlement fields are characterized by overlapping and interconnected urban systems that, over time, will require new forms of regional cooperation and planning.



## APPENDIX

### DATA SOURCES AND METHODOLOGY

This study describes the geographical patterning of commuter flows in Minnesota and contiguous counties in adjacent states between 1960 and 1990.<sup>1</sup> We hypothesize that the continued suburbanization of metropolitan areas has proceeded far beyond the suburban municipalities surrounding central cities, and that daily commuter flows have begun to incorporate exurban counties into multiple urban fields. To test this hypothesis we employ two complementary approaches. First, we use simple Pearson correlation coefficients to evaluate well-established relations between aggregate commuter flows and population, employment, and housing in the study area. Second, we apply multivariate statistical procedures to the problem of defining groups of counties that exhibit statistical similarity in the spatial distribution of their commuter flows, and we examine demographic changes within each of these groups of counties. Both approaches rely on data from the U.S. Bureau of the Census.

#### DATA

Data were collected for the 120 counties of the study area (Minnesota's 87 counties and 33 contiguous counties in adjacent states) from published sources. Data on aggregate commuter flows were derived from the Bureau of Economic Analysis' revisions to the U.S. Census Journey-to-Work Frequency Tables for 1960, 1970, and 1980. Commuting data for 1990 were obtained from a special tabulation provided by the U.S. Bureau of the Census.

Housing and demographic data were obtained from the printed reports of the U.S. Census of Population and Housing. Figures calculated from the 1970 and 1980 enumerations include the following:

- employment of the population sixteen years of age and over  
(1970 figures derived from Tables 121-122; 1980 from Table 176)
- total number of occupied year-round housing units  
(1970 figures from Table 60; 1980 from Table 46)

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<sup>1</sup>The research on which this report is based was funded by the Minnesota Department of Transportation and the University of Minnesota Center for Transportation Studies. The original grant provided resources to analyze commuting patterns between 1960 and 1980, but the anticipated availability of tabulations from the 1990 census led us to delay the report accordingly. Thus commuting patterns in 1990 are analyzed in this report, however time constraints did not permit examination of changes in population, employment, and housing between 1980 and 1990. Current research supported by Mn/DOT is addressing these latter changes.

Information on county employment was provided by *County Business Patterns*. The number of employees in business establishments, and the number of business establishments, were available from Table 2 for both 1970 and 1980.

## SIMPLE CORRELATIONS BETWEEN COMMUTING AND POPULATION, EMPLOYMENT, AND HOUSING

County-to-county commuter flows were arranged in a set of four 120 x 120 matrices (one matrix for each census year, 1960 to 1990), permitting the comparison of particular flows over time. The percentage change in commuter flows between 1970 and 1980 was calculated for the 120 counties of the study area and for specified regional county groups (e.g., the Twin Cities commuting field). Groups were defined to include counties sending at least one-half percent of their commuters (one percent in the case of the Twin Cities) to the respective central county (to the seven-county area in the case of the Twin Cities) in either 1970 or 1980. Percentage changes in the magnitudes of the commuter flows were expressed (a) as a share of the total number of work journeys beginning in the origin county, and (b) as a share of the total number of trip ends arriving at the destination.

The resulting array of values was correlated with measures of population, employment, and housing to provide rough measures of the association of selected pairs of variables. Assessment of significance levels was inappropriate given the non-inferential objectives of the analysis. Counties that were "new entries" to the commuting field of the central county in 1980 (e.g., sending no commuters in 1970) were excluded from the calculation of correlation coefficients, and appear on scatter diagrams as 100-percent increases.

## COMMUTING FIELDS DEFINED WITH FACTOR ANALYSIS

The second approach employed in this study involves the analysis of patterns of spatial regularity embedded in journey-to-work flow matrices. In addition to conventional ways of defining commuter fields -- for instance, the "daily urban system" -- we apply a multivariate statistical procedure, factor analysis, to analyze the similarity of spatial patterns of each county's commuter flows.

The term "factor analysis" has been applied to a wide variety of multivariate statistical procedures. In the main, these procedures are used to collapse large datasets into a smaller

number of statistically-defined measures that summarize as much as possible of the "patterned variation" of the original data.<sup>2</sup> The technique was developed by Spearman, and has subsequently been used most widely in psychology, where empirical research commonly involves analyzing a long list of personal characteristics -- variables -- of a large number of people (observations).<sup>3</sup> Geographers began to use factor analysis in the 1950s, and in its application to transport networks the approach has been used primarily as a sophisticated tool for describing complex spatial interaction patterns between origins and destinations.<sup>4</sup>

The term 'factor' has been the source of considerable confusion in recent years, since it commonly refers to two different techniques. The first, principal components analysis (PCA), employs matrix algebra to calculate observable, linear combinations of variables in a data matrix. PCA yields a set of uncorrelated components, calculated by extracting latent roots (eigenvalues) from the characteristic equation associated with the original matrix. Eigenvalues are extracted successively from the matrix in descending order of their contribution to the total variance, so the first few principal components typically account for most of the variation in the original data. The original variables are then correlated with the components and weighted by the square of the respective eigenvalue, yielding variable *loadings*. The correlation of observations with the components results in component *scores*. The variables and observations may then be grouped according to their respective loadings and scores on the different components.

While PCA has been used widely in geographical research, the approach is generally unsuited to the task of regionalizing transport networks as in the present study. Since the components are no more than linear combinations of the original, observed variables, the latter are typically associated with more than one component, and the residuals from the analysis are

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<sup>2</sup>Rummel, R.J. (1970), *Applied Factor Analysis* (Evanston, IL: Northwestern University Press), 14 ff.

<sup>3</sup>Spearman, C. (1904), "General intelligence objectively determined and measured," *American Journal of Psychology* 15, 201-93. For an exhaustive discussion of the details of various types of factor analysis, see Harman, H.H. (1976), *Modern Factor Analysis* (Chicago: University of Chicago Press).

<sup>4</sup>For a discussion of the conceptual basis of factor analysis as applied to geographical problems, see Gould, P. (1967), "On the geographical interpretation of eigenvalues," *Transactions of the Institute of British Geographers* 42, 53-85. For an excellent review of the various factor analytic methods used in geographical research, see Holmes, J.H. (1978), "Dyadic interaction matrices: a review of transformation purposes and procedures," *Progress in Human Geography* 2(3), 467-93. For more specific examples of the technique applied to transport networks, see: Garrison, W.L., and D.F. Marble (1963), "Factor-analytic study of the connectivity of a transport network," *Papers of the Regional Science Association* XII, 231-38; and, especially, Goddard, J.B. (1970), "Functional regions within the city centre: a study by factor analysis of taxi flows in central London," *Transactions of the Institute of British Geographers* 49, 161-81. For a more specialized approach to the study of transport networks, see Holsman, A. (1980), "Higher-order factor analysis and its application to transport networks," *Professional Geographer* 32(2), 192-98.

subject to considerable multicollinearity.<sup>5</sup> For the purposes of this study, then, PCA is subject to the same limitations as "daily urban system" definitions of commuting fields.

The second set of procedures, known as "common factor analysis," is distinguished from PCA by its conceptual basis. The original data are assumed to contain a set of *common factors*, each of which contributes to the variance of at least two of the observed variables, and *unique factors*, each of which contributes to the variance of only one of the observed variables. The unique factors, therefore, may be regarded as the residuals from the analysis.

Procedurally, common factor analysis is similar to PCA, although the common factors must be estimated iteratively since they are not observable linear combinations of the variables. Once the common factors are calculated, nonlinear mathematical transformations -- "rotations" -- may be used to allocate the explained variance according to some set criterion. Usually, the common factors are rotated to achieve "simple structure" -- i.e., so that each of the original variables is associated with one and only one rotated common factor. Rotation may be oblique, in which case the resulting factors are correlated with one another, or orthogonal, in which case they are uncorrelated and independent. Common factor analysis excludes that portion of the original variance unique to each observed variable (i.e., the unique factors) prior to rotation, and does not rely on linear dependence between the original variables.<sup>6</sup>

In the present analysis, common factor analysis was used to regionalize the study area into groups of counties exhibiting similarities in the spatial distribution of their work journeys. Commuter flows for each census enumeration between 1960 and 1990 were arranged in a 120-by-120 matrix, in which rows represent origins and columns depict destinations. The leading diagonal of each matrix, containing intra-county work journeys, was replaced with zeros in the regionalization analysis.<sup>7</sup> Each of these four matrices was nonsymmetrical, of course, since the reciprocal flows between any pair of counties rarely matched.

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<sup>5</sup>Harman, (1976), *op. cit.*

<sup>6</sup>At the scale of county commuter flows, column vectors rarely exhibit linear dependence. A county's commuters going to Hennepin County, for instance, show no *simple linear* relation to the number going to St. Louis County. Instead the pattern resembles the 'simple structure' of rotated factors, whereby observations cluster around the axes of rotated common factors.

<sup>7</sup>Intracounty flows were, however, included in all other calculations of changes in commuting between 1970 and 1980.

The first ten eigenvalues extracted from the matrices accounted for about one-third of the total variance (Table A-1), confirming the extreme complexity of work journey patterns observed at the county level. Subsequent eigenvalues contributed little to the explained variance, and may be regarded as highly localized flows between a few counties. Common factors were rotated according to the varimax criterion to achieve simple structure, that is, such that each county was associated with one and only one factor. An increase in the number of counties remaining correlated with more than one common factor, then, would provide rigorous support for our hypothesis of increasingly complex overlapping urban systems.

Table A1. Proportion of Variance Explained by first Ten Eigenvalues, 1960-1990.

Data set	Proportion (%)
1960	30.4
1970	31.9
1980	31.5
1990	33.4

*Source: output of factor analysis.*

Inspection of the rotated factor patterns indicated that standardized loadings exceeding 0.20, and factor scores exceeding 2.00, defined groups of counties with statistically similar commuting patterns.<sup>8</sup> These groups may therefore be regarded as statistically-defined commuting fields. Results were mapped to reveal the changes in the study area's dominant commuting fields between 1960 and 1990. Figures depicting all commuting fields in the study area (Figures 1 through 4) were constructed by identifying all counties with scores and loadings exceeding the specified threshold, and differentiating between the various fields. Figures depicting individual fields as they changed between 1970 and 1990 (e.g., Figures 25, 26, and 27 for the Twin Cities) were constructed with the following procedure. First, prominent destinations (loadings exceeding 0.20) and prominent origins (scores exceeding 2.00) were mapped. Second, the original matrix of commuter flows was inspected to identify the two counties sending the greatest number of workers to each prominent origin, and links were drawn accordingly. Third, links were drawn between each prominent destination and the two counties from which it drew the greatest number of commuters.<sup>9</sup>

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<sup>8</sup>Since the data may be regarded as "universe," significance levels are irrelevant in the evaluation of factor scores and loadings.

<sup>9</sup>These links do not always coincide, and adjacent origins and destinations may remain unconnected (e.g., Isanti County north of the Twin Cities drew the majority of its commuters in 1990 not from nearby Anoka County, but from Kanabec and Chisago; see Figure 27). In cases where the two counties sending or receiving the greatest number of commuters were not identified in the factor analysis as prominent origins or destinations, the matrix was searched iteratively until such a county was found.

