

Intra–Regional Variations of Commuting Times in a Decentralized Urban Area

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Abstract:

A lively policy debate, the effect on travel time of the decentralization of employment, has emerged as decentralization of the urban form becomes more evident over time. Researchers have argued that greater centrality leads to higher commuting costs, which encourages decentralization of urban form. (10) Gordon et al. (8, 9) found that deconcentration and relocation of both firms and households accompanying metropolitan growth have alleviated the potentially adverse impact of congestion. Decentralized employment centers provide a spatial structure conducive to residential site choices that allow shorter commuting times. In a study of the San Francisco Bay area, which has a distinct decentralized urban form, Cervero and Wu (5) found that commuting trips made by suburban center employees were shorter than those employed in larger and denser urban centers. Based on the Atlanta Metropolitan Area, Sultana study found that each employment center and subcenter's commuting time was strongly correlated with their relative location to the CBD. (12)

Keywords: urban decentralization | Atlanta | CBD | commuting

Article:

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INTRA-REGIONAL VARIATIONS OF COMMUTING TIMES IN A
DECENTRALIZED URBAN AREA

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1. INTRODUCTION

A lively policy debate, the effect on travel time of the decentralization of employment, has emerged as decentralization of the urban form becomes more evident over time. Researchers have argued that greater centrality leads to higher commuting costs, which encourages decentralization of urban form. (10) Gordon et al. (8, 9) found that deconcentration and relocation of both firms and households accompanying metropolitan growth have alleviated the potentially adverse impact of congestion. Decentralized employment centers provide a spatial structure conducive to residential site choices that allow shorter commuting times. In a study of the San Francisco Bay area, which has a distinct decentralized urban form, Cervero and Wu (5) found that commuting trips made by suburban center employees were shorter than those employed in larger and denser urban centers. Based on the Atlanta Metropolitan Area, Sultana study found that each employment center and subcenter's commuting time was strongly correlated with their relative location to the CBD. (12)

In contrast, recent national statistics suggest a trend toward longer commutes during the 1980s, a period of rapid decentralized growth in the United States. By testing the 27 largest urban areas in Canada, Bourne (3) argued that, despite decentralization of employment, commuting distance increased. According to Bookout, this situation represents "an even poorer relationship between jobs and housing than experts expected to find". (2) Other research, based on a Netherlands study, reported that decentralization did not reduce commute time. (11) Other kinds of transportation relevant research on the effect of office. Researchers argued that decentralization of office spaces has dramatically changed commuting modes from public transit to private automobiles. (1, 4, 6)

These mixed research results bring up the question of whether decentralization is more desirable than centralization. It is noteworthy to mention that most of the evidence is drawn from either a theoretical view or empirical research, based on whole metropolitan areas, although there are exceptions. (5, 12) Using larger areal units of analysis gives only generalizations; it does not provide a sense of intra-regional variation in commuting. In order to find clearer answers to these questions, more intra-regional empirical inquiries are needed using new decentralized metropolitan areas, as larger scale data are more available. The Atlanta Metropolitan Area is well known as a distinct decentralized urban area, which has the highest suburb-to-suburb commuting of any metropolitan area in the United States. (12) Using large-scale data from the 1990 U.S. Census of Transportation Planning Package (CTPP), this study analyzes the empirical relationships between locations of jobs and

commuting times. Specifically, this research examines whether the locations and varied sizes of employment centers or subcenters have different commuting patterns. This analysis helps and enriches our knowledge in geographic research by understanding how subcentering and commuting mutually affect each other.

2. RESEARCH QUESTIONS AND HYPOTHESES

Two questions arise from the existing literature. First: do smaller centers influence workers' commuting time differently from the major center in downtown Atlanta? Second: does decentralization increase dependence on automobiles? To answer these questions, the following hypotheses are tested: (i) the CBD or other first ranking major centers are destinations for longer commutes than medium or smaller centers; (ii) central city locations of employment centers and subcenters and suburban locations of employment centers and subcenters show different commuting patterns; and (iii) suburbanization of jobs increases automobile dependence.

3. DATA AND METHODOLOGY

3.1. DATA

This analysis uses detailed journey-to-work data from the 1990 US Census of Transportation Planning Package (CTPP). The 1990 CTPP data include three parts, classified according to the type of persons surveyed. Data are provided at a high level of geographical resolution, by Transportation Analysis Zones (TAZs). Data from the second part of the CTPP database are used in this research. The second part of the CTPP data provides information on workers, such as location of employment and characteristics of the worker and the average time spent commuting. The geographical data (polygon files) of TAZs in this study were collected from the Atlanta Regional Commission (ARC), a 10-county planning agency.

3.2. METHODOLOGY: IDENTIFYING CENTERS AND SUBCENTERS

In order to analyze the distribution of centers, subcenters, and their associated commuting patterns, the locations of employment: CBD, centers, and subcenters were identified in the Atlanta metropolitan area. An ArcView GIS method was used to identify centers and subcenters. Defining an employment center has two components: a density threshold and a minimum total (absolute) employment. (5, 7, 13) One criterion for identifying an employment center was a contiguous set of TAZs, each with an employment density above four workers per acre. The second criterion was that the combined TAZs of a center must sum to at least 10,000 workers. However, if total employment is equal to 7,000 in the outer boundary, it is considered a center even if it does not meet the density criterion.

To identify a subcenter, two criteria were followed: 1) if density criteria are met, but employment totals are not sufficient, or vice versa, a group of zones or a single zone will be considered a subcenter; 2) a subcenter can be defined as a zone whose measure of employment concentration is higher than all adjacent zones. To measure employment concentration, gross employment density or employment per population is used to identify a subcenter. In addition, a regression model is used to determine the effect of the decentralization of job locations on commuting times.

4. DISTRIBUTION OF EMPLOYMENT LOCATION AND COMMUTING

4.1. EMPLOYMENT CENTERS AND COMMUTING

Figure 1 shows the spatial distribution of employment centers and subcenters in the Atlanta Metropolitan Area. Eleven employment centers (ECs) are identified. The CBD and

Midtown areas together comprise the largest employment center with very high densities and the longest commuting times (31.69 minutes). For analytical simplification, these 11 ECs are further stratified into four hierarchical groups or classes (Table 1). The region's primary center is the CBD and the Midtown area with high densities (22.0 workers/acre). The second-tier centers are Cumberland-Galeria, Doraville-Norcross-Northlake, Atlanta Airport-East Point, Buckhead-North Druid Hills, and Sandy Springs. They have fairly large employment sizes and moderate-to-high employment densities, and they lay in suburban locations. The third-tier ECs, Fulton Industrial District and Decatur, have moderate employment concentrations and low densities. The fourth-tier ECs are Emory/CDC, Lawrenceville and Atlanta-Dekalb. They all have low employment numbers but higher employment densities since two of those ECs are located in the central area.

FIGURE 1
IDENTIFIED EMPLOYMENT CENTERS AND SUBCENTERS

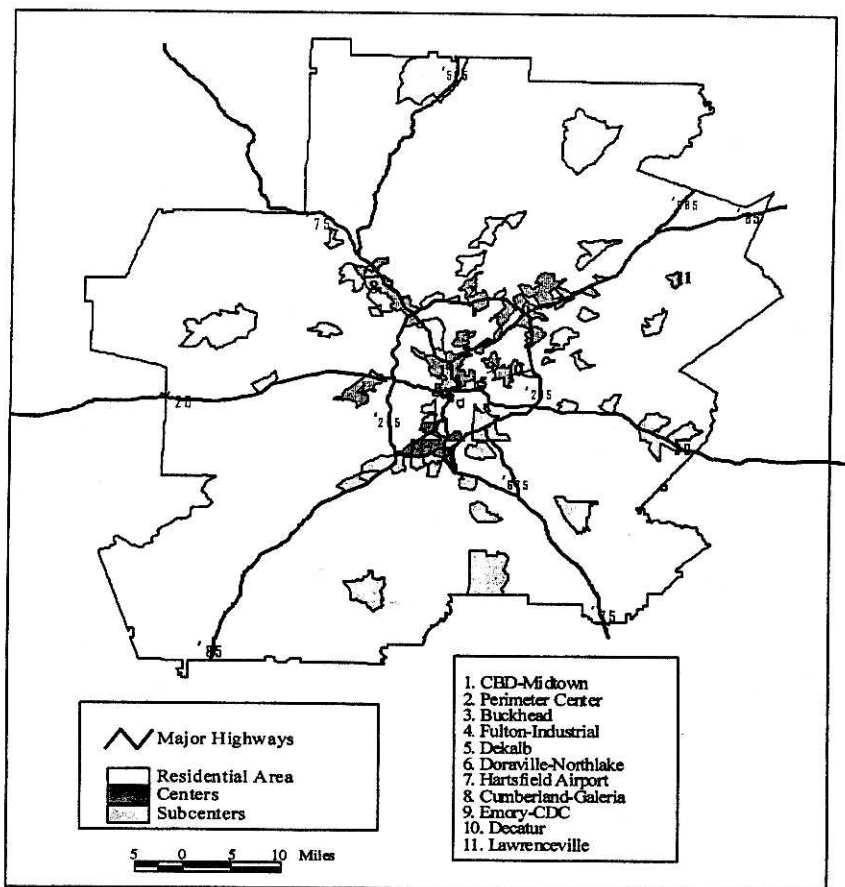


Table 1 shows the hierarchically classified ECs. Mean commuting time is highest for workers in the largest, innermost centers and lowest for those working in the smallest, outermost centers. The region's primary center, the CBD, has the highest commuting time, 2-5 minutes greater than the lower tier centers. The second longest mean commuting time is to second-tier employment centers which are about 3 minutes less than the primary centers. In the third-tier employment centers, workers have 3 minutes less commuting time than those of primary centers. However, the third-tier centers have commuting times only slightly longer than second-tier centers. This probably happens because most of the third-tier centers are located in the central area and have high densities. Therefore, the commuting times may be associated with the locations of the centers.

TABLE 1
AVERAGE EMPLOYMENT AND COMMUTING CHARACTERISTICS OF
EMPLOYMENT CENTER CLASSES IN ATLANTA REGION, 1990

| Center Type | Employment Size | Density | One-way commute time (minutes) | Mode ^a | | |
|-------------|-----------------|---------|--------------------------------|-------------------|----------|----------------|
| | | | | Drive Alone | Car pool | Public Transit |
| Primary | 242172 | 22.47 | 31.69 | 70 | 14 | 13 |
| Second-tier | 77475 | 8.59 | 28.34 | 83 | 12 | 3 |
| Third-tier | 30894 | 6.87 | 28.44 | 78 | 14 | 6 |
| Fourth-tier | 12219 | 13.57 | 25.80 | 78 | 13 | 5 |

^aThe percentage of commutes made using the given mode of transportation.

Note: All are statistically significant at .05 level

4.2. SUBCENTERS AND COMMUTING

TABLE 2
ONE-WAY MEAN TRAVEL TIME BY CLASSIFIED SUBCENTERS (ACCORDING TO DENSITY)

| Employment Size | Criteria | Density | Mean travel times | Mode | | |
|-----------------|----------|---------|-------------------|-----------------|--------------|--------------------|
| | | | | Drive alone (%) | Carpools (%) | Public Transit (%) |
| 37, 665 (n= 11) | D> 4.0 | 5. 68 | 26.27 | 80 | 13 | 4 |
| 179, 515 (n=29) | D< 4.0 | 1.11 | 24.82 | 82 | 14 | 2 |

Note: All are statistically significant at .05 level

Forty subcenters are identified (Figure 1). The longest commute is 34 minutes, which is longer than to the CBD, to the East Point subcenter. The East Point subcenter has a high density of employment and is located in the central area. Other subcenters to which commuting time is more than 30 minutes are all located in the central area and close to high-density areas. In all cases, except in the Cumberland-Galeria area, which is located in a densely developed area, suburban subcenter commuting times are shorter than 30 minutes, with the lowest commuting time being 19 minutes in Douglasville subcenter. Commutes to jobs in less dense subcenters also imply shorter commuting (Table 2).

5. AUTOMOBILE DEPENDENCE

These findings suggest that the decentralization of employment increases automobile-based traffic flows (Tables 1 and 2). The results show that there are greater shares of drive-alone automobile trips related to the less dense and outer perimeter employment centers and subcenters. Compared to the CBD, there is great variation in the drive-alone mode within

the rest of the employment centers in the Atlanta region. The shares of drive-alone trips are negatively related to employment density. In the Atlanta area, drive-alone automobile trips are low to the primary center (CBD) and highest in second-tier centers because most of the second-tier centers are located in the suburbs.

The share of public transportation is positively related to employment density and location. Denser and central-area locations of ECs have averaged relatively higher shares of transit-user workers. The CBD has the highest percentage of workers who use public transportation. The second-tier employment centers have the lowest share of public- transit use, since all of these employment centers are located in the suburbs. In Atlanta, the MARTA rail and bus system network is limited to service only in the central area. Carpool is not necessarily positively related to the denser employment centers. Primary centers have the highest percentage of carpool commuters, but in suburban locations there are also similar percentages of commuters who carpool. Similarly, denser subcenters have relatively low shares of solo commuters and high shares of public transit, but carpool does not necessarily decrease in suburban subcenters. All together, these findings suggest that modal implications of decentralization should not be taken lightly. Evidence from Atlanta suggests that decentralization of urban development increases drive-alone commuters and decreases public-transit users. Therefore, public transit is positively related to high-density employment.

6. REGRESSION RESULTS

A regression model is used to determine the joint effect of all the variables that affect commuting time. The dependent and independent variables are chosen based on a large body of theoretical and empirical research (Table 3). The dependent variable is MTT (one-way mean travel time to work for each center and subcenter). To choose independent variables, various urban spatial structure characteristics are considered. Congestion typically lengthens the overall commute duration. Thus, the DENSITY variable is chosen to explain the commuting length. The variable, employment concentration types (ECNTYPE), is used because employment centers have different densities and total numbers of workers compared to subcenters, and these differences may have different influences on commuting times. Location of employment centers and subcenters (LOCATE) is used because central area location of employment centers and subcenters have traditional centrality job patterns and are agglomerated with high densities. In contrast, suburbanization of jobs brings work closer to home. Several socio-economic characteristics of workers are also included in the model, since traditional theory expects that high-income (PCTM50K) groups live farther from their workplace to find more spacious housing and cleaner air. In a decentralized urban structure, the income effects may not be as strong because higher income workers do not necessarily have to trade off commuting costs against housing space as jobs become suburbanized. Since modes of transportation are associated with commuting time, it is divided into three variables: PCTDAL (percentage of workers drive alone), PCTCP (percentage of workers carpool) and PCTPT (percentage of workers use public transit).

TABLE 3
VARIABLE NAMES, DESCRIPTIONS, AND DEFINITIONS

| Variables name | Definition and Description |
|-----------------|--|
| MTT | Mean Travel Time (one-way) |
| DENSITY | Workers per acre |
| TEMP | Total Employment |
| ECNTYPE (dummy) | Employment concentration types; Centers = 0 and Subcenters = 1 |
| LOCATE (dummy) | Location of employment; central area = 0 and suburbs = 1 |
| PCTM50K | Percentage of workers who earn more than \$50,000 |
| PCTDAL | Percentage of workers who drive alone to work |
| PCTCP | Percentage of workers who carpool to work |
| PCTPT | Percentage of workers who use public transportation |

In the colinearity diagnosis, stepwise regression found that density (DENSITY) and employment concentration types (ECNTYPE) were highly correlated. Similarly, DENSITY and location of employment centers and subcenters (LOCATE) were also highly correlated, so stepwise regression removed the variable DENSITY. Since the variables public transit (PCTPT) and drive alone (PCTDAL) were highly correlated with location (LOCATE), the variables PCTPT and PCTDAL were removed from this model. The model has good explanatory power (with an adjusted R-square of .650). Several variables are highly significant and all the coefficients have the expected signs. Indeed, location is a major factor for longer commuting times. The model predicts that suburban locations of either center or subcenters will average 4.5 minutes less commuting time than central-area location of jobs, which implies that higher density is related to longer commuting times. This finding supports the arguments that low-density suburban jobs (decentralized employment centers) facilitate shorter work trips. The model also predicts that commuting time increases as percentage of workers who earn more than \$50,000 increases. This finding contradicts the notion that wealthy people in decentralized urban areas will not have longer commuting times since decentralization of jobs will bring more wealthy people into their workplaces.

TABLE 4
REGRESSION RESULTS FOR INTRA-REGIONAL VARIATION OF COMMUTING TIMES

| Variables | Model 1 ^a |
|-----------|----------------------|
| Constant | 28.388*** |
| ECNTYPE | -1.284 |
| LOCATE | -4.419*** |
| PCTM50K | .586*** |
| ETYPRK1 | -.158** |
| PCTCP | .041 |

R-square = .650***

* significant at p < .001 level

** significant at p < .01 level

7. CONCLUSION

By using a standard ArcView GIS and consistent method, this study identified 11 centers and 40 subcenters in the Atlanta metropolitan area to analyze intra-regional variations in commuting times in a decentralized urban area. The result confirms that decentralization appears to have induced shorter commuting. This research finds that central city located employment centers or subcenters have longer commuting times than comparable locations outside of the central city. This could reflect the tendency of decentralized employment growth to put more jobs closer to residences, or it might reflect the tendency for commutes to outlying work centers and subcenters to be made along less-congested highways in faster

moving modes, mainly private automobiles, as results indicate that decentralization increases automobile dependence. Evidence drawn from this research does not support the argument that decentralization of employment centers may reduce high-income workers' commuting times. However, the prediction of decentralized urban structure research, that commuting cost savings are among the benefits of decentralization, stands up to empirical scrutiny.

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