

GIS-Based Analysis of the Commuting Behavior and the Relationship between Commuting and Urban Form

1. Abstract

A prevailing view in the commuting is that commuting would reconstruct the urban form. By employing the GIS techniques and census data, this article first analyzes how characteristics of residents, like sex, age, and income, affect their commuting behaviors. Then, the article checks the relationship between commuting and urban form. Although the article has approved the links among the characteristics of residents, commuting behavior, and urban form, the model and function of how they work are still vague.

2. Introduction

The commuting is an issue that should be considered by all planners, policy makers, and municipal administrators when they are trying to draw the future of the city, especially the Los Angeles County where the fragment has made the commuting play a key role in connecting of cities.

The analysis of commuting choice is so complex because of its huge and different variables. Most of them could become the dominant factor of commuting choice under special circumstances. Moreover, the issue of commuting has become even more complicated due to its relationship with the urban form. The commuting, which interact with the urban pattern, has now become a critical issue for urban economic theory and public policy analysis (Giuliano & Small, 1993).

The standard urban model, as Hamilton pointed out at 1982, underestimated the commuting distance of the urban residents. Although there were several theories as the amendment for the standard urban model, the household's preference for the amenities was always ignored in those theories (Feng, 2008).

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Instructors: Barry Waite, Bonnie Shrewsbury

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Here, this article is going to use the census data and GIS technology to analyze the commuting behavior by using cross-over method to check the relationship between characteristics of residents and their commuting features, including commuting time and commuting choice. And then, the article uses the similar method to exam the relationship between the commuting and urban form by comparing the features of commuting and urban form that includes the density and distribution of race groups.

3. Data Collection

There are two kinds of main data necessary for the GIS technology analysis, the polygon data and the table data. The polygon data used in this article comes from the 2010 Census TIGER/Line Shapefiles, accessed from ERSI website, <http://www.census.gov/geo/www/tiger/tgrshp2010/tgrshp2010.html>. I choose the Los Angeles County census tract as the basic map for analysis. The table data utilized in the GIS maps are based on the census tract data, all of them coming from the Factfinder2, <http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml>. I have used several tables, most of them coming from the 2007-2011 American Community Survey except for URBAN AND RURAL. I have listed their information in the Table 1 below.

ID	Document Name	Source
B01003	TOTAL POPULATION	2007-2011 American Community Survey
B08006	SEX OF WORKERS BY MEANS OF TRANSPORTATION TO WORK	2007-2011 American Community Survey
B08011	SEX OF WORKERS BY TIME LEAVING HOME TO GO TO WORK	2007-2011 American Community Survey
B08012	SEX OF WORKERS BY TRAVEL TIME TO WORK	2007-2011 American Community Survey
B08013	AGGREGATE TRAVEL TIME TO WORK (IN MINUTES) OF WORKERS BY SEX	2007-2011 American Community Survey
B08101	MEANS OF TRANSPORTATION TO WORK BY AGE	2007-2011 American Community Survey
B08105A	MEANS OF TRANSPORTATION TO WORK (WHITE ALONE)	2007-2011 American Community Survey
B08105B	MEANS OF TRANSPORTATION TO WORK (BLACK OR AFRICAN AMERICAN ALONE)	2007-2011 American Community Survey
B08105C	MEANS OF TRANSPORTATION TO WORK (AMERICAN INDIAN AND ALASKA NATIVE ALONE)	2007-2011 American Community Survey

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B08105D	MEANS OF TRANSPORTATION TO WORK (ASIAN ALONE)	2007-2011 American Community Survey
B08119	MEANS OF TRANSPORTATION TO WORK BY WORKERS' EARNINGS IN THE PAST 12 MONTHS (IN 2011 INFLATION-ADJUSTED DOLLARS)	2007-2011 American Community Survey
B25075	VALUE	2007-2011 American Community Survey
DP05	ACS DEMOGRAPHIC AND HOUSING ESTIMATES	2007-2011 American Community Survey
H2	URBAN AND RURAL	2010 Census.
S0802	MEANS OF TRANSPORTATION TO WORK BY SELECTED CHARACTERISTICS	2007-2011 American Community Survey

Table 1 Census Tract Data Information

4. Data Proceeding

4.1 Polygon Data Proceeding

For the reason of formatting and aesthetics, I didn't use the original version of polygon data for the basic map (left part of Figure 1). I cut two south parts of the map which are unconnected with the main part (right part of Figure 1). Because these two parts don't contain too much information, the cutting of the map has little effect on the whole analysis. Therefore, the polygon data proceeding of cutting is reasonable and acceptable.

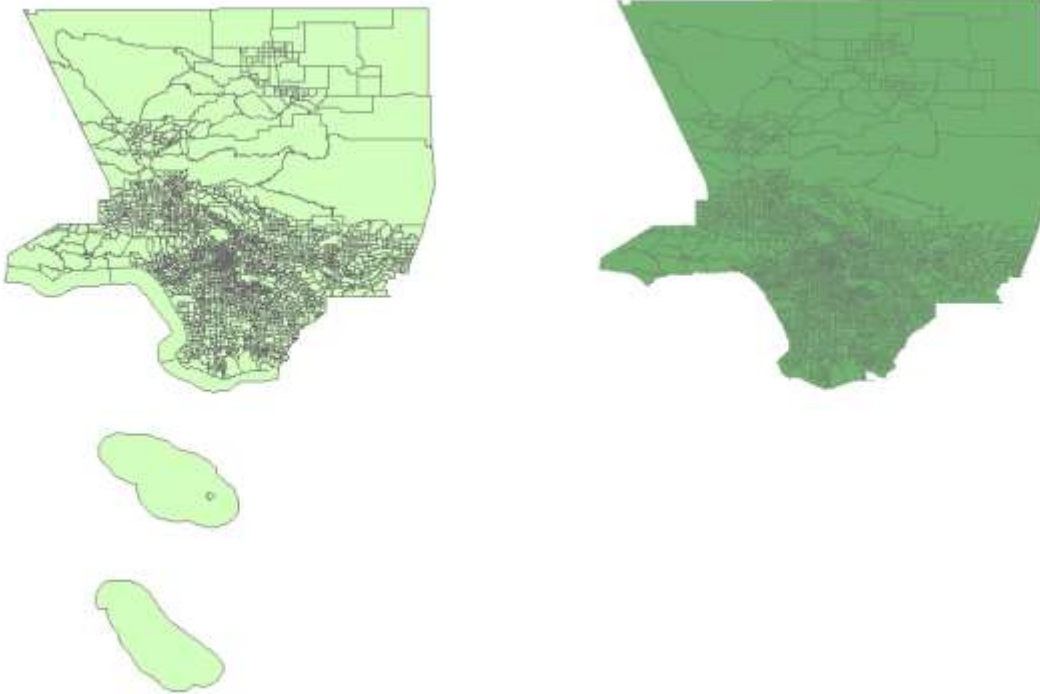


Figure 1 The maps without/with cutting

4.2 Table Data Proceeding

The census tract data are in the files with suffix “CSV”. All the tables used in the ArcGIS here have to be converted to Excel 2003 mode after formatting the tables with only one title, the only one pattern that ArcGIS could recognize. I have created a new field in the polygon data with specific information, based on which two tables could match each other and join together. By joining technology in ArcGIS, all information in the tables would show up on maps. Some maps have utilized ratios of two columns to analyze the relationship between them. Finally, I export the maps as JPEG for analyzing and presenting.

5. Commuting Behavior Analysis

5.1 Commuting Time Analysis

5.1.1 Aggregate Commuting Times

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The aggregate commuting time, which is the total of the males' and females' commuting time, is showed in the Figure 2.

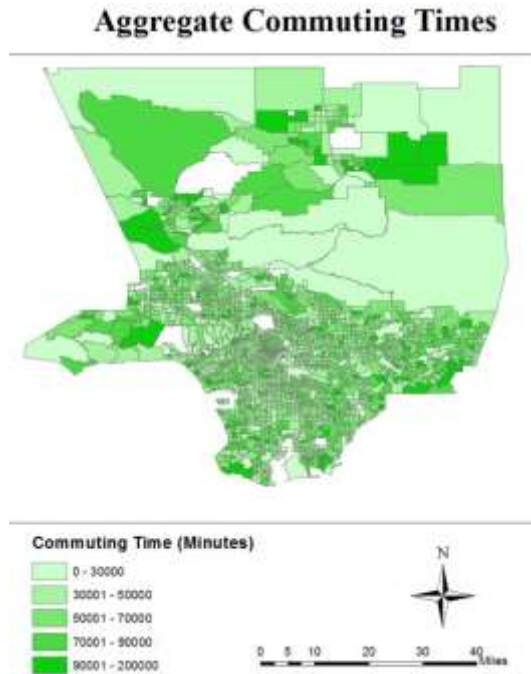


Figure 2 Aggregate Commuting Time

As showed in Figure 2, the basic feature of the commuting time is that the residents in the south part of the Los Angeles spend averagely more time in commuting than the residents living in the north, meaning that the isolation of living and working in the south part is more severe than the north part. In addition, the patterns of the areas in the south are much more fragmentary, while the residents who have similar commuting time in the north seems living together. Two explanations could be employed here to demonstrate the differentiation of the fragment pattern between the south and north. The first is that jobs in the south are more diverse than the north. The second is that the gentrification of the north is more severe than the south.

5.1.2 Commuting Times and Sex

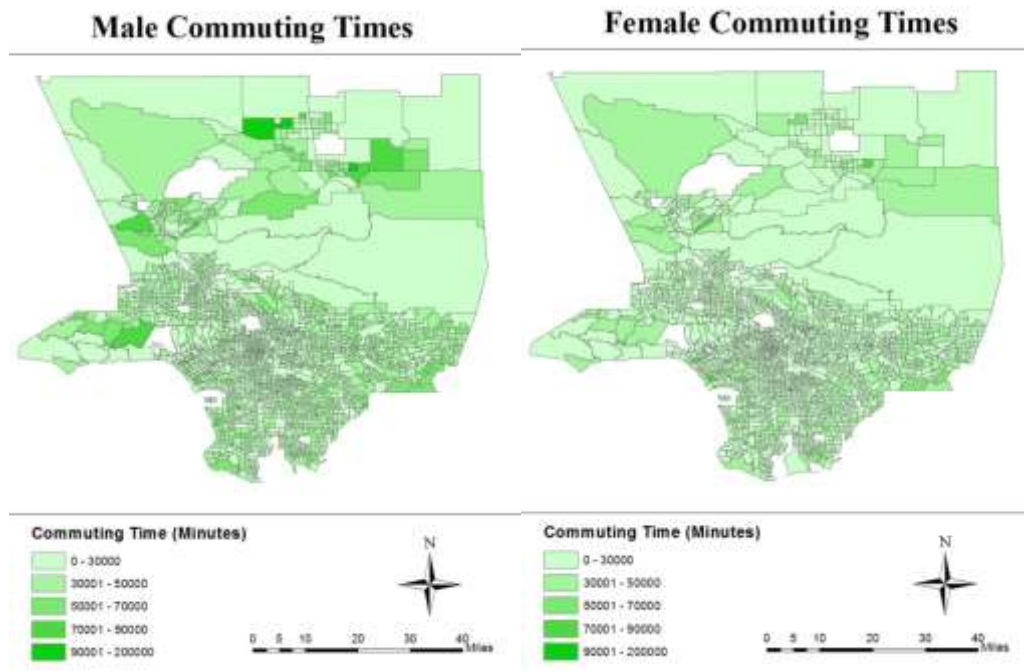


Figure 3 Difference of the Commuting time between male and female

Two maps are presented in a similar pattern. The only thing that distinguishes them is the commuting time of male in some parts is longer than female. But generally, the sex doesn't have big influence on commuting time.

5.2 Commuting Choice Analysis

The analysis of commuting time is really complicated because too many variables functioning in changing the commuting time. It is influenced directly by not only the distance but also affected by the choice of transportation, as well as amount of other factors.

Observing commuting choice features is another way to analyze commuting behavior. Although commuting choice is affected by the distance, it will be simple than analyzing commuting time, because the options of choice, like car or public transportation, are much less the differences of time, like from 1 to 10000 minutes. It could demonstrate more information of the urban than commuting time, because the commuting choice could reflect the income level of the residents, development of the public transportation,

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density and so on. Therefore, it is more meaningful to analyze the commuting choice than commuting time, due to its simplicity and capability of information.

5.2.1 Commuting Choice and Age

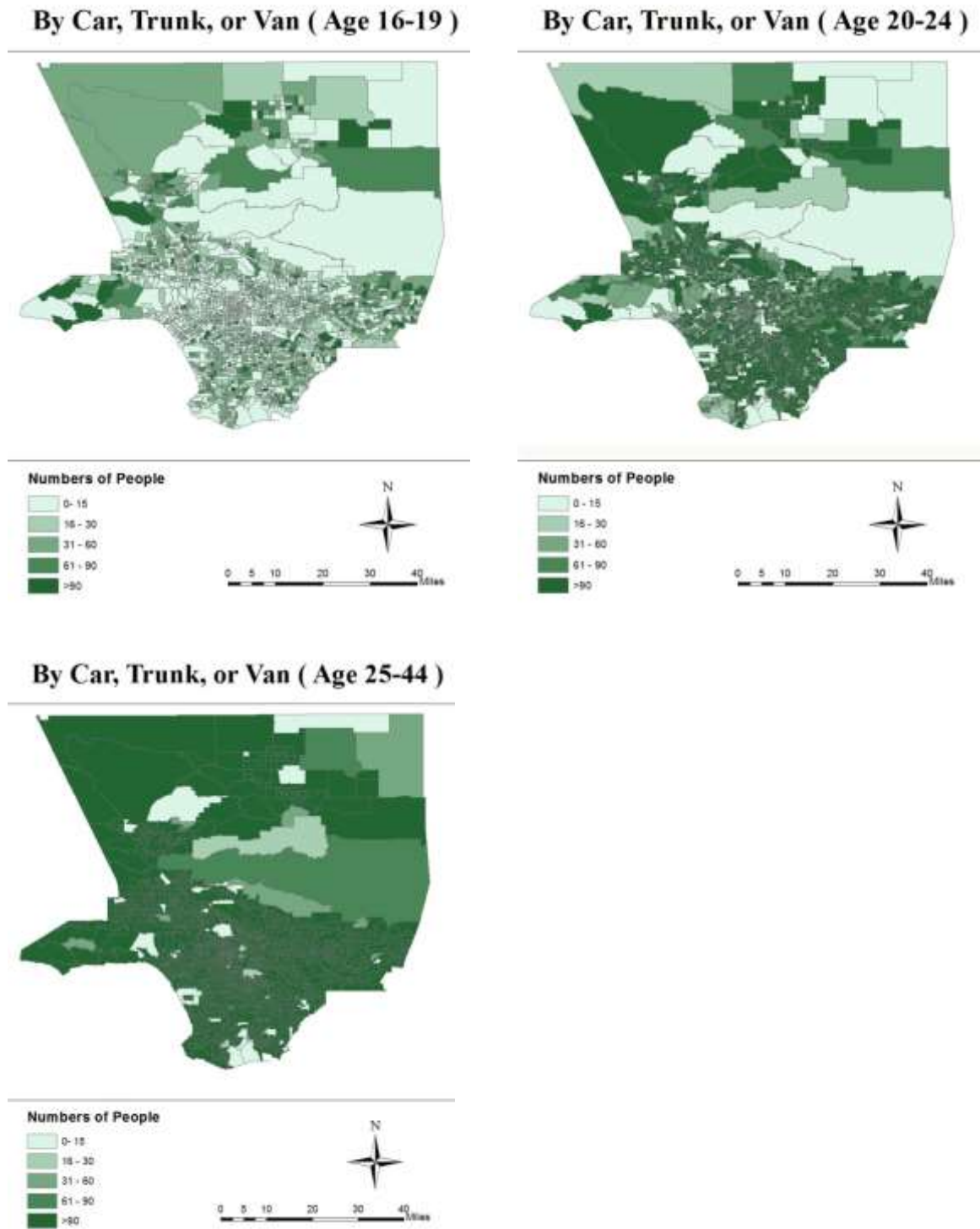


Figure 4 Private Transportation

It is obvious that as people become older, the number people who choose car, trunk or van as their transportation will become larger. It may be because that the working people

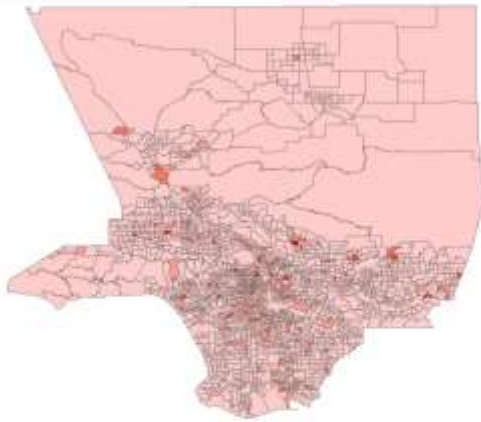
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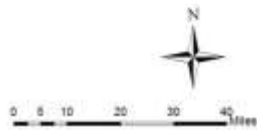
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between 25-44 are more than the teenagers who work. But it is still the fact that the proportion of people using private vehicle would increase as people grow older. It may be because that as people become older, it is more likely to buy private transportation due to the improvement of their economy condition. And commuting choice maps also reveal that the level of fragmentation of the south Los Angeles is higher than the north.

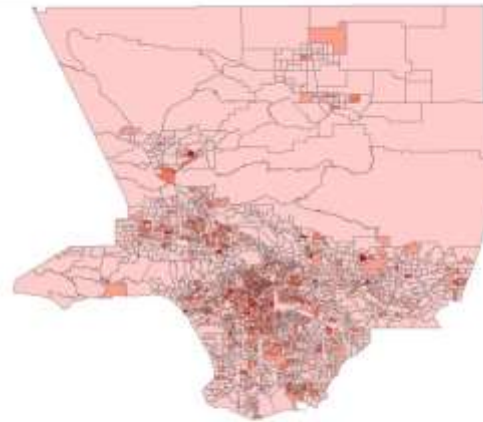
Public Transportation (Age 16-19)



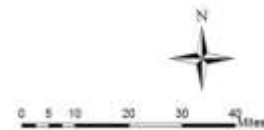
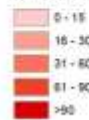
Number of People



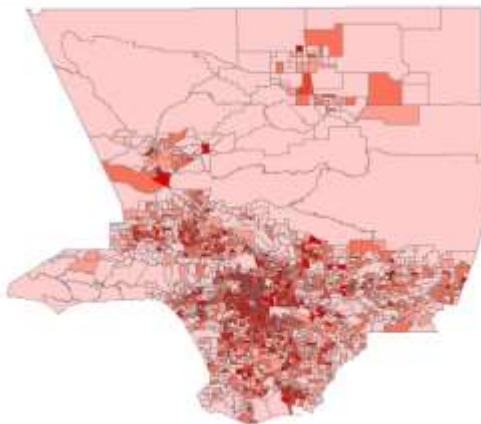
Public Transportation (Age 20-24)



Number of People



Public Transportation (Age 25-44)



Number of People

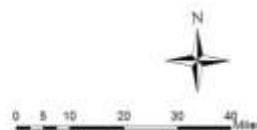
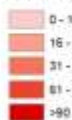


Figure 5 Public Transportation

Although the number of people choosing public transportation would become larger as the age increase, the speed of the increase is relatively slow compared by the speed of the

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increase of private vehicles. Moreover, there is nearly no change in the north of the Los Angeles in three maps, which may indicate both the north residents' preference to the private transportation and the undeveloped public transportation in the north Los Angeles. It's one of the features of urbanization that city nowadays depends on private transportation for connecting more than before. It may be also due to the sprawl of the city that infrastructures and shops there are so inadequate that it will be significantly inconvenient for living if people don't have private vehicle there.

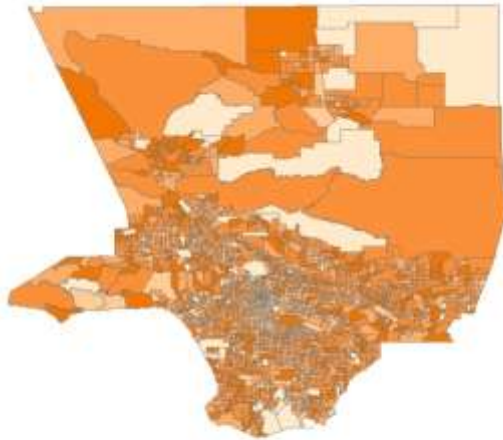
Here is a dilemma for the government. Since most of the residents living in the north of Los Angeles have cars for their transportation and only a few people use public transportation, municipalities are less likely to agree on spending revenue on improving the public transportation there when the costs and outcomes are considered. The government would tend to spend more money on other aspects of development to benefit more people and to create more obvious influence. Because of the hesitance from government to improve public transportation, the bad condition of public transportation would push more residents to buy private cars, which would in turn exacerbate the public transportation. Moreover, the requirement of private car and high cost of transportation resulted from terrible public transportation would enforce poor people move out of the area, and speed up the process of gentrification.

5.2.2 Commuting Choice and Income

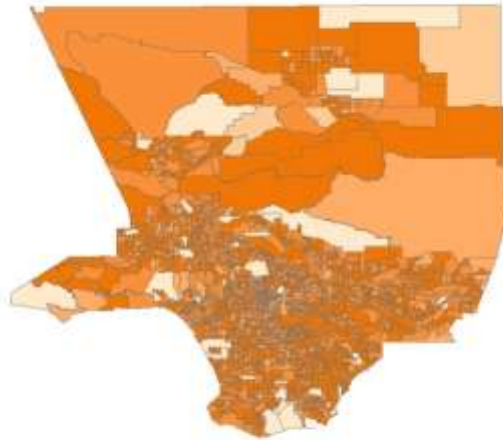
One difficulty in the analysis of the relationship between commuting choice and income is that the levels of income are too many to appropriately choose representative regions. I choose three regions for analyzing, \$0-9,999, \$35,000-49,000, and \$65,000-74,000. The big intervals between each region could help to make the results affected by income more observable.

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**Proportion of the People (Income \$ 0 ~ 9,999)
Using Private Transportation Only**



**Proportion of the People (Income \$ 35,000 ~ 49,000)
Using Private Transportation Only**



**Proportion of the People (Income \$ 65,000 ~ 74,000)
Using Private Transportation Only**



Figure 6 Private Transportation and Income

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Even though there is a little increase of the use of private cars as income increasing, the change is so slight that it is really unreliable to claim that income plays a key role in affecting the choice of private car. Moreover, it is unsafe to point out which one of the two reasons, the increase of income or the increase of age, is the leading reason of the change of preference, because these two reasons always twist with each other. For example, the income is likely to increase if the age is increasing. Therefore, the changes showed in the income maps may result from increasing age rather than increasing income, vice versa. The analysis here cannot distinguish the functions of them clearly.

6. Commuting and Urban Form

6.1 Commuting and Density

Density and distribution of race are two representatives of urban form. I choose these two aspects to reveal the relationship between commuting and urban form.

Density of County

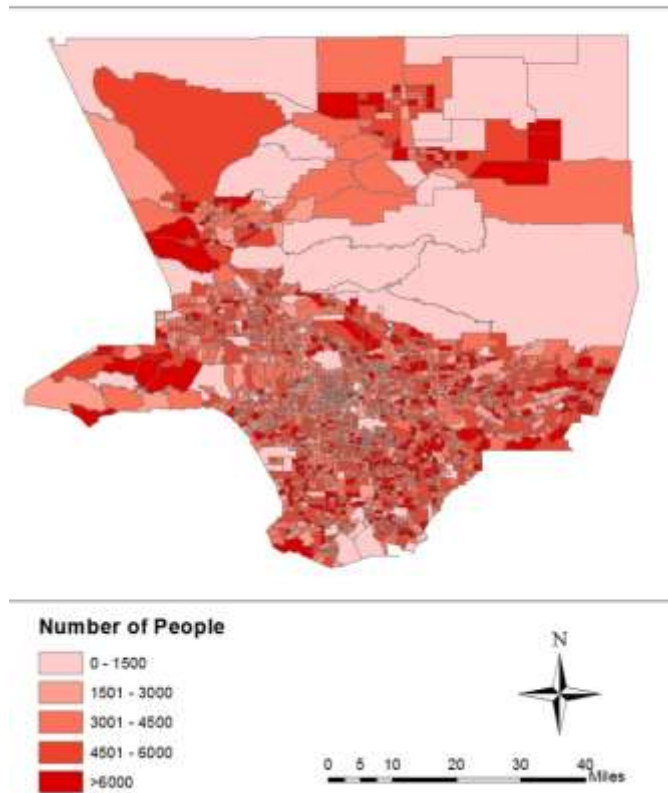


Figure 7 Density of County

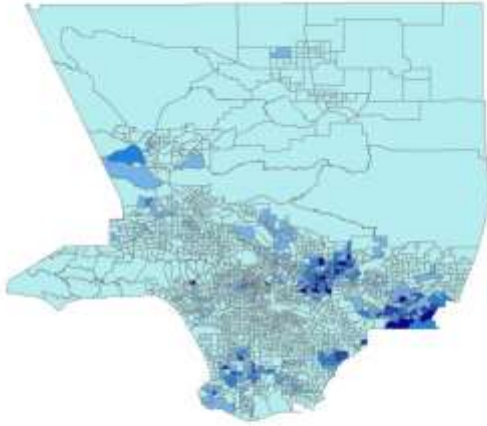
The links between work and residence are believed to be changed by the deconcentration of large urban areas (Clark & Linde, 1993). This means that the commuting is actually influenced by the urban form. The density map shows the similar pattern as the commuting maps, which could approve that there factually exists links between density and commuting. Density and commuting are two things that interact with each other. Because of the improvement of commuting, people are likely to choose some remote areas from the central city where the living environments are better, accelerating the decentralization and the sprawl of city. On the other hand, because of the change of city form which is due to the planning and policy, people are more likely to choose and invest in the areas where having good infrastructure and future, resulting in a change of commuting.

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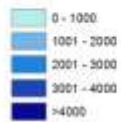
6.2 Commuting and Distribution of Race

In this part, I only choose white, American African or black, and Asian, three categories of race for analyzing, which the maximums of population in Geo ID units are all above 2000, a number that could have obvious influence on shaping urban form (Figure 8).

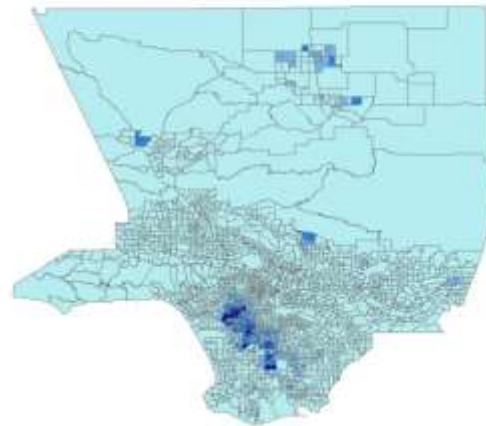
Race Distribution (Asian)



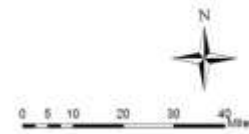
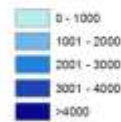
Number of People



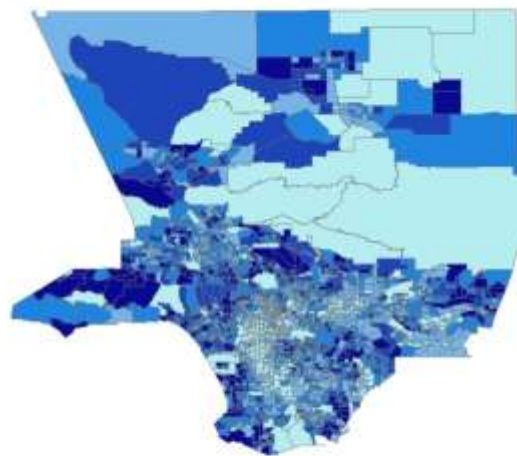
Race Distribution (American African & Black)



Number of People



Race Distribution (White)



Number of People

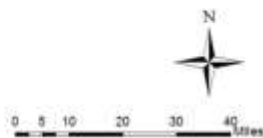


Figure 8 Distribution of Race

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Except the distribution of the white, two others show an apparent centralization pattern in only several areas and have few people in the other places. Only the distribution of the white presents a similar pattern of the commuting maps, which may result from the preference of the race culture. This similar pattern may also come from the reasons of house value, density, or economy condition. However, no matter which of these factors, or some of them at the same, affect the pattern of commuting, it is safe to state that the links between commuting and distribution of race exist, even though there are some chains and other influential factors existing between commuting and distribution of race. The truth is that the study of commuting by analyzing the distribution of race is feasible, vice versa.

7. Conclusion

As showed in the previous maps, sex and income have little effect on commuting behavior. But commuting behavior would have obviously changes as the changes of age. Furthermore, the changes of commuting choice of private vehicles are more significant than the changes of the choice of public transportation. The article also has approved the links between the urban form, especially density and distribution of race, and the commuting behavior by examining the similarity of their pattern features.

However, without creating a dependable methodology to check the causal relationship between the characteristics of residents and the commuting behavior, and to test the mode of how commuting shapes the urban form, these two issues are still uncertain. The difficulties come from not only the complex relationships among the commuting behavior, characteristics of residents, and urban form, but also the interaction of every aspect inner them. The characteristics of residents for example, age, income, and preference are related to each other and none of them is in the dominant position of the characteristics of residents that could lead the change of all other things alone, making the analysis incredibly difficult.

Because of the complexity of commuting behavior and difficulties in analyzing the relationships, the efforts in constructing commuting model or building the relationship between commuting and urban form are flawed by their assumptions which have either

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omitted some important factors or simplified the process. A new methodology is eagerly required for the breakthrough of the research in this field.

Reference

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