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Modeling the effect of accessibility and congestion in location choice

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ABSTRACT

This study explores the relationship between accessibility and congestion, and their impacts on property values. Three research questions are addressed: (1) What is the relation between accessibility and congestion both regional and neighborhood level? (2) Is there a trade-off between accessibility and congestion? (3) What is the effect of accessibility and congestion on property value? To answer these questions, spatial analysis and econometrics are applied to four metropolitan areas in Florida: Miami, Tampa, Orlando, and Jacksonville.

The spatial patterns of accessibility and congestion, and the possibility of trade-offs are analyzed using the Hot Spot analysis and correlation analysis. The hypotheses that accessibility has a positive effect and congestion has a negative effect on property value are tested using econometric models. The results show that the effects of accessibility and congestion vary by MSA because each MSA has different degrees of coordination between land use and transportation systems. Only neighborhood park accessibility and neighborhood congestion show a consistent result with the hypothesis regardless of metropolitan areas. Several possibilities of trade-off between accessibility and congestion are shown in the Miami and Tampa MSA. For instance, residents who reside in neighborhoods with low congestion might experience low regional job accessibility. In this case, residents should consider trade-off between neighborhood congestion and regional job accessibility in their residential choice.

EXECUTIVE SUMMARY

Accessibility and congestion are important factors considered in residential location choice. Based on the bid-rent theory developed by Alonso, residents decide their residential location by considering the balance between land prices and commuting cost within a given income. In addition to job accessibility, accessibility to regional and local amenities such as retail shops, parks, and transit stops coupled with travel preferences will also affect location decisions. Congestion also affects residential location choice because the level of congestion is associated with travel cost and community amenities. Specifically, congestion at the regional level increases travel cost in terms of time and money. At the neighborhood level, congestion generates negative externalities such as noise and pollution.

The relative importance of the effects of accessibility and congestion, and their interaction in residential choice are still a matter of debate. Compact development can generate fewer trips by car and less vehicle miles traveled (VMT) because the dense and mixed land use decreases trip distance and facilitate travel by transit, walking or bicycling. However, compact development and interconnected street patterns generate higher accessibility and could increase trip frequency and create more congestion. All other things being equal, the increased accessibility through compact development may aggravate congestion since higher residential or population density results in more travel. In this way, accessibility and congestion represent a trade-off that could be internalized in property values as people weigh it in their residential choice.

This study explores these relationships through three specific research questions: (1) What is the relation between accessibility and congestion at both regional and neighborhood level? (2) Is there a trade-off between accessibility and congestion? (3) What is the effect of accessibility and congestion on property value? To answer them, spatial analysis and econometrics are applied to four metropolitan areas in Florida: Miami-Fort Lauderdale-Pompano Beach Metropolitan Statistical Area (Miami MSA), Tampa-St. Petersburg-Clearwater MSA (Tampa MSA), Orlando-Kissimmee-Sanford MSA (Orlando MSA), and Jacksonville MSA.

Congestion and accessibility are operationalized both at regional and neighborhood level using various data sources such as property tax rolls, NAVTEQ road network, and transportation planning models. The spatial patterns of accessibility and congestion, and the possibility of trade-off are analyzed using the Hot-Spot analysis and correlation analysis. The hypotheses that accessibility has a positive effect and congestion has a negative effect on property value are tested using econometric models such as multilevel regression and spatial econometrics to address spatial autocorrelation and heteroskedasticity.

The results show that the effects of accessibility and congestion vary depending on MSAs because each MSA has different land use and transportation coordination. Regardless of the four different metropolitan areas, only neighborhood park accessibility and neighborhood congestion is consistent results with the hypothesis. However, some variables such as regional shopping accessibility and neighborhood retail accessibility are shown insignificant. The other variables such as regional job accessibility, neighborhood transit accessibility, and regional congestion show mixed results across the four metropolitan areas. Several possibilities of trade-offs between the accessibility and congestion are shown in the Miami and Tampa MSA. For instance, residents living in less congested neighborhoods may have lower regional job accessibility. In this case, residents should consider trade-off between neighborhood congestion and regional job accessibility in their residential choice. However, Jacksonville MSA and Orlando MSA do not show possibilities of trade-offs between accessibility and congestion.

CHAPTER 1 BACKGROUND

1.1. INTRODUCTION

This report provides empirical findings about trade-offs between accessibility and congestion in residential location choice by examining their effects on single family property values. The concern of home buyers over the accessibility and congestion is reflected in property values when they make residential location choices. This property value effects are investigated in an expanding literature. However, little is known about the trade-offs between the accessibility and congestion, and their respective impacts on property values.

Accessibility is one of the most important factors for residential location. For example, low income households may prefer inner city neighborhoods that have high transit accessibility or high accessibility to jobs because of transportation cost (Blair and Carroll, 2007; Glaeser, Kahn and Rappaport, 2008). In contrast, upper- and middle- households living in gentrified areas may put more emphasis on accessibility to cultural activity (Zukin, 1987) and residents in suburban communities may stress on amenities surrounded by natural resources and low density development (Colwell, Dehring and Turnbull, 2002; Kim, Horner, and Marans, 2005; Rouwendal and Meijer, 2001).

Congestion also affects residential location choice because it generates negative externalities such as noise and pollution (Malpezzi, 1996; Li and Brown, 1980). For instance, if all other things are equal, highly congested areas, such as the inner city near downtown, experience lower housing prices. Therefore, low-income households could afford to locate in these areas because of higher housing affordability and high-income people who dislike congestion may prefer suburban communities. Indeed, congestion in central areas is one of the main factors of migration to suburbs (Downs, 1999; Galster, et al., 2001; Mieszkowski and Mills, 1993). In sum, congestion and accessibility can be important determinants of residential choice because of the effect on housing costs.

However, the relative importance of the effects of accessibility and congestion, and their interaction are still a matter of debate. For example, some authors state that dense and mixed land uses generate fewer trips by car and less Vehicle Miles Traveled (VMT) since these urban configurations facilitate travel by transit, walking or bicycling (Cervero and Duncan, 2006; Chatman, 2008; Crane and Crepeau, 1998; Holtzclaw, Clear, Dittmar, Goldstein, and Haas, 2002; National 2009). However, compact development generates higher accessibility and could increase trip frequency and create more congestion (Boarnet and Crane, 2001; Chatman, 2008; Crane, 1996; Krizek, 2003; Sarzynski, Wolman, Galster, and Hanson, 2006; Shiftan, 2008). All other things being equal, since higher residential or population density results in more travel, the increased accessibility through compact development may aggravate congestion. In this way, accessibility and congestion represent a trade-off that could be internalized in property values as people weigh it in their residential choice.

This study explores these relationships through three specific research questions: (1) What is the relation between accessibility and congestion at both the regional and neighborhood level? (2) Is there a trade-off between accessibility and congestion? (3) What is the effect of accessibility and congestion on single family property values? To answer them, spatial analysis and econometrics are applied to four metropolitan areas in Florida: Miami-Fort Lauderdale-Pompano Beach Metropolitan Statistical Area (Miami MSA), Tampa-St. Petersburg-Clearwater MSA (Tampa MSA), Orlando-Kissimmee-Sanford MSA (Orlando MSA), and Jacksonville MSA.

The theoretical framework is summarized in the following section of this chapter. In chapter 2, the research approach, including data sources, operationalization of congestion, accessibility, and control variables, as well as the methods of analyses such as the spatial econometric models and multilevel regression model based on a hedonic price approach, are described. In chapter 3, results and findings from econometric models are summarized. Finally, implications and limitations of the study are discussed in chapter 4.

1.2. THEORETICAL FRAMEWORK

Accessibility at a regional scale has been the key variable in location models since Alonso (1964) introduced bid rent theories in the analysis of the urban space (Alonso, 1964). These models represent the location decision as a trade-off between accessibility and land area. According to these theories, households try to minimize distance to employment centers by locating in close proximity to central areas. However, these locations are more expensive, and therefore denser, creating a conflict with the second goal of households: maximize the amount of space consumed. In these models, a trade-off can be defined by an occasion associated with involvement of losing one aspect of quality for deciding residential location (land price paid), and in turn obtaining another quality in the location decision (land size consumed). Thus, from the perspective of these theories, residents decide their residential location considering the balance between land price and land size.

For most of the 20th century the car altered this trade-off giving wealthy families the opportunity to access cheaper suburban land and choice among a broader range of residential locations over low-income households because of their less constrained income condition. This aspect of different income levels created an urban space in which poor households tended to be located closer to the city centers at higher densities. However, with the increase in affordability of automobiles and the growth of commuting time, this advantage was eroded and the rich began to return to the city centers generating processes of gentrification (Leroy and Sonstelie, 1983; Skaburskis, 2005). In sum, from the perspective of the theories and location changes of wealthy and poor families due to advances in technology, residents decide their residential location considering the balance between land prices and commuting cost within a given income level.

Furthermore, not only land price and income affect residential location decision but also individual preferences toward local services could affect location decision depending on spatial scale. At the neighborhood scale, accessibility to local services such as retail shops, parks, and transit stops coupled with travel preferences will affect location decisions. As noted earlier, for example, low income households could prefer neighborhoods having high transit accessibility or high accessibility to jobs because of transportation cost (Blair and Carroll, 2007; Glaeser et al., 2008). Some might prefer to live in areas that have quality schools for their children (Holme, 2002). Some residents on suburban areas may emphasize recreation opportunities including parks and open space (Colwell et al., 2002; Bhat and Guo, 2004; Bhat and Guo, 2007). In this way, accessibility to urban services at the neighborhood level is an important consideration in residential location choice.

Recently, proponents of new urbanism argue that mixed land use could benefit residents by bringing more people who are amenable to high density closer to a mix of uses. Neighborhoods designed using new urbanism and smart growth principles that include mixed development, pedestrian friendly environment, transit-oriented development, and proximity to local services could encourage non-motorized travel behaviors like walking and bicycling, and thus improve the public health of the community (Cevero and Kockelman, 1997; Handy, Boarnet, Ewing, and Killingsworth, 2002). The residents living in mixed used communities can benefit from increased accessibility through land use mix. In fact, new urbanism design features have positive impacts on property values, indicating that residents may be willing to pay a premium for mixed use and higher accessibility (Song and Knaap, 2003; Song and Knaap, 2004; Song and Quercia, 2008). For instance, people who like to walk, that has access to service to natural amenities, like park and mountains and other natural feature might want to live in well-designed pedestrian-oriented suburban community. In addition, people who like to participate in cultural activities, high density and high accessibility to local commercial services like retail, and restaurant may prefer to live in proximity to well-designed city center developed with transit-oriented development. However, some people prefer not to live in neighborhoods with high density because they do not want high congestion with reduced local amenity (Churchman, 1999).

Nonetheless, high neighborhood accessibility does not necessarily mean high regional accessibility. Neighborhoods that have better accessibility to local services are not necessarily located near the city center or other major regional destinations. In fact, many communities with neo-traditional styles associated with new urbanism have been built in suburban areas rather than city centers or inner city neighborhoods (Cervero and Kockelman, 1997; Cervero and Radisch, 1995; Khattak and Rodriguez, 2005). These suburban new urbanism communities can have higher neighborhood accessibility to retail and parks, but they may have lower regional accessibility to job centers.

Congestion affects residential location choice in terms of transportation cost and negative externalities. From a metropolitan perspective, congestion increase transportation cost including time and money. According to the Texas Transportation Institute's (TTI), in 2007 the average peak-period traveler in the urbanized areas of the United States experienced an additional 36 hours extra in travel time and consumed an additional 24 gallons of fuel due to congestion (Schrank and Lomax, 2007). This represents an individual annual cost of $757 and an aggregate cost for the nation of $87.2 billion. Since congestion increases commuting time and cost, people would try to avoid travel in congested routes and locations connected by congested routes. Empirically, Bhat and Guo (2007) shows that high-income households are less likely to select neighborhoods that have high commuting time to the major employment destinations (Bhat and Guo, 2007).

At the neighborhood scale, congestion increase traffic volume on the local road network. Accordingly, congestion affects residential choice directly since it generates negative externalities such as noise, barrier effects, pollution, and high risk of accidents (Malpezzi, 1996). Congested roads tend to be noisier because of the volume of traffic and the tendency of drivers to honk their horns impatiently. Congestion creates barrier effects in neighborhoods because of the higher number of cars crossing a point at any given time. Pollution increases with congestion because it raises fuel consumption per mile and because intermittent engine operation intensifies the volume of emissions per gallon. Congestion affects crash frequency (as opposed to severity) because congested conditions increase traffic density, cause people to switch lanes continuously, and raise the variability of speeds (Wells, 2006; Cambridge Systematics, 2008). These effects generate negative externalities for residents; noise generates stress and affects concentration. Barrier effects make crossing streets more difficult, limit mobility, and affect social interaction. Indeed, streets with significant traffic prevent neighbors’ communication, restrict children’s street play, scare residents, and increase the likelihood of car crashes (Appleyard, 1981). Pollution affects human health. Frequent crashes affect the sense of safety and cause costly personal injuries and property damage (Bilbao-Ubillos, 2008). So, if all other things are equal, highly congested areas, such as the inner city near downtown, may experience lower housing prices representing these negative externalities. Therefore, low-income households would tend to occupy these neighborhoods taking advantage of the higher housing affordability. In contrast, upper middle income people who dislike local congestion may prefer suburban communities that are designed to minimize the influx of traffic with cul-de-sac and loop road systems. Indeed, congestion in central areas has been identified as one of the main factors of migration to the suburbs (Mieszkowski and Mills, 1993) and as an important driver of neighborhood decline (Kennedy and Leonard, 2001).

As noted in the introduction, the nature of the relationship between accessibility and congestion is a matter of debate in the specialized literature. On the one hand, higher accessibility could create incentives for less automotive travel decreasing congestion (Cervero and Duncan, 2006). In this case, accessibility and congestion would move in the same direction and their importance in location will be reinforced. On the other hand, higher accessibility could mean more trips increasing the frequency of travel and the congestion associated with it (Crane, 1996; Krizek, 2003; Sarzynski et al, 2006; Shifttan, 2008). In this case, accessibility and congestion would represent a trade-off pulling households to different locations.

In sum, the effect of accessibility and congestion on location choice is an important consideration for housing and transportation planners since, in the long term, accumulated household’s decisions about residential location will change the land use and transportation configurations modifying the spatial structure of the city. Therefore, the role of accessibility and congestion, and their interactions in residential choice needs to be understood systemically.

CHAPTER 2 RESEARCH DESIGN

This study analyzes four major metropolitan areas in Florida: Miami–Fort Lauderdale–Pompano Beach, FL MSA, Jacksonville, Florida MSA, Tampa-St. Petersburg-Clearwater MSA, and Orlando–Kissimmee–Sanford, Florida MSA. In this report, we use combined data from various sources like Florida Department of Revenue and Census, and use geospatial technique such as Moran's I and hot-spot analysis. In order to see the effects of accessibility and congestion on sale price for single family housing, we conduct hedonic analysis with least square models, multilevel regression, and spatial econometric models. Then, z-scores of accessibility variable and congestion variable are estimated and plotted in a map if existence of trade-off between accessibility and congestion is confirmed. Lastly, we summarize the analysis results.

2.1 STUDY AREAS

As noted earlier, four largest MSAs in Florida are analyzed. The Miami MSA consists of three counties: Miami-Dade, Broward, and Palm Beach County. For this region, the Southeast Florida Regional Planning Model (SFRPM) is used to analyze regional congestion. The base year of the model is 2005. The Tampa MSA is composed of Hillsborough, Pinellas, Pasco, and Hernando counties. The Tampa Bay Regional Planning Model (TBRPM) with a base year 2006 is applied for this region. The Orlando MSA is comprised of Orange, Seminole, Osceola, and Lake County. As a transportation model, the 2030 Long Range Transportation Plan model (LRTPM) with a base year 2004 is used. Finally, the Jacksonville MSA is made up of five counties: Duval, Clay, St. Johns, Nassau and Baker County. The Northeast Regional Planning Model (NERPM) with a base year 2005 is applied to measure regional congestion in the Jacksonville MSA.

2.2. OPERATIONALIZATION OF DATA

The observations for this study are the transacted sales of single family housing parcels in the four major metropolitan areas in Florida. The analyses were conducted to single family housing parcel because single family parcels contain individual data on sale price unlike multifamily housing that does not have sale price data for individual units. In order to control seasonal effect in housing price, only parcels that were transacted in January of the base year are selected. The information about the sale price and property characteristics, such as built year, lot size, and floor areas, is obtained from the property tax rolls from the Florida Department of Revenue (FDOR).

Accessibility and congestion are operationalized into four categories: regional accessibility, neighborhood accessibility, regional congestion, and neighborhood congestion. Regional and neighborhood accessibility are operationalized using the road network distance based on the NAVTEQ road network of 2010. Because of the limitation of road network data set, this study assumes that road network of 2010 is the same as that of base year. In order to identify regional job centers, employment data of Traffic Analysis Zone (TAZ) from each transportation planning model, which provides traffic analysis based on the four steps transportation model, provided by the Florida Department of Transportation (FDOT), is used. The location of shopping destinations, such as regional and community shopping centers, is identified using the land use data from the property tax rolls. For measuring park accessibility, each county's GIS center information is used, and bus transit route information from the Florida Geographic Data Library (FGDL) is applied in measuring bus transit accessibility.

For regional congestion, the skim matrix, which reports travel time between origin and destination TAZs, both at free flow and congested conditions from each region's transportation planning model, is used. Finally, traffic count data from the FDOT is used to operationalize neighborhood congestion.

In measuring proximity to water areas, the National Hydrography Dataset with 1:24,000 scale is used. For intersection density, the location of intersections is identified using the NAVTEQ road network. The number of workers at the census block group level is calculated based on the Longitudinal Employer Household Dynamics (LEHD). Other relevant data such as socio-economic information from Census 2000, the American Community Survey 2005-2009, the Elementary School Attendance Boundary for each county and the Florida Comprehensive Assessment Test (FCAT) score from the Florida Department of Education (FDOE) are used to construct control variables representing neighborhood characteristics.

2.2.1. OPERATIONALIZATION OF ACCESSIBILITY

This study operationalizes accessibility both at regional and neighborhood level. The regional accessibility to job centers (regional job accessibility) is measured using a gravity model as expressed in equation (1). For the purposes of this study, only job centers are included in calculating the regional job accessibility. As peak hour congestion mainly results from commuting to employment centers in the morning, job accessibility is measured only considering job centers in order to have comparable measurements. Also, the regional accessibility to job centers can reflect the urban form around the job centers. The gravity model is widely used for accessibility measure. K-factor is called a distance decay factor or an adjustment factor that is applied to normalize distance between origin and destination in the gravity model. The k-factor is typically linear (k=1) or negative exponential (k=2). Since the gravity model is highly dependent on local conditions and the road network, the model is likely to have non-linear relationship with distance. Thus, this study uses 2 as decay factor to examine the non-linearity of distance. The regional job centers are identified by using ten workers per acre employment density threshold at the TAZ level. The ten workers per acre density is one of the most frequently used thresholds to identify employment sub-centers (McMillen, 2003).

$$Regional\ Job\ Accessibility\ of\ i\ parcel = \sum_{j=1}^{N} \frac{E_j}{D_{ij}^k} \tag{1}$$

Where E_j : number of employee of a job center j

D_{ij} : network distance from a property i to a job center j

N: number of jobs centers

k: distance decay factor (k = 2)

Similarly, regional accessibility to regional shopping malls (regional shopping accessibility) is measured using equation (2). The regional shopping centers, which are taken from the FDOR data, include the category of regional shopping centers and department stores.

$$Regional\ Shopping\ Accessibilty\ of\ i\ parcel = \sum_{j=1}^{N} \frac{F_j}{D_{ij}^k} \tag{2}$$

Where F_j = floor areas of a regional shopping center j

D_{ij}: network distance from a property i to a regional shopping center j

N: number of regional shopping centers

k: distance decay factor (k = 2)

For neighborhood accessibility, three travel destinations — retail, parks and bus transit — are considered. First, neighborhood accessibility to retail use (neighborhood retail accessibility) is operationalized as an inverse of the shortest network distance from an origin single family parcel to a shopping center. The shopping centers in this case include all neighborhood, community, and regional shopping centers. Second, neighborhood park accessibility is measured by total sum of land areas of public parks, including city parks, county parks and state parks, within a half mile from the origin single family property. A half mile distance is applied as a walking distance. Finally, neighborhood transit accessibility is operationalized as a sum of length of bus transit routes within a half mile from the origin single family housing parcel.

2.2.2. OPERATIONALIZATION OF CONGESTION

Congestion is also operationalized at the two different geographical levels: regional and neighborhood congestion. The regional congestion is operationalized as the difference between weighted travel time to job centers at a congested condition and that of a free flow condition. As noted earlier, peak hour congestion mainly results from commuting to job centers; only the commuting time to job centers are considered in calculating the regional congestion. The travel time from the origin property to a destination job center is measured using the travel time from an origin TAZ, in which the single family housing parcel is located, to a destination TAZ where the job center is located based on the free flow time and congested time skim tables of the transportation planning model of each region.

The number of job centers is used to weigh. Each MSA has different proportion of job centers compared to number of TAZ. The number of TAZ within the Miami MSA is 4,106, and the number of job centers in the Miami MSA is 709. The Jacksonville MSA contains 1,862 TAZs of which employment centers account for 147. The Tampa MSA contains 2,251 TAZs while the number of job centers is 247. The number of TAZs in the Orlando MSA is 1,678, and the number of job centers is 163. A comparison of the employment in major job centers to the overall MSA population found that Miami MSA has about 25%, the Jacksonville MSA has 14%. The Tampa MSA contains about 20%, and the Orlando MSA includes 27%. This suggests that the employment in each of these MSAs is de-concentrated.

Conceptually, the measure for the regional congestion indicates the expected average travel time increase through congestion. The operationalization of regional congestion to job centers (regional congestion) is expressed by equation (3).

$$Regional\ Congestion\ of\ a\ property\ i = \sum_{j=1}^{N}(W_j * T_{ij}) \text{ at a congested condition - } \sum_{j=1}^{N}(W_j * T_{ij}) \text{ at a free flow condition} \quad (3)$$

Where, W_j: number of employee within a TAZ j, in which a job center is located

T_{ij} : travel time from a TAZ i, in which a single family property is located, to a TAZ j, where job center j is located.

N : number of job centers

The neighborhood congestion is operationalized using the Roadway Congestion Index (RCI) based on Blanco et al. (2010) who applied the methodology suggested by the Texas Transportation Institute to Florida (Schrank and Lomax, 2007, and Schrank and Lomax, 2009). Based on the traffic count, number of lanes, and road length information for major roads, the neighborhood congestion is calculated using equation (4). All freeways, major and minor arterials classified by the FDOT within a half mile buffer from the origin single family housing property are aggregated to calculate the RCI. If the RCI is larger than one, the road capacity is not sufficient to maintain free flow speed. In other words, the road segments are in congested condition. If freeways and arterials do not pass through within a half mile buffer from a single family parcel, the value of RCI is assumed as zero.

$$Neighborhood\ Congestion\ of\ property\ i = \frac{FreewayVMTperLn.Mi. * FreewayVMT + ArterialsVMTperLn.Mi. * ArterialsVMT}{14{,}000 * FreewayVMT + 5{,}000 * ArterialsVMT} \quad (4)$$

Where, VMT is vehicle miles traveled.

2.2.3. OPERATIONALIZATION OF CONTROL VARIABLES

As control variables, several property and neighborhood characteristics, as well as location information are used. First, property age, floor area, and lot size of a single family parcel are applied as property characteristics. Regarding the neighborhood characteristics, three density variables, — intersection density, housing density, and job density —, school quality, and neighborhood income and poverty level are used. Intersection density is measured as the number of intersections within a half mile buffer from a single family parcel. Housing and job density are measured by number of housing units (or jobs) per developable land acres at a census block group level. The developable land is calculated by subtracting area of water bodies from total land area of each census block group. Median family income and poverty rate of each census block group are used to control different economic status of neighborhoods. School quality is measured by averaging the FCAT score of reading and math for fifth grade. The FCAT score of each school is normalized by the Florida average score. Finally, water proximity and x, y coordination are used as locational information. Dummy variable for water proximity is created. If water areas such as beaches and lakes are located within a half mile distance from a single family parcel, the value is set as one and all other cases are set as zero. The x, y coordination of single family property is also included to minimize spatial autocorrelation and heteroskedasticity in hedonic price model. The measurement of variables and sources of data including transportation planning model of each MSA are summarized in Table 2-1.

Table 2-1. Variables and sources of data

Factors	Measures	Data sources	Year considered
Sale price Floor area (ft^2) Lot size(acre)	Transaction price at January of base year Total living area Land area of a single family parcel	Property tax rolls from the Florida Department of Revenue	Base year - 2004: Orlando - 2005: Miami, Jacksonville - 2006: Tampa
Regional acc. to job centers Regional acc. to shopping malls	Gravity accessibility (k=2) Gravity accessibility (k=2)	NAVTEQ road network Number of employee of TAZs Land use from the tax rolls	2010 Base year Base year
Neighborhood retail acc.	Inverse distance to closest retail use	NAVTEQ road network Land use from the tax rolls	2010 Base year
Neighborhood park acc.	Sum of park areas within a half mile buffer	County GIS center	2012
Neighborhood transit acc.	Sum of bus transit routes within a half mile buffer	FGDL	2008
Regional congestion	Difference between congested and free flow condition travel time to job centers	Miami: SFRPM Tampa: TBRPM Orlando: LRTPM Jacksonville: NERPM	2005 2006 2004 2005
Neighborhood congestion	RCI within a half mile buffer	Traffic count and road information from FDOT	Base year
Proximity to water areas	Dummy (distance is shorter than 0.5 mile, then 1, else 0)	NHD water bodies 1:24,000	2010
Intersection density	Number of intersection within a half mile buffer	NAVTEQ intersection	2010
Housing density	Housing units per developable acres	Census 2000 ACS 2005-2009	2005, 2006
Job density	Number of workers per developable acres	LEHD	Base year
School quality	Average of math and reading score normalized by state average score	FCAT score for grade 5 School attendance boundaries	Base year & 2010
Median family income	Median family income of a census block group	Census 2000	2000
Poverty rate	Poverty rate of a census block group	Census 2000	2000

2.3. METHODS OF ANALYSIS

This study analyzes the relationship between congestion and accessibility, and their effect on property value by four ways: (1) descriptive statistics, (2) correlation analysis, (3) spatial pattern analysis, and (4) regression models. First, descriptive statistics of variables are presented and the level of congestion and accessibility is discussed. Second, Pearson correlation analysis between accessibility and congestion variables is conducted to figure out their association, specifically focusing on the possibility of a trade-off.

Third, spatial pattern of accessibility and congestion are analyzed using Hot Spot Analysis. The hot spot analysis shows where a variable is spatially clustered with high or low value based on the Getis-Ord Gi* statistic (Getis and Ord, 1992). In the result maps of hot spot analysis, the red colored area is the hot spot of an event (a variable of interest) in which the variable has a very high value compared to nearby locations, and the blue colored area is the cool zone of an event in which the variable have very low value compared to adjacent areas. As a spatial weighting matrix for the analysis, the Delaunay triangulation method is applied to Miami, Tampa, and Orlando MSA. However, the k-nearest neighborhood method (k=14) is applied to the Jacksonville MSA because it generates more significant Moran's I and Z-score than the Delaunay triangulation method.

Finally, this study applies spatial econometrics models to address spatial autocorrelation and heteroskedasticity in estimating the effect of accessibility and congestion on single family property values. Hedonic price modeling allows estimating attributing value or demand to differential characteristics of property (Sirmans, Macpherson, and Zietz, 2005). According to hedonic theory, the property is the composite goods that can be discomposed into several attributes like property characteristics, and environmental characteristics (Sirmans et al., 2005; Cevero and Duncan, 2004). Especially, the hedonic pricing model is often used in estimating cost or pricing relevant to quality of air, pollution, accessibility to amenities like park, cultural center and local restaurant, accessibility to job centers and CBD, and congestion (Ottensmann, Payton, and Man, 2008; Shin, Washington, and Choi, 2009; Kawamura and Mahajan, 2005; Martinez and Viegas, 2009). This approach to valuation of housing price represents people's utility or preference that people place on a certain property (Sirmans et al. 2005). Accordingly, considering the fact that people's preference for location choice is monetized into property value, it can be assumed that the property value reflects people's perception toward bundle of characteristics of property and surrounding neighborhoods. For instance, a negative effect on property value means negative perception from residents whereas a positive effect on property value indicates higher preference from residents. Thus, results of hedonic modeling could provide clues on trade-offs between accessibility and congestion.

In general, ordinary least squares (OLS) estimation is used for the hedonic price modeling. However, property value estimation using ordinary least square regression (OLS) is usually criticized in the literature because sale price tend to be spatially clustered and heterogeneous, characteristics that may result in bias in the estimation (Kim, Phipps, and Anselin, 2003; Paterson and Boyle, 2002). Therefore, this study applies multi-level regression, which is also called hierarchical regression, and spatial econometrics to address spatial dependence issue. Followings are conceptual model specifications for each regression.

(1) OLS: $y = \beta X + \varepsilon$

(2) Multilevel: $y = \beta X + \gamma Z + \varepsilon$

(3) Spatial Autoregressive Model (SAR): $y = \rho Wy + \beta X + \varepsilon$

(4) Spatial Error Model (SEM): $y = \beta X + \lambda W \upsilon + \varepsilon$

(5) Spatial Combo Model (SCM): $y = \rho W y + \beta X + \lambda W \upsilon + \varepsilon$

Where, y is a dependent variable, X is a vector of independent variables, β is a vector of coefficients of each variable including intercept, and ε is residual. In the multilevel model, Z is a vector of variables for random effect, and γ is a vector of coefficients of variables for random effect. In the spatial regression models, ρ is a coefficient of spatial autoregressive term, W is a spatial weighting matrix, λ is a coefficient of spatial error term, υ is a spatial error term. Like the hot spot analysis, the Delaunay triangulation and k nearest neighborhood method are applied to create spatial weighting matrix. Existence of spatial autocorrelation in residual is tested using the Moran's I.

For the regression models, outliers of sample data are eliminated based on the Cook's D statistics. The OLS is estimated based on the heteroscedasticity-consistent covariance matrix estimators suggested by MacKinnon and White (1985) to address the heteroskedasticity issue. Multi-collinearity is examined using the variance influence factor (VIF). Since all VIF values are less than five, multi-collinearity is not a problem of this data set. However, the OLS estimator does not satisfy the normality assumption of residual. Therefore, the estimated results of the OLS may have some bias.

In the multilevel model, housing submarkets are classified using K means cluster analysis based on housing and job density, poverty rate, median family income, school quality, and x, y coordination. The identified housing submarkets are used as a higher level group. The variables for lower level are the same as the OLS, but only the intercept variable is included for random effect in higher level. The multilevel regression is conducted using maximum likelihood method.

Regarding the spatial econometric models, the models are estimated using the PySAL which is an open source library for spatial analysis developed by the GeoDa Center for Geospatial Analysis and Computation at the Arizona State University. The SAR model is estimated by two stage least square based on Anselin (1988) with White consistent estimator to address heteroscedasticity. The SEM and SCM are estimated by generalized method of momentum based on Arraiz et al (2010) which also address heteroscedasticity. For SAR and SCM, WX variables are included as instrument variables for spatial lagged term.

The detailed conceptual model specification except spatial or random term is expressed in equation (5).

$$\text{Log Sale Price}_i = \alpha_i + \beta_0 \cdot \text{Regional Accessibility} + \beta_1 \cdot \text{Local Accessibility} + \beta_2 \cdot \text{Regional Congestion} + \beta_3 \cdot \text{Local Congestion} + \beta_4 \cdot \text{Control} + \varepsilon \tag{5}$$

The regional and neighborhood accessibility variables are expected to increase the housing price because households prefer areas that are more accessible to job centers, shopping centers, and parks. Regional congestion may reduce housing price because residents are expected to experience longer commuting times. Neighborhood congestion may decrease the property value by creating negative externalities such as pollution and noise.

Regarding control variables, the older and smaller housing may have lower property values. The density variables could have ambiguous results but, in general, they may negatively affect housing price because people tend to have higher preference for suburban communities characterized by auto oriented homogeneous low density residential communities. It is anticipated that the median family income increases the housing price, and the poverty rate reduces the housing price. In general, higher income or lower poverty rates means better neighborhood quality, and the quality is positively internalized into housing price. The school quality is expected to affect property value positively because people are willing to pay more on housing in order to take advantage of higher education levels and safer schools. The proximity to water areas may positively affect property value because the areas can provide benefits to residents as open space and recreation places.

CHAPTER 3 RESULTS AND FINDINGS

This section provides an overview of each major MSA and descriptive statistics of variables used in regression models. Additionally, results of hotspot analysis and regression models are presented. Finally, a summary of findings for each region will be presented.

3.1. MIAMI MSA

3.1.1. GENERAL OVERVIEW OF MIAMI MSA

General map of Miami MSA is shown in Figure 3-1. The Miami MSA consists of three counties: Palm Beach, Broward, and Miami-Dade Counties with central cities like West Palm Beach, Fort Lauderdale and Miami, respectively. The Miami MSA has the largest population accounting for about 25% of the entire population in Florida. Because of Atlantic Ocean in the east and Everglades in the west, land development pattern is confined to a linear shape along the east coast. Five interstate highways serve traffic in the Miami MSA area including I-95 (north to south along the coast), I-75 (from Miami to the west), I-595 (Broward coast to I-75), I-195 and I-395. US-27 also connects to the central city of Fort Lauderdale and the city of Miami.

The spatial pattern of job centers and TAZs is presented in Figure 3-2. Job centers are largely distributed throughout the regions and many jobs are concentrated in Miami-Dade County. The spatial pattern of regional shopping centers in Figure 3-3 shows that regional shopping centers are located throughout the metropolitan area.

The Spatial pattern of regional accessibility is shown in Figure 3-4. Single family parcels with high regional job accessibility are largely concentrated in the city of Fort Lauderdale, the City of Miami, and the I-95 corridor in Broward and Miami-Dade Counties. In particular, Hialeah which is located to the west of the City of Miami, and Coral Gables which is located to

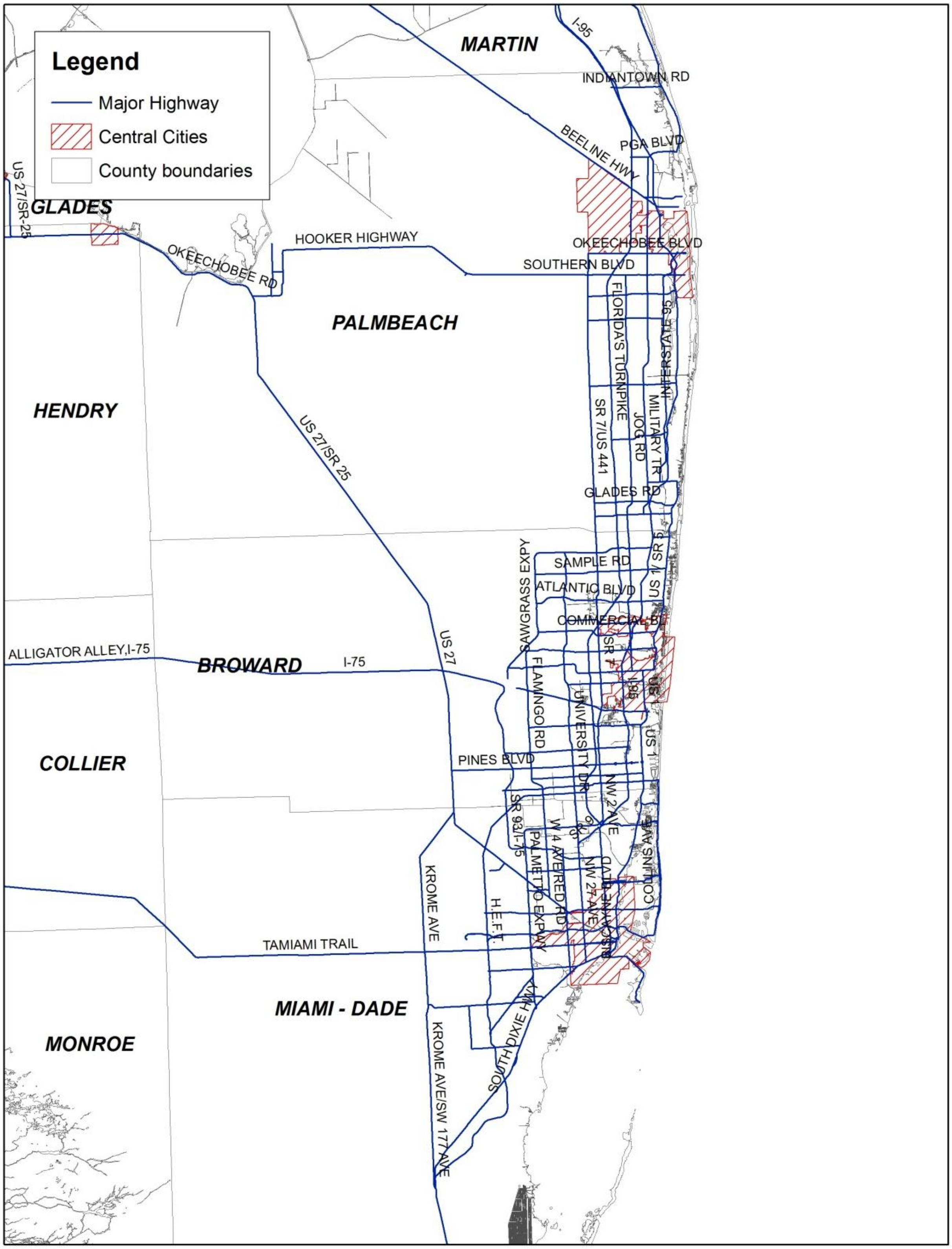

Figure 3-1. General Map of the Miami MSA

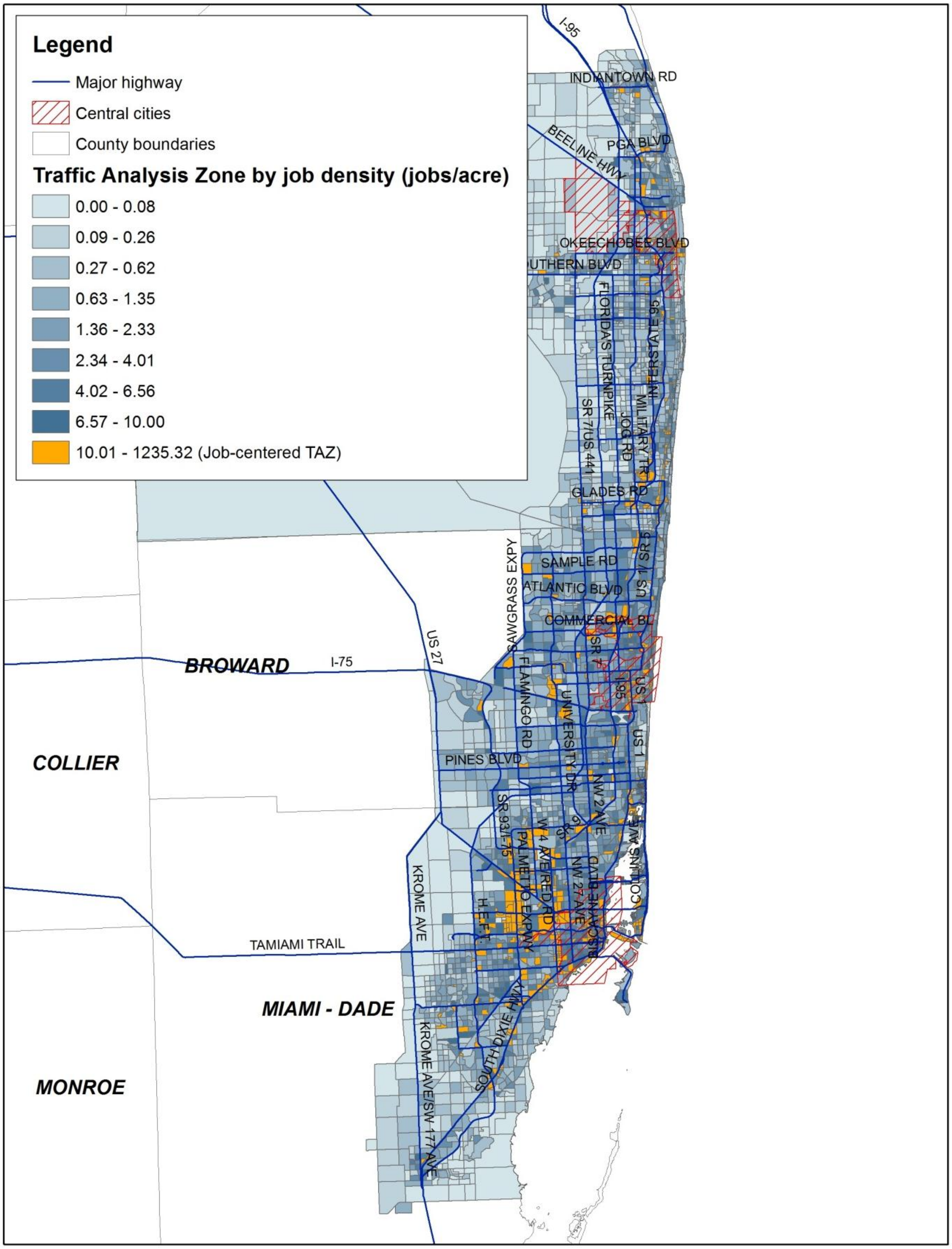

Figure 3-2. Spatial Pattern of Job Centers and TAZ in the Miami MSA

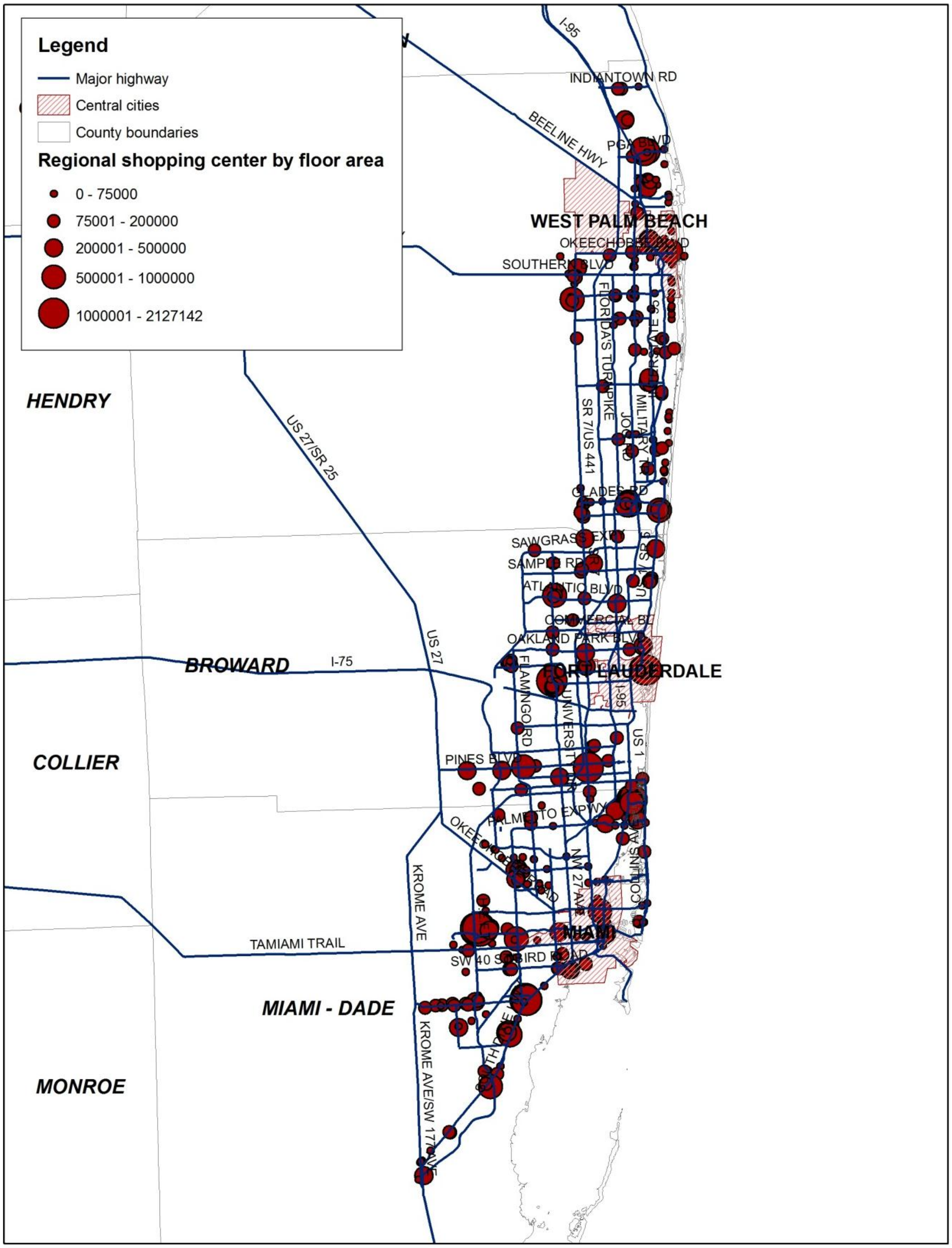

Figure 3-3. Spatial Pattern of Regional Shopping Centers in the Miami MSA

the south, contain single family homes that have the highest regional job accessibility. Hollywood and Boca Raton in Broward County, and the West Palm Beach in Palm Beach County have single family parcels that are highly accessible to job centers. This pattern may occur because many employment centers are clustered in southern part of Broward County and several high-tech job centers like Boca Raton and Fort Lauderdale attracting more trips.

Many single family parcels with high regional shopping accessibility are located in several southern cities in southern Miami-Dade County like Coral Gables. Single family homes in North Miami Beach, and Hialeah also have high regional shopping accessibility. This may be because regional shopping centers in south Miami are located along South Dixie Highway, US27, and main expressways that can be accessible easily from a variety of origins. Also, several major roads like Dixie Highway and I-95 that connect to the areas of job centers and shopping centers might play an important role in improving regional shopping accessibility.

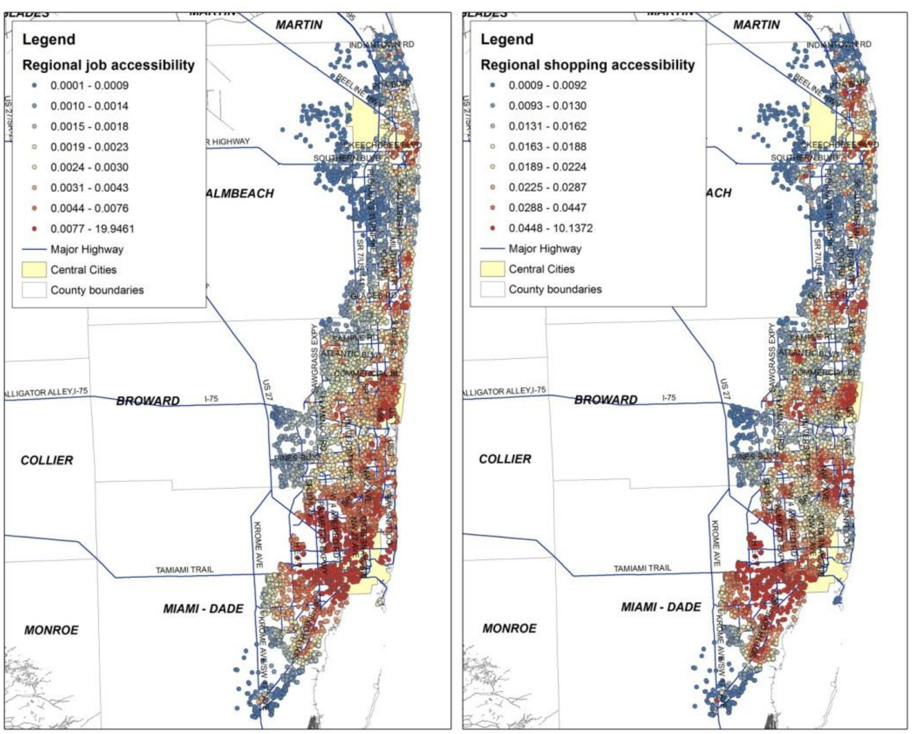

Figure 3-4. Spatial Pattern of Regional Accessibility in the Miami MSA

3.1.2. DESCRIPTIVE STATISTICS

The descriptive statistics for the variables used in the econometric models are shown in Table 3-1. The regional accessibility to job and shopping centers seems to be low because they standardized by the square of network distance. The statistics for neighborhood accessibility show that there is a large spectrum of local accessibility values. On average, the minimum distance to retail services is about 0.63 mile,— inverse of the neighborhood retail accessibility value —, and approximately 0.023 square mile of park and about 3.4 miles of transit route length are located within a half mile from a single family housing.

The level of regional congestion is not high. The mean of regional congestion of the 5706 single family houses in 2005 indicates that on average residents of these housing spend more than 3 minutes in commuting at the congested condition compared to free flow condition. The regional congestion ranges from 1.7 to 5.6 minutes. The neighborhood congestion ranges from 0 to 6 with mean value of 2.1. The maximum value of 6 indicates the traffic volume is six times of the road capacity.

Table 3-1. Descriptive Statistics for the Miami MSA

Variables	N	Mean	Std-Dev	Min.	Max.
Ln(sale price)	5706	12.530	0.573	10.457	15.664
Property age (year)	5706	25.856	19.764	0.000	105.000
Floor area (ft^2)	5706	2030.770	963.514	0.041	77.734
Lot size (acre)	5706	2.129	2.937	0.0407	77.7344
Regional job accessibility	5706	0.005	0.030	0.000	1.582
Regional shopping accessibility	5706	0.028	0.054	0.001	3.021
Neighborhood retail accessibility	5706	1.568	1.809	0.115	50.000
Neighborhood park accessibility	5706	0.023	0.041	0.000	0.442
Neighborhood transit accessibility	5706	3.416	4.267	0.000	33.985
Regional congestion	5706	3.156	0.751	1.648	5.602
Neighborhood congestion	5706	2.112	1.397	0.000	6.010
Intersection density	5706	153.727	54.765	4.000	472.000
Housing density (unit/acre)	5706	3.021	2.244	0.004	27.428
Job density (workers/acre)	5706	1.878	3.301	0.000	101.905
School quality	5706	0.998	0.063	0.842	1.145

Median family income (1,000$)	5706	59.106	26.047	7.222	200.001
Poverty rate (%)	5706	0.104	0.095	0.004	0.779
Water proximity (dummy)	5706	0.246	0.431	0.000	1.000
X coordination	5706	775.908	10.155	730.660	793.630
Y coordination	5706	246.228	42.759	164.370	335.506

Note: X coordination and Y coordination do not necessarily ensure to be interpreted as results of this analysis. They are inserted to the regression model to control spatial bias that could be derived from locations of single family houses.

3.1.2. CORRELATION ANALYSIS: TRADE-OFF

The results of correlation analysis in Table 3-2 demonstrate the possibility of trade-offs between accessibility and congestion both at regional and neighborhood level. The regional congestion is positively related with the regional job and shopping accessibility. Also, as shown by accessibility to park and retail, neighborhood accessibility and neighborhood congestion are positively correlated. As the location with higher accessibility has higher congestion level, the trade-off in residential location choice between accessibility and congestion may exist when the accessibility positively affect property value and congestion negatively internalized into property value.

Table 3-2. Correlation between Accessibility and Congestion in the Miami MSA

	ln(sprice)	reg.job.acc	reg.shop.acc	retail	parks	transit	Reg_con	Nh_con
ln(sprice)	1.000							
reg.job.acc	0.011	1.000						
reg.shop.acc	0.045	0.032	1.000					
retail	-0.176	0.039	0.233	1.000				
parks	0.056	-0.005	0.070	0.002	1.000			
transit	-0.236	0.109	0.131	0.249	0.041	1.000		
Reg_con	0.185	0.062	0.067	0.053	0.008	0.101	1.000	
Nh_con	-0.145	0.062	0.109	0.157	0.027	0.362	0.102	1.000

3.1.3. SPATIAL PATTERNS OF CONGESTION AND ACCESSIBILITY

The spatial patterns of regional accessibility are shown in Figure 3-5. The properties having higher regional job accessibility are spatially clustered within CBD areas of City of

Miami and Ft. Lauderdale. The regional shopping accessibility is more dispersed than the regional job accessibility. In particular, properties with higher regional shopping accessibility are spatially clustered in southwest suburban areas of Miami Dade County.

The spatial patterns of neighborhood accessibility are shown in Figure 3-6. In general, single family parcels having higher neighborhood retail accessibility are spatially clustered within central city or inner city areas. In contrast, houses with lower retail accessibility are spatially clustered in the urban fringe and rural areas. The hot spots of the neighborhood park accessibility are located along coast lines and in suburban areas. Inner city areas of Miami-Dade County and Broward County are the hot spots of the neighborhood transit accessibility, and suburban areas are cool zones of the neighborhood transit accessibility.

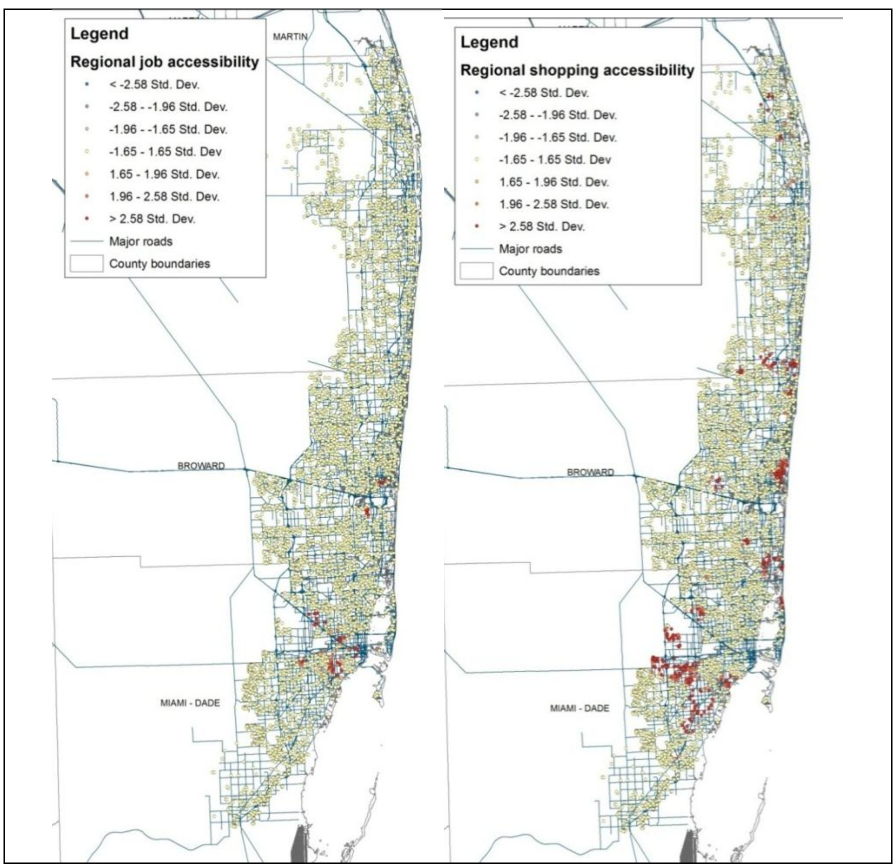

Figure 3-5. Spatial Clustering of Regional Accessibility in the Miami MSA

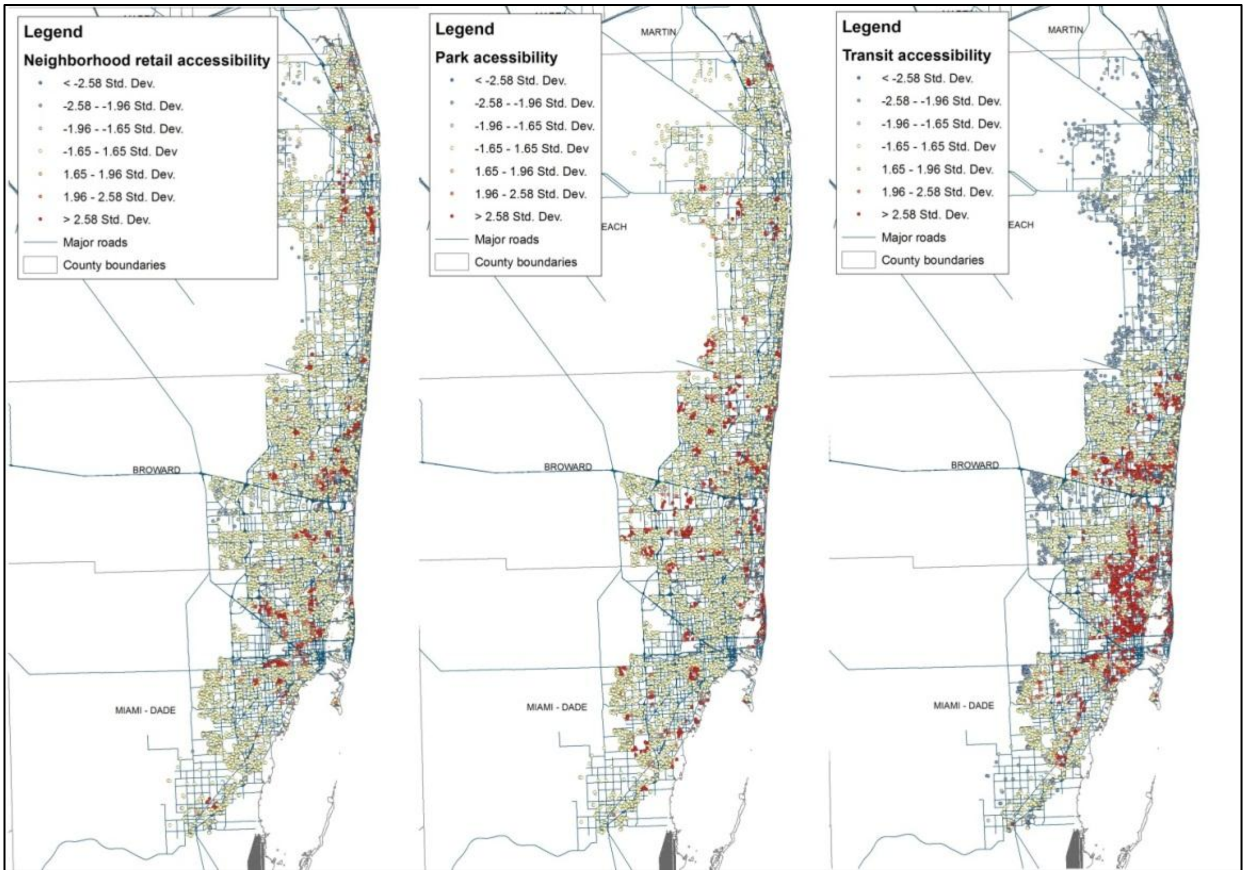

Figure 3-6. Spatial Clustering of Neighborhood Accessibility in the Miami MSA

The properties having higher regional congestion are spatially clustered in south side of the City of Miami in Fort Lauderdale, and in suburban areas of Palm Beach County. In contrast, parcels with lower regional congestion are clustered in suburban areas of Miami-Dade County and Broward County, and inner city areas of Palm Beach County as shown in Figure 3-7. Palm Beach County has different spatial patterns of regional congestion compared to other counties. This may be affected by distribution of jobs in the Miami MSA. Since more than two third of jobs in the region are located between the City of Miami and Ft. Lauderdale, regional job accessibility of suburban areas in Miami-Dade and Broward County are much higher than that of Palm Beach County as shown in Figure 3-1. Inner city areas are hot spots of the neighborhood congestion and urban fringe areas have less cool zones in the neighborhood congestion.

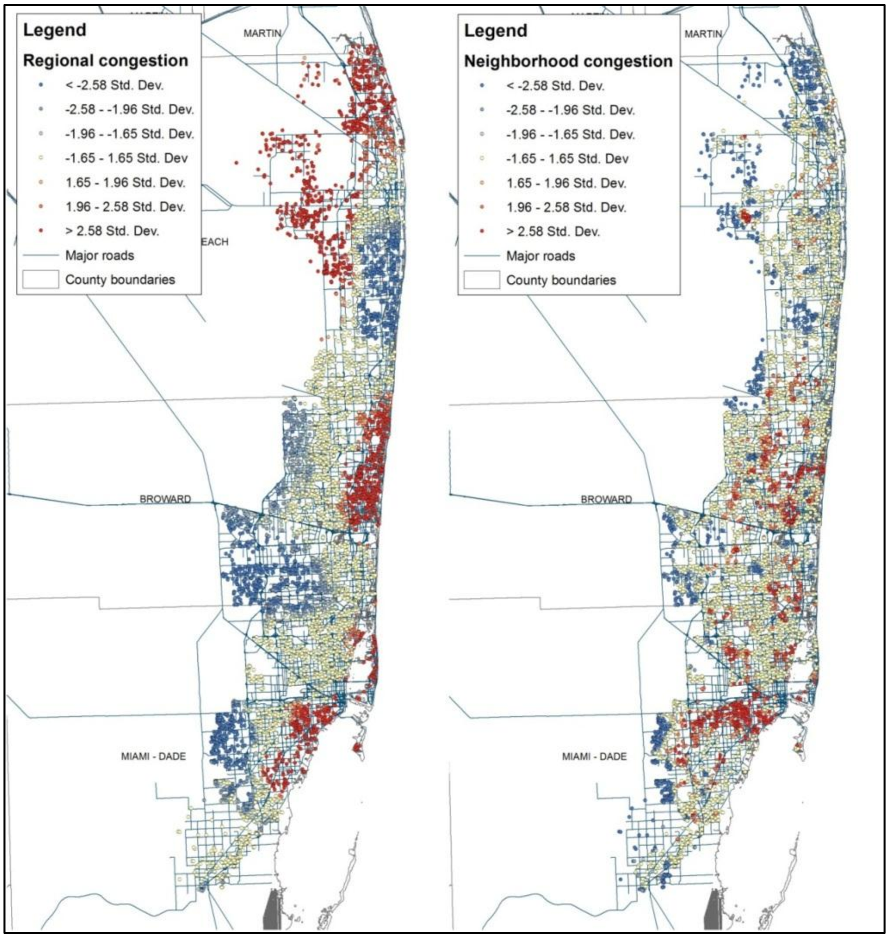

Figure 3-7. Spatial Clustering of Congestion in the Miami MSA

3.1.4. RESULTS OF ECONOMETRIC MODELS

The results of regression analysis for the Miami MSA are summarized in Table 3-3. In general, the directions of the estimated parameters are the same regardless of the type of model used, but the statistical significance of some variables varies depending upon the model. The Moran's I of each model shows that even though spatial econometric models are applied, the spatial autocorrelation of residual is not removed. However, the tendency towards spatial autocorrelation is reduced when the multilevel regression is applied. In Moran's I test, the Z-score is measures of standard deviation which determines whether or not we can reject null hypothesis when we know critical Z-score. In any case, the null hypothesis is that there is no spatial pattern or clustering. The critical Z-score is absolute value of 1.65 at 90% confidence level, the critical value of Z-score at a 95% confidence level is absolute value of 1.96, and the critical Z-score at 99% confidence level is absolute value of 2.58. If the calculated Z-score is greater than the critical Z-score, then we can reject the null hypothesis. When the significance of Z-score is confirmed, the Moran's I can be used to evaluate the spatial pattern: clustering, random, and dispersion. A Moran's I value that is close to +1.0 means clustering whereas the value that is close to –1.0 indicates dispersion.

Table 3-3. Estimated Results of Regression Models for the Miami MSA

Variables	OLS	Multi-level	SAR	SEM	SCM
Property age (year)	-0.0018*	-0.0026*	-0.0017**	-0.0018**	-0.0017**
Floor area (ft^2)	0.0004*	0.0003*	0.0004**	0.0004**	0.0004**
Lot size (acre)	0.0122*	0.0113*	0.0116**	0.0117**	0.0116**
Regional job accessibility	0.2591	0.1721	0.2924**	0.2823**	0.2865**
Regional shopping accessibility	0.2310*	0.0569	0.2376	0.2357	0.2313
Neighborhood retail accessibility	-0.0008	-0.0037	-0.0006	-0.0006	-0.0007
Neighborhood park accessibility	0.0255	-0.0059	0.0327	0.0498	0.0350
Neighborhood transit accessibility	-0.0084*	-0.0060*	-0.0080**	-0.0081**	-0.0078**
Regional congestion	0.0657*	0.0486*	0.0608**	0.0626**	0.0603**
Local congestion (RCI)	-0.0119*	-0.0097*	-0.0108**	-0.0112**	-0.0112**
Intersection density	-0.0001	-0.0004*	-0.0001	-0.0001	-0.0001
Housing density (unit/acre)	0.0182*	0.0115*	0.0198**	0.0194**	0.0195**
Job density (workers/acre)	0.0066*	0.0033*	0.0070**	0.0069**	0.0069**
School quality	1.2821*	0.8455*	1.0213**	1.0518**	1.0321**
Median family income (1,000$)	0.0046*	0.0040*	0.0049**	0.0049**	0.0049**
Poverty rate (%)	-0.5338*	-0.5332*	-0.5553**	-0.5575**	-0.5509**
Water proximity (dummy)	0.1407*	0.0841*	0.1381**	0.1367**	0.1372**
X coordination	0.0115*	0.0167*	0.0106**	0.0109**	0.0108**
Y coordination	-0.0040*	-0.0048*	-0.0038**	-0.0038**	-0.0038**
Intercept	2.1629**	-0.9854	2.3979**	2.7995**	2.2691**
Rho	-	-	0.0505**		0.0501**
Lambda	-	-		0.1084**	0.0551*
Adj. R-square (Pseudo R^2)	0.7639	-	0.7622	0.7611	0.7622
Moran's I (Z-score)	0.22 (28.49)	0.13 (16.54)	0.22 (28.91)	0.22 (28.47)	0.22 (28.47)

Note: *, ** are significant at 5% and 1% level, respectively. The results of random solution in the multilevel regression are not reported in this table.

Overall, the directions of estimated parameters are consisted with the hypothesis of this study: property value of single family housing is positively related with accessibility, and property value of single family housing is negatively associated with congestion. However, some variables (e.g. transit accessibility and poverty rate) show counterintuitive results to the original hypothesis.

Specifically, the transit accessibility shows a negative effect on sale price. The transit accessibility tends to be higher in inner city areas where the residences of low income households are concentrated. Although the poverty rate is included to control the concentration of the poor, unobserved negative externalities of inner city areas may create some bias in the results of transit accessibility. Moreover, in the condition that auto vehicles are the dominant travel mode and transit mode share is low (as it is the case in Miami), transit accessibility may not have a positive effect on housing prices.

The neighborhood retail accessibility also negatively affects housing price, but the estimators are not statistically significant. The weak negative association between the neighborhood retail accessibility and the property value could be a reflection of people's preference for the single, segregated land uses that characterize suburban residential communities.

The regional congestion has a positive effect on sale price. In terms of spatial distribution, the property value and regional congestion are positively correlated in Palm Beach County, the City of Coral Gables (south side of the City of Miami), and areas along the coast.

Both housing and job density have positive effects on sale price. As noted earlier, the average residential density of the Miami MSA is only three housing units per acre. Normally, residential density should be more than 5 or 6 units per acre to support transit service, so the low housing density in Miami MSA may indicate that transit service is not fully supportive to many single homes. When density level is low, increased density may imply the increased demand without decreasing community amenities. Subsequently, density can increase property value. However, increased density does not necessarily mean an increase in sale price because there might be non-linear effect of density on sale price (Galster et al., 2000; Galster et al., 2006). The density is associated with economic development and amenity of neighborhoods. Increasing density could bring investment and attract new development, and increase housing value in neighborhoods. However, once density reaches a certain threshold, the housing value can be dropped in the long term. This is because residents in the neighborhoods often oppose density growth for which can have negative impacts on communities such as loss of amenities and additional traffic congestion (Pendall, 1999; Filion and McSpurren, 2007; McConnell and Wiley, 2010).

With regard to trade-offs, there is possibility of trade-off between the neighborhood congestion and regional job accessibility in residential location choice. In order to examine the relation between location and trade-off, this study uses Z-score and its spatial distribution. The Z-scores can be subdivided into four groups: high congestion-high accessibility, high congestion-low accessibility, low congestion-high accessibility, and low congestion-low accessibility. By subdividing the whole sample into four groups based on neighborhood congestion and regional job accessibility, it may be possible to confirm the trade-off effect.

Z-score plot between the two variables is shown in Figure 3-8. The graph shows that variability of regional job accessibility is relatively less than that of neighborhood congestion. The spatial distribution of Z-scores for neighborhood congestion and regional job accessibility is shown in Figure 3-9. The map shows that areas of high congestion-high accessibility group are mostly located in Miami-Dade County, and that single family parcels in low congestion-low accessibility group are located near the urban fringe or in suburban areas. Some areas of high congestion-low accessibility are located in inner suburban areas where most neighborhoods are designed in a traditional neighborhood pattern. The results may imply that Miami-Dade County has the most congested neighborhoods containing single family housing parcels with the highest accessibility to employment centers.

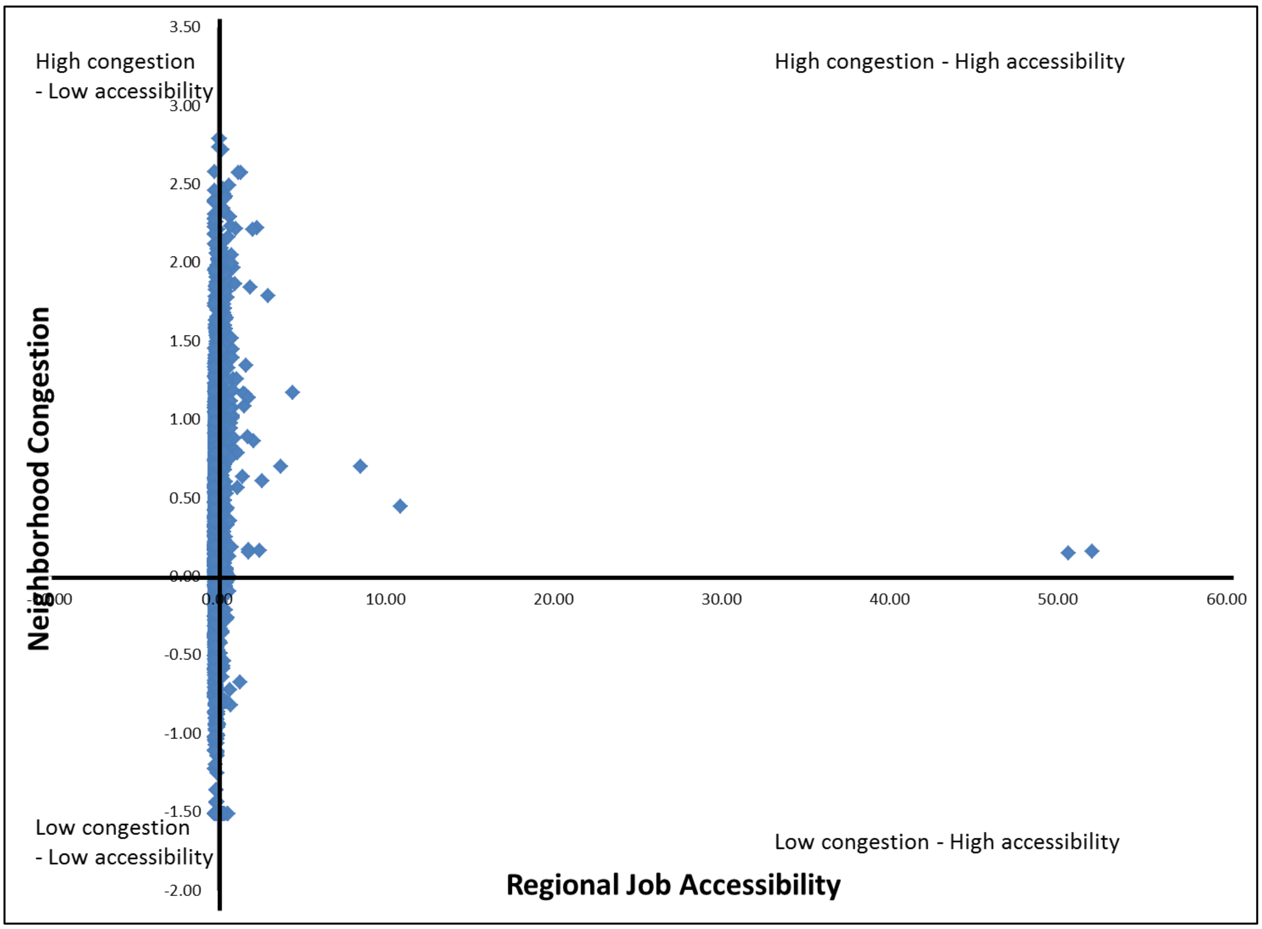

Figure 3-8. Z-score Plot between Neighborhood Congestion and Regional Job Accessibility in the Miami MSA

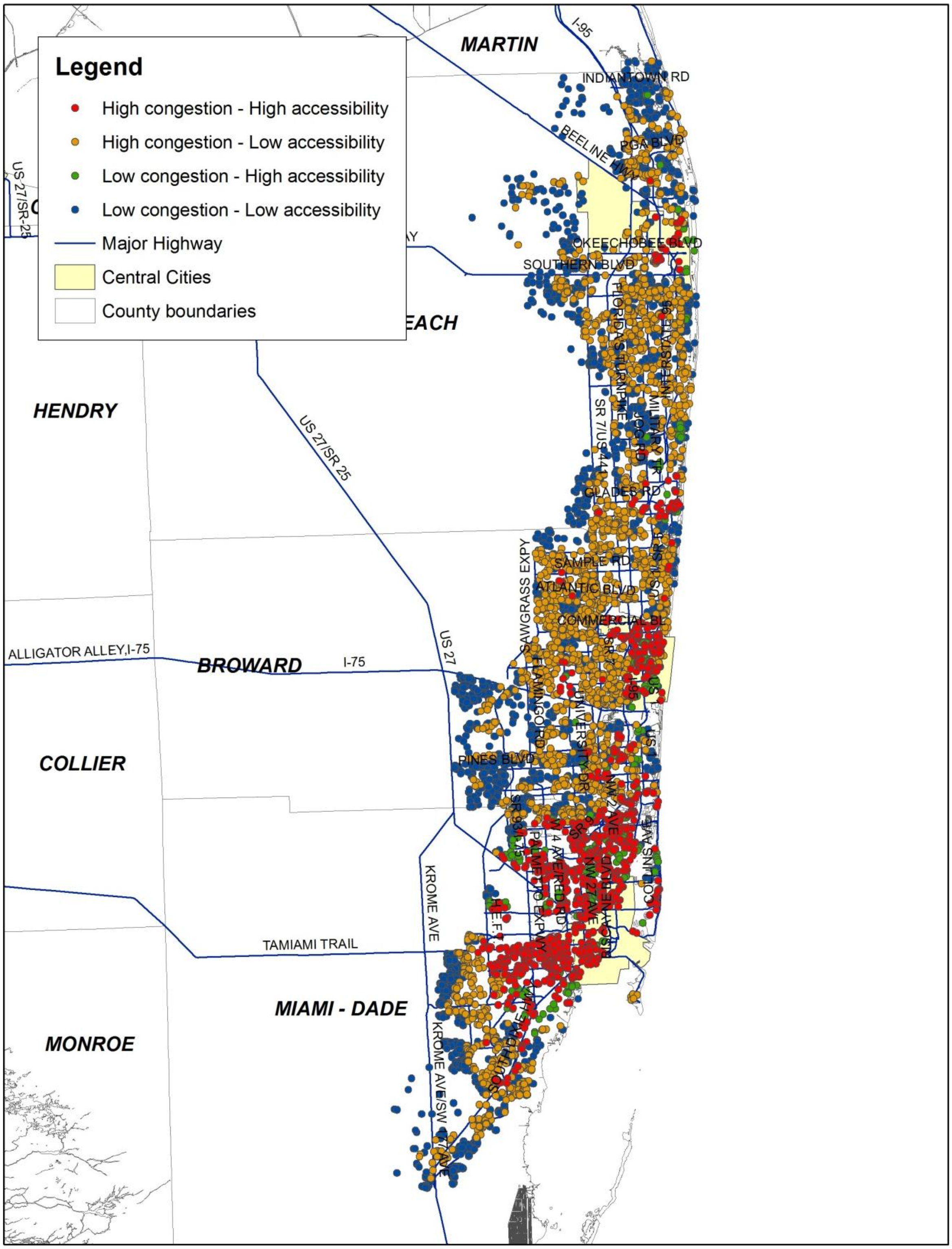

Figure 3-9. Spatial Distribution of Z-score for Neighborhood Congestion and Regional Job Accessibility in the Miami MSA

3.1.5. SUMMARY OF FINDINGS FOR MIAMI MSA

Based on the analyses by the spatial patterns of accessibility and congestion, and their effect on property values in the Miami MSA, this study suggests several findings. First, the spatial pattern of regional congestion in Palm Beach County is opposite to that of Broward and Miami-Dade County. The suburban areas of Palm Beach County have relatively higher regional congestion compared to central city areas, but this pattern is reversed in Broward and Miami-Dade Counties. These differences may be a result of the concentration of jobs in Broward and Miami-Dade Counties. Second, there is a possibility of trade-off between regional job accessibility and neighborhood congestion in residential choice. In terms of the effects on property value, only regional job accessibility has a statistically significant positive effect and the neighborhood congestion has a negative effect. This might be because the areas having high congestion are highly accessible to job centers. Therefore, there is possibility of trade-off between neighborhood congestion and regional job accessibility in their residential location choice.

3.2. TAMPA MSA

3.2.1. GENERAL OVERVIEW OF TAMPA MSA

The map of the Tampa MSA is shown in Figure 3-10. The Tampa MSA comprises Hillsborough, Pinellas, Hernando, and Pasco Counties with central cities: Tampa, St. Petersburg and Clearwater, Brooksville, and Port Richey and New Port Richey, respectively. Four interstate highways cross the Tampa MSA area. I-275 runs through west to east and connects to I-4 and I-75 in the City of Tampa. US-19 is another major road that connects south to north and the coast. St. Petersburg and Tampa are connected by the Courtney Campbell Parkway, I-275 and Gandy

Boulevard. Job centers are largely concentrated in central city areas such as City of Tampa and St. Petersburg.

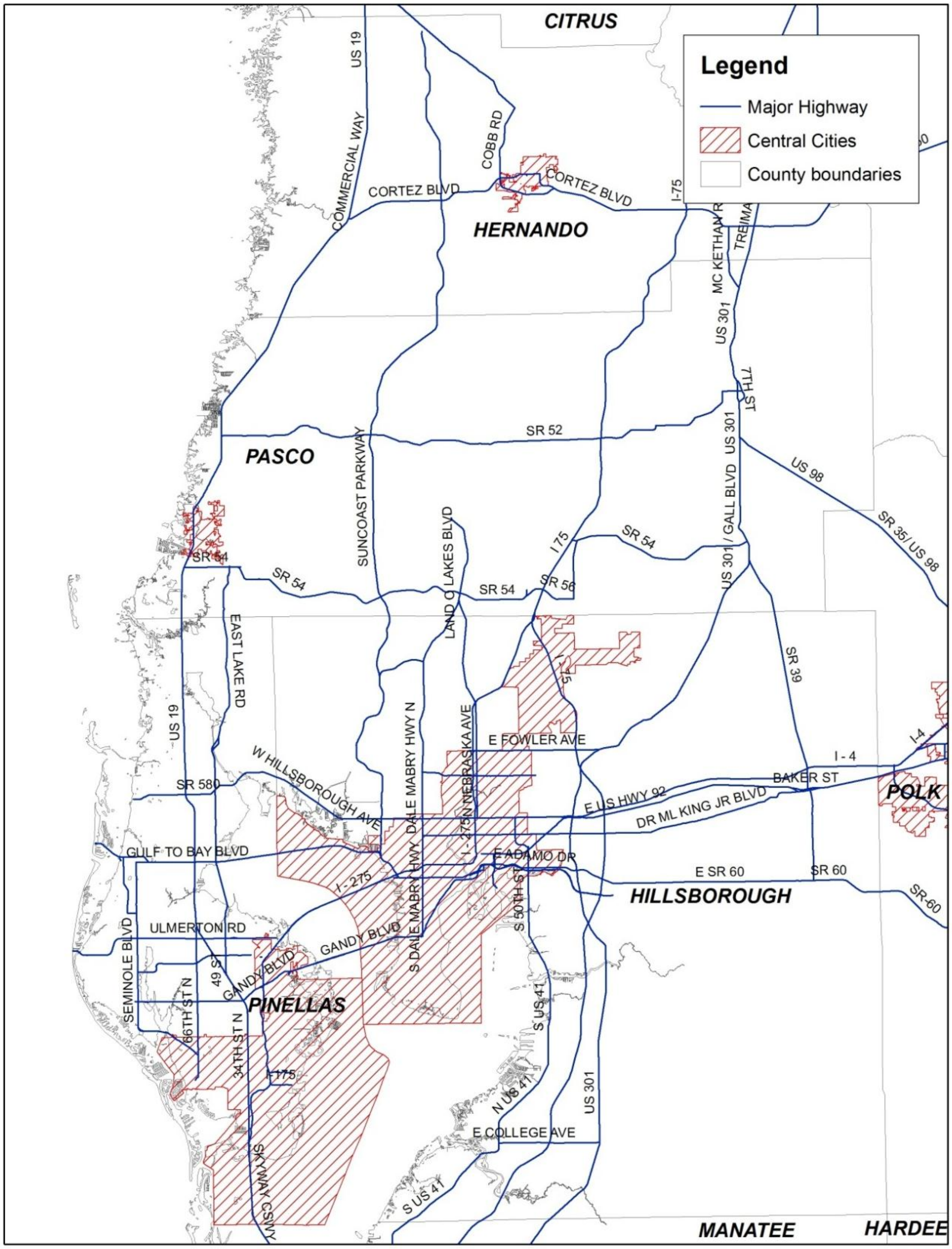

Figure 3-10. General Map of the Tampa MSA

The spatial pattern of job centers and TAZ is presented in Figure 3-11. The job centers are largely located on the Tampa coast and central cities like the City of Tampa. The spatial pattern of regional shopping centers is shown in Figure 3-12. It shows that regional shopping centers in Tampa MSA is mostly located in urban fringes that they are located along major roads and major highways such as West Hillsborough Avenue , I-275, East SR60, US 301, and US 19.

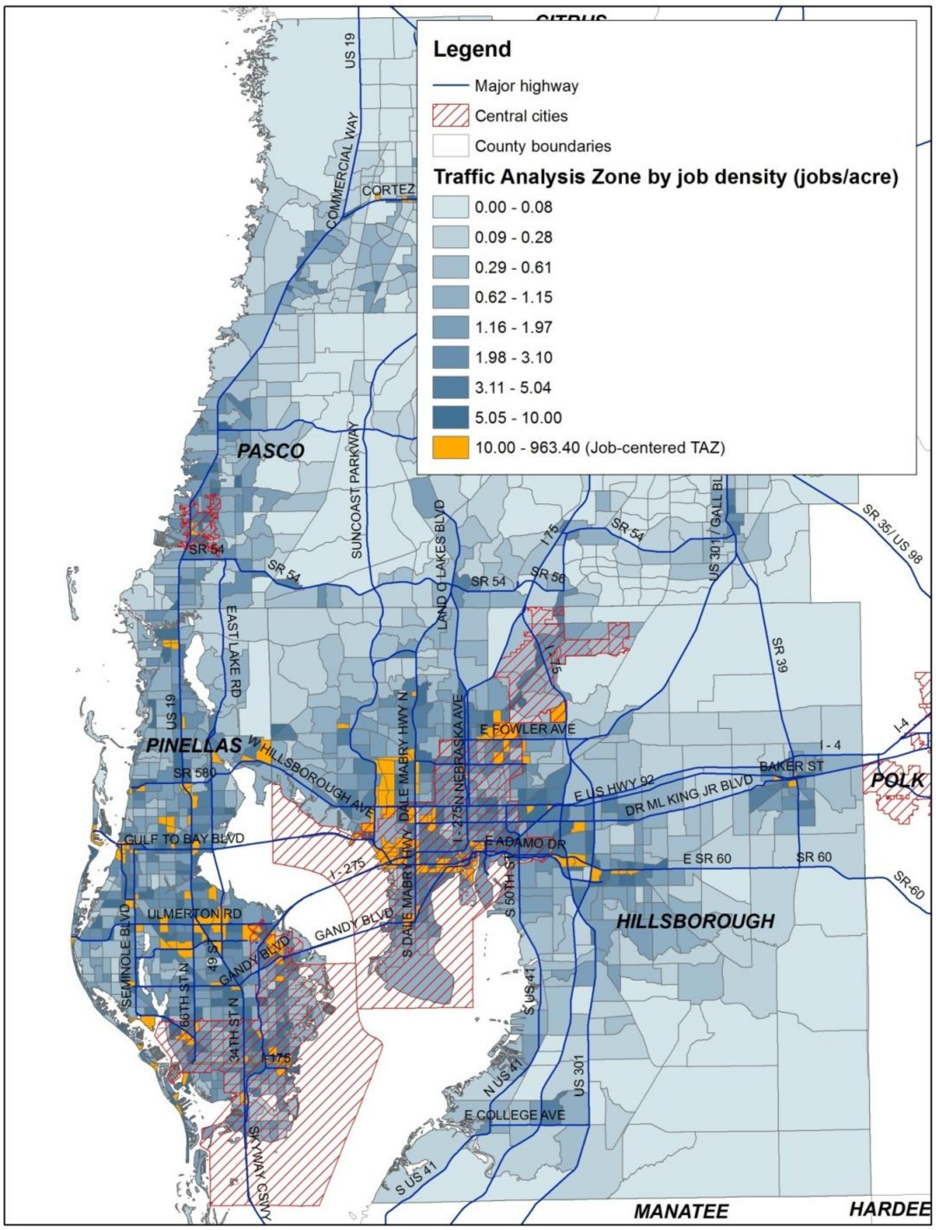

Figure 3-11. Spatial Pattern of Job Centers and TAZ in the Tampa MSA

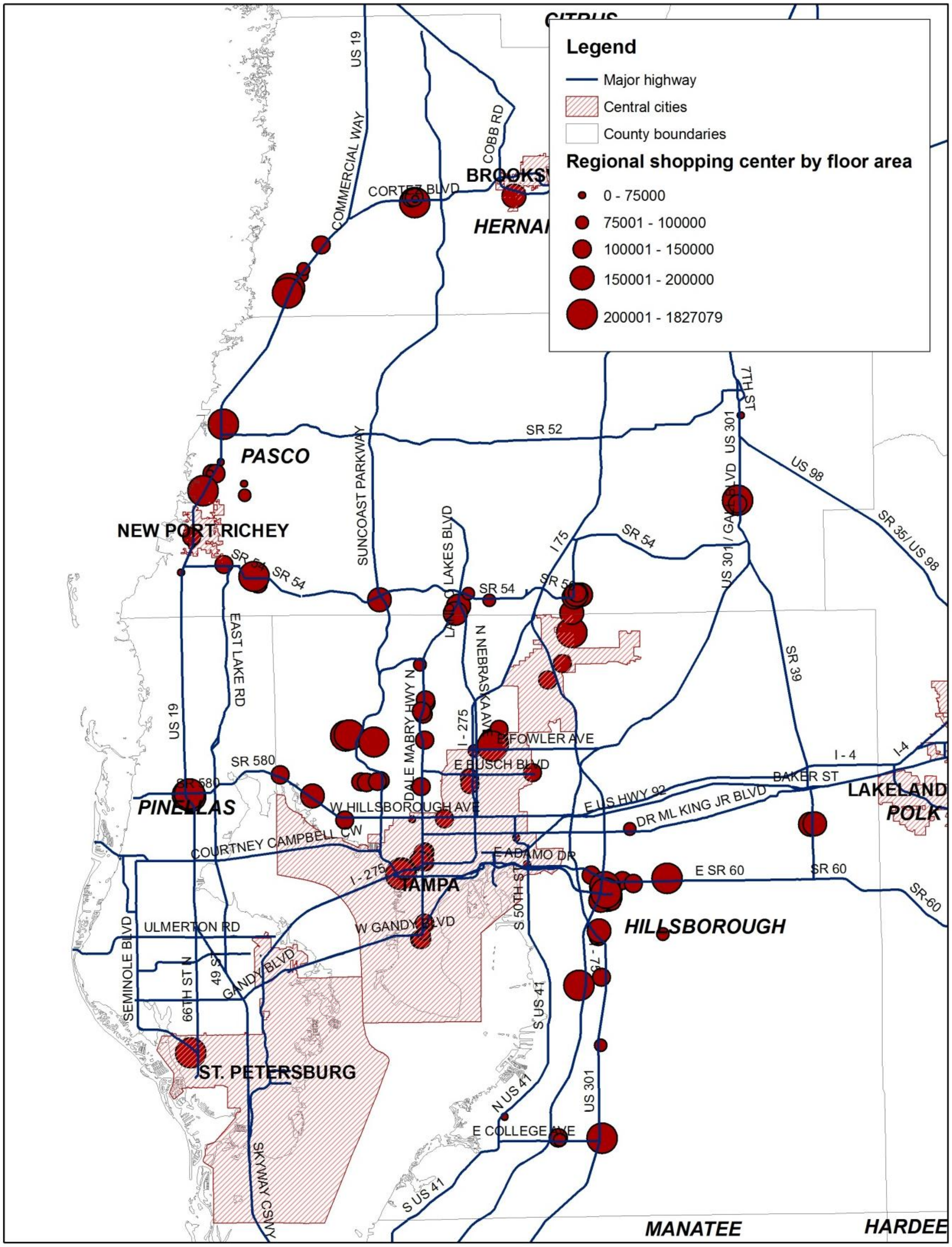

Figure 3-12. Spatial Pattern of Regional Shopping Centers in the Tampa MSA

The spatial pattern of regional job accessibility in Tampa is presented in Figure 3-13. Single family parcels that have high regional job accessibility are mostly concentrated in St. Petersburg and Tampa cities and several cities along the west coast including Pinellas Park, Largo and Clearwater. The other single family parcels in the northern part of Tampa MSA show lower regional job accessibility. This may occur because many job centers are located in southern part of the Tampa MSA.

The spatial pattern of regional shopping accessibility is shown in Figure 3-13. Most single family parcels with high regional shopping accessibility are located in the City of Tampa and the City of Town 'N' Country while St. Petersburg and Clearwater have low regional shopping accessibility. This might be because regional shopping centers are spread out along the major roads in Tampa and Town 'N' Country.

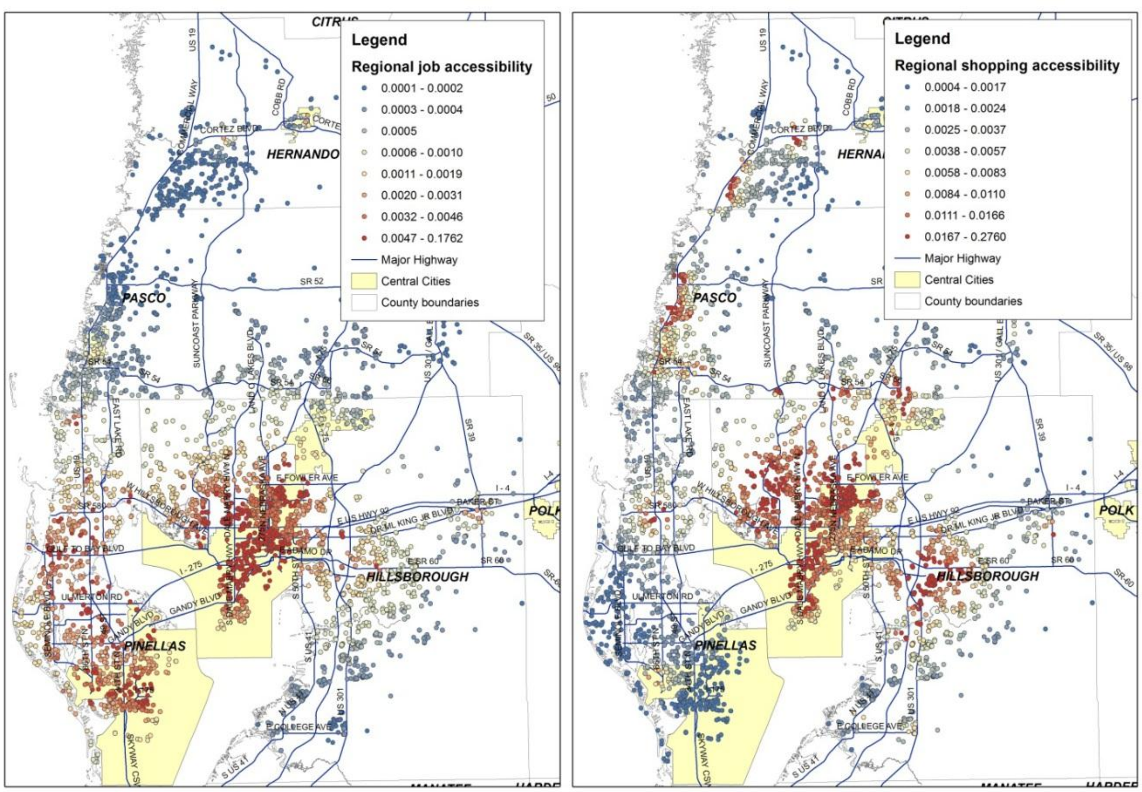

Figure 3-13. Spatial Pattern of Regional Accessibility in the Tampa MSA

3.2.1. DESCRIPTIVE STATISTICS

The descriptive statistics for the variables used in the econometric models are summarized in Table 3-4. The statistics for the neighborhood accessibility show that there is a large spectrum of local accessibility values. On average, minimum distance to retail services is about 0.52 mile,— inverse of the neighborhood retail accessibility value —, and approximately 0.038 square mile of park is located within a half mile from a single family housing, as well as about 1.3 miles of transit route is located nearby single family housing.

Table 3-4. Descriptive Statistics for the Tampa MSA

Variables	N	Mean	Std-Dev	Min.	Max.
Ln(sale price)	3841	12.241	0.711	9.616	14.668
Property age (year)	3841	23.064	19.228	0.000	106.000
Floor area (ft^2)	3841	1797.370	747.088	429.000	6951.000
Lot size (acre)	3841	0.260	0.614	0.010	10.721
Regional job accessibility	3841	0.002	0.006	0.000	0.176
Regional shopping accessibility	3841	0.009	0.012	0.000	0.276
Neighborhood retail accessibility	3841	1.917	3.388	0.095	107.100
Neighborhood park accessibility	3841	0.038	0.075	0.000	0.823
Neighborhood transit accessibility	3841	1.291	2.068	0.000	29.852
Regional congestion	3841	22.001	7.686	10.572	41.518
Neighborhood congestion	3841	1.517	1.571	0.000	10.615
Intersection density	3841	118.926	62.147	0.000	364.000
Housing density (unit/acre)	3841	2.093	2.350	0.000	50.496
Job density (workers/acre)	3841	2.073	7.463	0.000	328.962
School quality	3841	0.990	0.061	0.821	1.169
Median family income (1,000$)	3841	46.333	20.319	4.648	200.001
Poverty rate (%)	3841	0.138	0.118	0.002	1.000
Water proximity (dummy)	3841	0.199	0.399	0.000	1.000
X coordination	3841	547.001	16.918	513.309	590.487
Y coordination	3841	451.463	22.591	408.563	517.466

Note: X coordination and Y coordination do not necessarily ensure to be interpreted as results of this analysis. They are inserted to the regression model to control spatial bias that could be derived from locations of single family houses.

The mean of regional congestion of the single family houses in Tampa MSA indicates that on average residents of this housing spend more than 22 minutes commuting in congested condition than other drivers traveling in free flow condition. The regional congestion ranges from 10.6 to 41.5 minutes. The level of regional congestion is more severe than that of the Miami MSA. The neighborhood congestion ranges from 0 to 10.6 with 1.5 mean value.

3.2.2. CORRELATION ANALYSIS: TRADE-OFF

The results of correlation analysis in Table 3-5 demonstrate that there are several possibilities of trade-off between accessibility and congestion. The regional job and shopping accessibility are positively related with the neighborhood congestion. Also, the neighborhood retail and transit accessibility are positively associated with the neighborhood congestion. However, the regional congestion is only positively correlated with the neighborhood parks accessibility. Compared to the Miami MSA case in which all congestion variables are positively related with accessibility, the directions of correlation between accessibility and congestion are mixed in the Tampa MSA. As the regional congestion and neighborhood congestion are negatively associated, the single-family housing with higher neighborhood congestion may have lower regional congestion.

Table 3-5. Correlation between Accessibility and Congestion in the Tampa MSA

	ln(sprice)	reg.job.acc	reg.shop.acc	retail	parks	transit	Reg_con	Nh_con
ln(sprice)	1.000							
reg.job.acc	-0.076	1.000						
reg.shop.acc	-0.054	0.283	1.000					
Retail	-0.110	0.188	0.206	1.000				
Parks	0.081	-0.114	-0.138	-0.132	1.000			
Transit	-0.270	0.476	0.138	0.228	-0.149	1.000		
Reg_con	0.096	-0.370	-0.253	-0.258	0.270	-0.480	1.000	
Nh_con	-0.254	0.169	0.225	0.134	-0.105	0.238	-0.242	1.000

3.2.3. SPATIAL PATTERNS OF CONGESTION AND ACCESSIBILITY

As shown in Figure 3-14, the properties having higher regional job accessibility are spatially clustered within downtown areas of Tampa, St. Petersburg, and Clearwater. Hot spots are shown for the regional shopping accessibility and regional job accessibility. The parcels having higher regional shopping accessibility are clustered in several suburban areas.

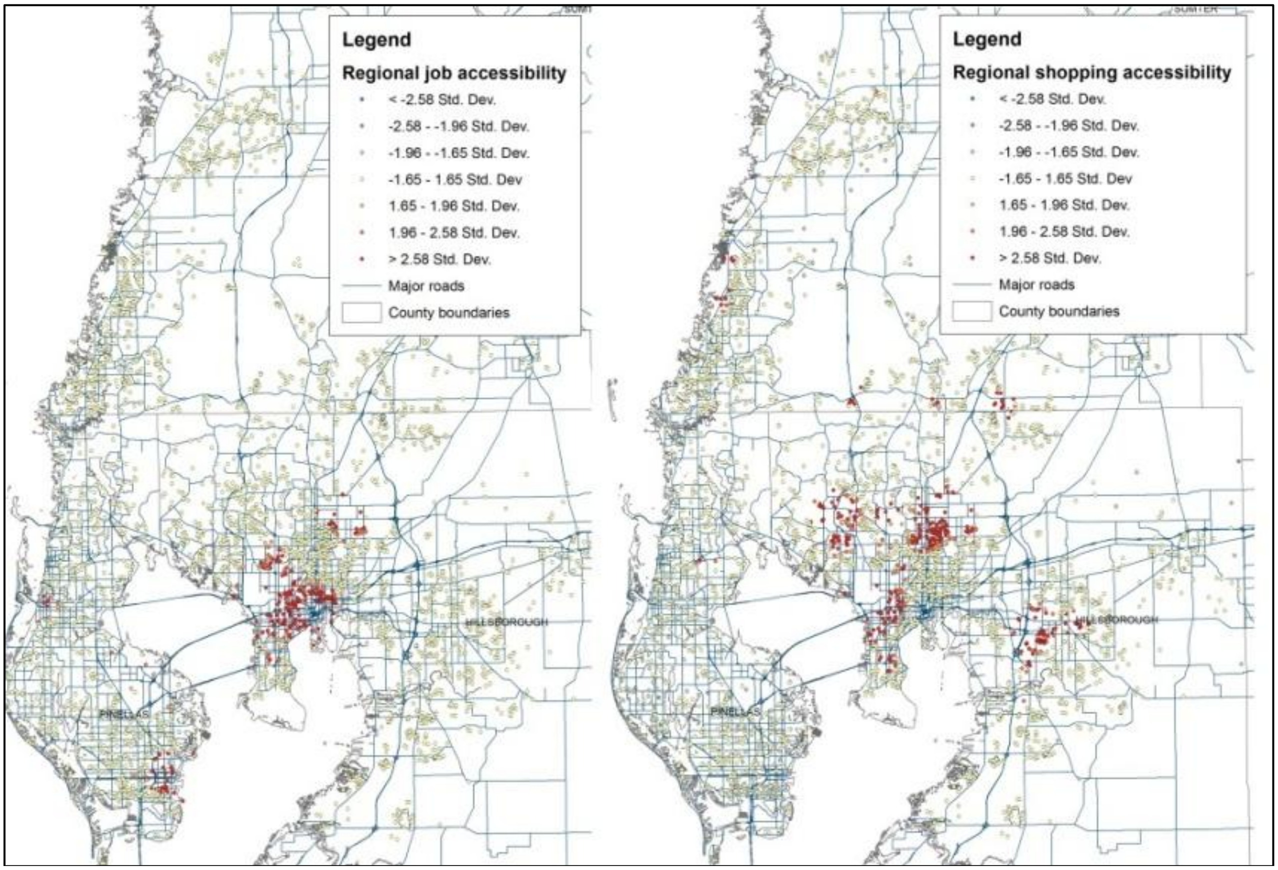

Figure 3-14. Spatial Clustering of Regional Accessibility in the Tampa MSA

The spatial patterns of neighborhood accessibility are shown in Figure 3-15. In general, single family parcels having higher neighborhood retail accessibility are spatially clustered within the City of Tampa. The hot spots of neighborhood park accessibility are located in suburban areas in Pasco County. Similar to the regional job accessibility, inner city areas of the City of Tampa, St. Petersburg, and Clearwater are hot spots of neighborhood transit accessibility, and suburban areas in Pasco and Hernando County have low neighborhood transit accessibility.

Higher regional congestion is spatially clustered in suburban areas in Pasco and Hernando County, and lower regional congestion is clustered in downtown and inner city areas of cities of Tampa and St. Petersburg as shown in Figure 3-16. In the Tampa MSA, the two central counties, — Hillsborough and Pinellas County — have cool zones of regional congestion,

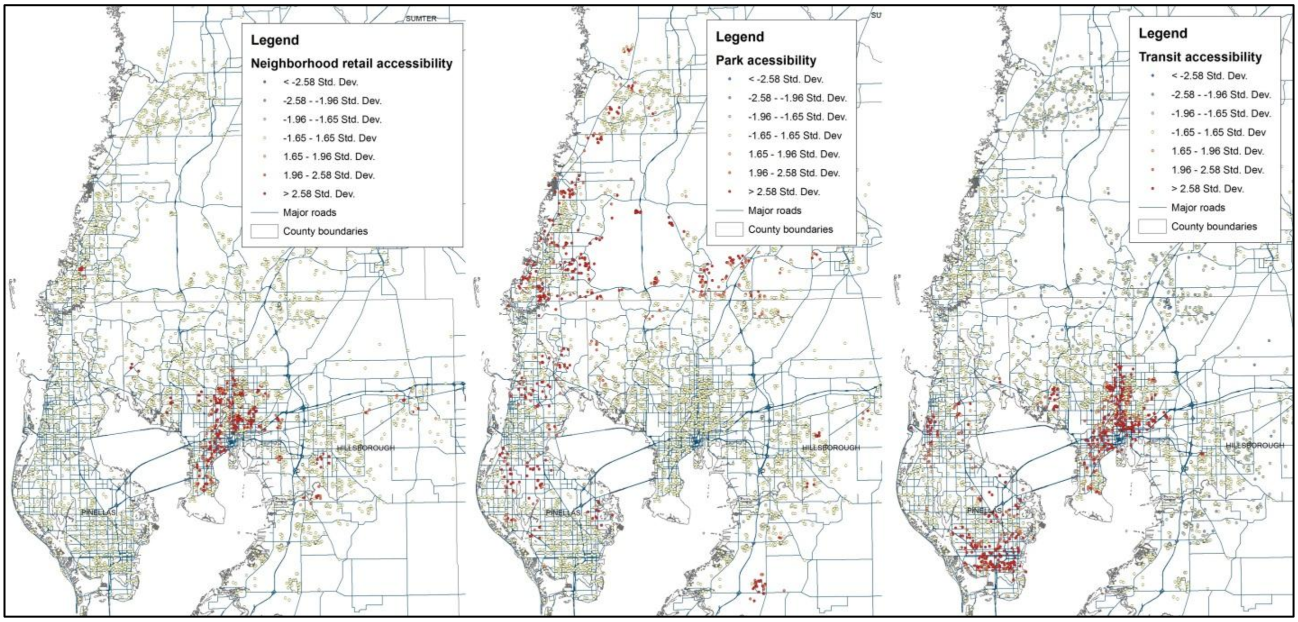

Figure 3-15. Spatial Clustering of Neighborhood Accessibility in the Tampa MSA

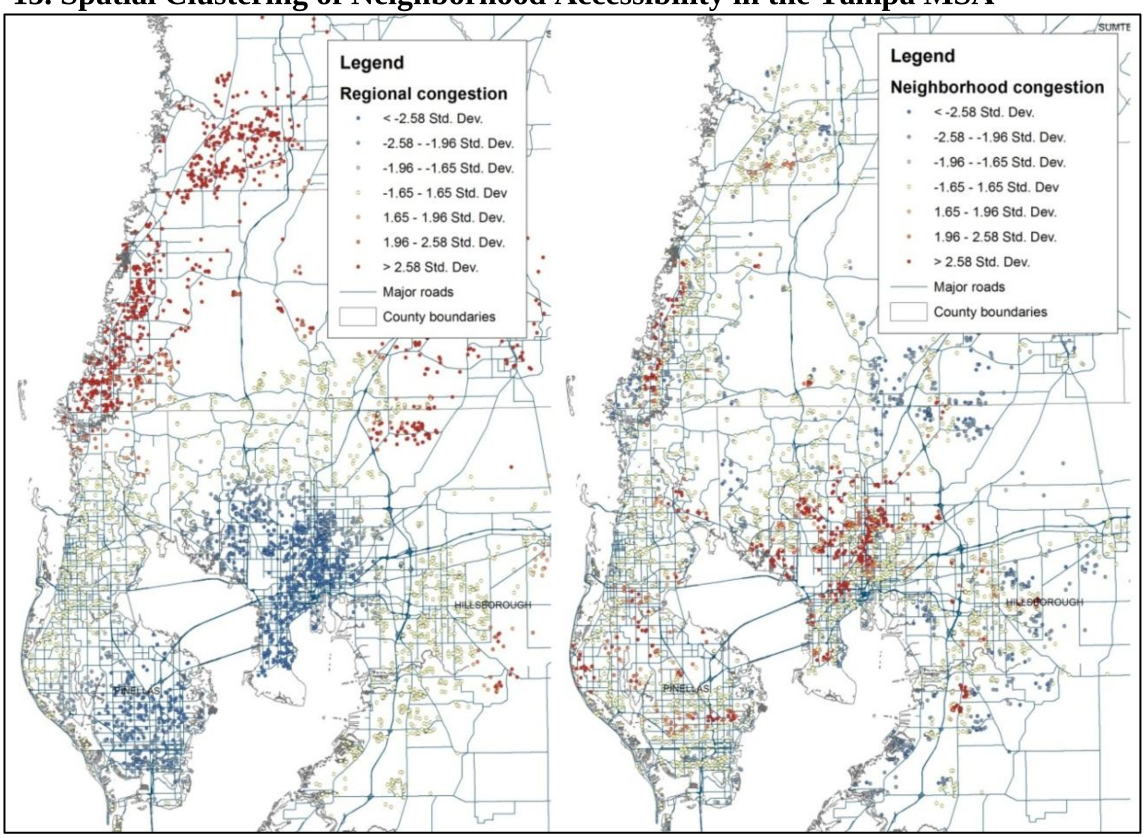

Figure 3-16. Spatial Clustering of Congestion in the Tampa MSA

and the two suburban counties, — Pasco and Hernando County — have hot spots of regional congestion. The hot spots of the neighborhood congestion are scattered along the major highways, but cool zones of the neighborhood congestion are located within suburban areas of the Tampa MSA.

3.2.4. RESULTS OF ECONOMETRIC MODELS

The results of regression analysis for the Tampa MSA are summarized in Table 3-6. Like the Miami MSA, the overall all directions of estimated parameters are the same regardless of the model used but the significance of some variables differs. The statistically significant Z-score of the Moran's I in each model indicates that spatial autocorrelation exists. However, the SEM and SCM model drastically reduces the Z-score by addressing spatial autocorrelation with a spatial error term. The direction of estimated parameters are consistent with the hypothesis of this study except for the regional shopping accessibility. Regional shopping accessibility significantly reduces property value in the OLS and multi-level model, and the results of other spatial econometric models also report a negative effect. At the neighborhood level, the neighborhood retail accessibility does not have a positive effect in contrast to the park and transit accessibility. Hence, contrary to the hypothesis, in the Tampa MSA accessibility to shopping may reduce property value.

Unlike the Miami MSA, only housing density has a positive effect on single-family sale price. The average residential density of the Tampa MSA is only two housing units per acre. As noted earlier, increased density may imply the increased demand without affecting community amenities. Consequently, housing density can increase property value.

Table 3-6. Estimated Results of Regression Models for the Tampa MSA

Variables	OLS	Multi-level	SAR	SEM	SCM
Property age (year)	-0.0108**	-0.0092**	-0.0077**	-0.0085**	-0.0078**
Floor area (ft^2)	0.0003**	0.0004**	0.0003**	0.0004**	0.0003**
Lot size (acre)	0.0340**	0.0629**	0.0523**	0.0721**	0.0677**
Regional job accessibility	4.0035**	4.5043**	1.6132*	2.4776**	1.6538*
Regional shopping accessibility	-1.5192**	-1.3453*	-0.6521	-0.6942	-0.6124
Neighborhood retail accessibility	-0.0012	0.0038	-0.0003	0.0018	0.0010
Neighborhood park accessibility	0.1352	0.2966**	0.0381	0.2291*	0.0855
Neighborhood transit accessibility	0.0294**	0.0095	0.0203**	0.0069	0.0155**
Regional congestion	-0.0118**	-0.0127**	-0.0062**	-0.0105**	-0.0072**
Neighborhood congestion	-0.0398**	-0.0183**	-0.0220**	-0.0163**	-0.0181**
Intersection density	-0.0019**	-0.0015**	-0.0007**	-0.0018**	-0.0008**
Housing density (unit/acre)	0.0369**	0.0002	0.0241**	0.0103**	0.0169**
Job density (workers/acre)	0.0010	0.0000	0.0002	-0.0006	-0.0003
School quality	3.2520**	1.5447**	1.4773**	2.2482**	1.4262**
Median family income (1,000$)	0.0012**	0.0004	0.0007*	0.0007*	0.0008*
Poverty rate (%)	-0.0539	0.0353	-0.0180	0.0138	0.0116
Water proximity (dummy)	0.1388**	0.1407**	0.0949**	0.0848**	0.0889**
X coordination	-0.0038**	-0.0043**	-0.0028**	-0.0029*	-0.0029**
Y coordination	-0.0016**	-0.0030*	-0.0021**	-0.0021*	-0.0023**
Intercept	11.8792**	14.2819**	7.6459**	12.5060**	8.3486**
Rho			0.4389**		0.3956**
Lambda				0.6653**	0.3983**
Adj. R-square (Pseudo R^2)	0.5213	-	0.6630	0.4977	0.6491
Moran's I (Z-score)	0.1583 (16.78)	0.1939 (20.50)	0.1441 (15.24)	-0.0269 (-2.81)	-0.0352 (-3.69)

Note: *, ** are significant at 5% and 1% level, respectively. The results of random solution in the multilevel regression are not reported in this table.

Regarding trade –offs, there is several possibilities of trade-offs between pairs like neighborhood congestion and regional job accessibility, neighborhood congestion and the transit accessibility, and regional congestion and park accessibility in residential location choice. In order to examine trade-off of these pairs, Z-score of each variable is estimated and distributed on a map of Tampa MSA.

The Z-score of regional congestion and park accessibility are shown in Figure 3-17. This graph is divided into four groups which are spatially distributed as shown in Figure 3-18 to demonstrate the relationship between location and trade-off. The figure shows that single family housing with high congestion-high accessibility are mostly located in outside of central cities and in suburban areas. Single family parcels in low congestion-low accessibility are located in central cities, inner suburban areas and urban fringes near central cities. Single family parcels in the high congestion-low accessibility group are located in outside of the City of Tampa and in central regions of the Tampa MSA. This might indicate that location of living in single family parcels having high regional congestion is related to location of employment centers where open spaces and park areas are limited.

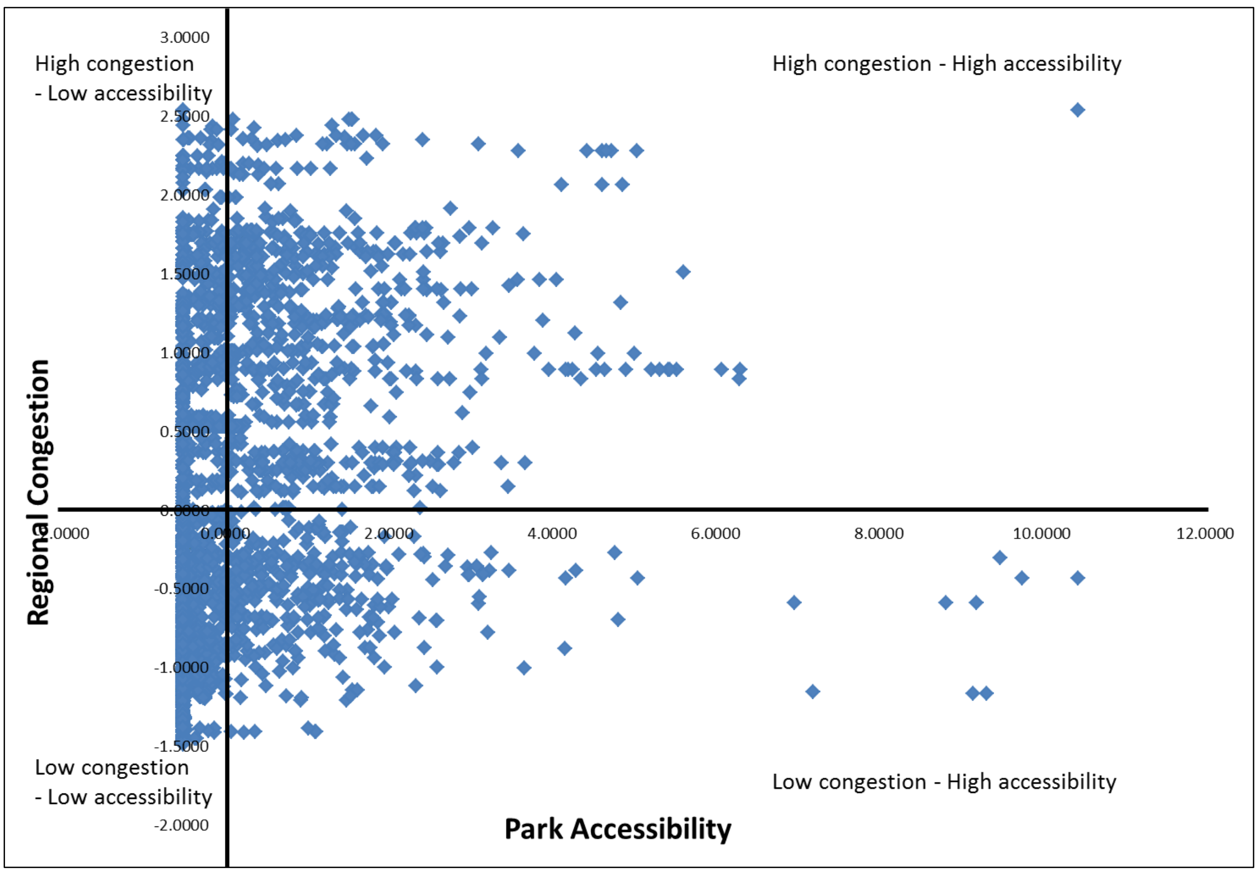

Figure 3-17. Z-score Plot between Regional Congestion and Park Accessibility in the Tampa MSA

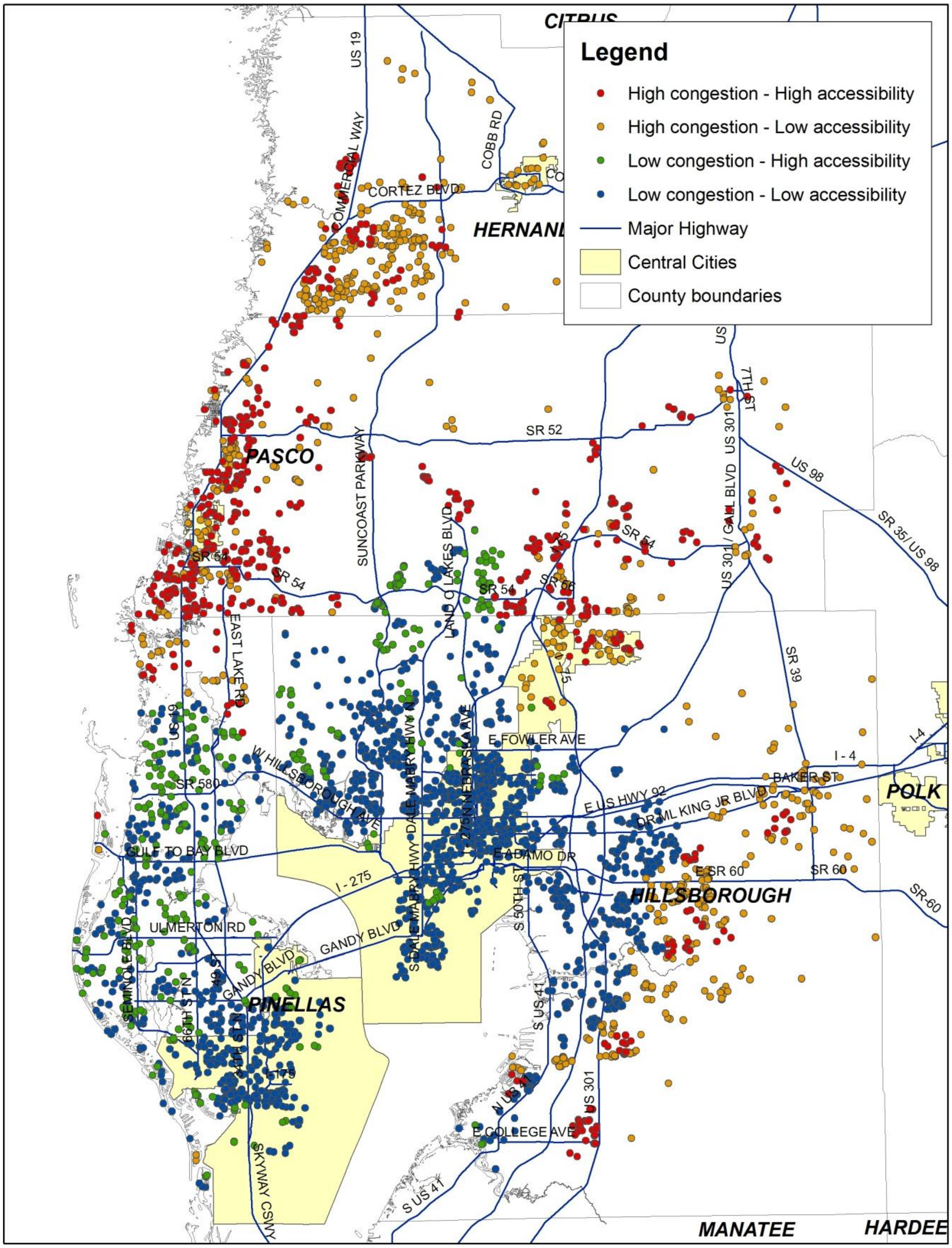

Figure 3-18. Spatial Distribution of Z-score for Regional Congestion and Park Accessibility in the Tampa MSA

The Z-score plot between neighborhood congestion and job accessibility is shown in Figure 3-19. Based on the information from the Z-score plot, spatial distribution of Z-score for neighborhood congestion and regional job accessibility is shown in Figure 3-20. The graph shows that most samples in high congestion-high accessibility group are located in central cities, urban fringes and southwest coast in Pinellas County. However, single family housing samples with low congestion-low accessibility group are located in suburban areas. A large portion of high congestion-low accessibility group is located in outside of central cities and inner suburban areas. The results imply that local network is highly congested, and that single family homes are highly accessible to job centers in central cities and urban fringes.

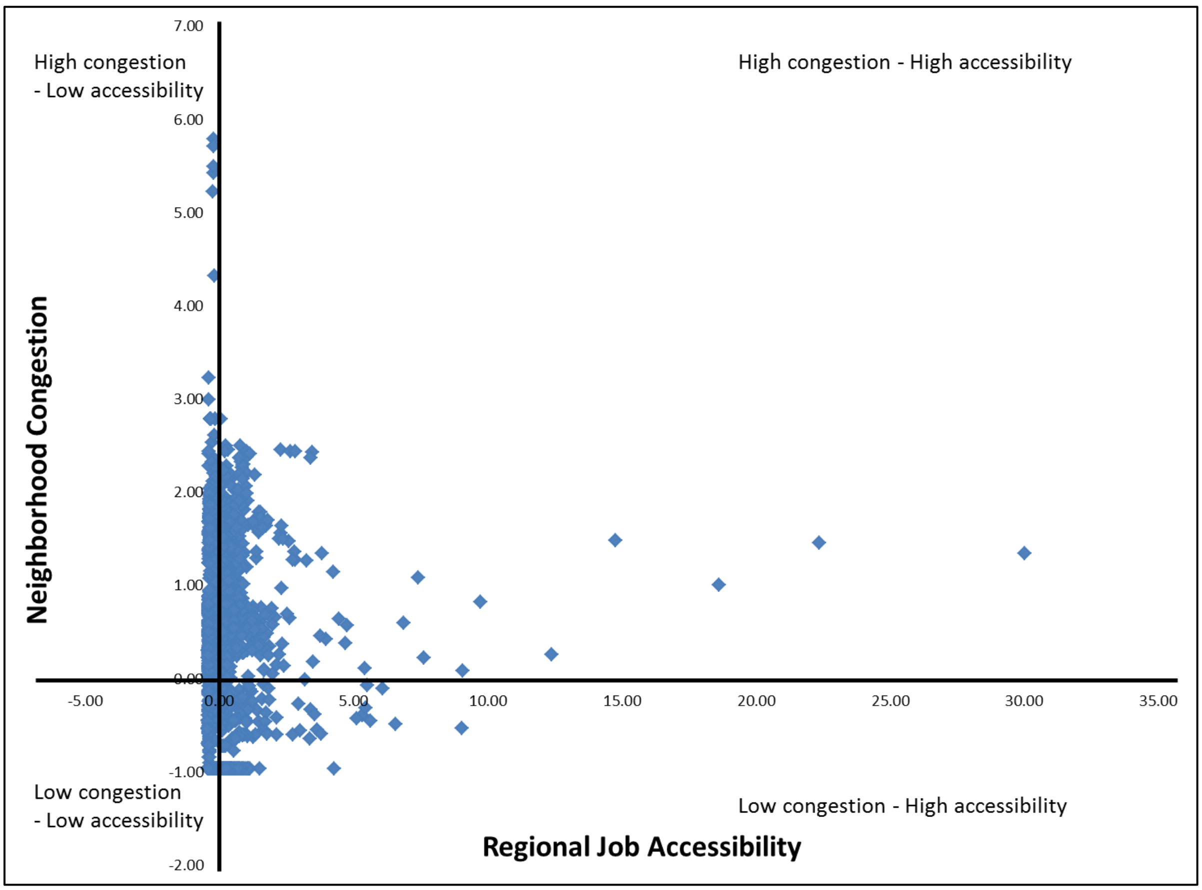

Figure 3-19. Z-score Plot between Neighborhood Congestion and Regional Job Accessibility in the Tampa MSA

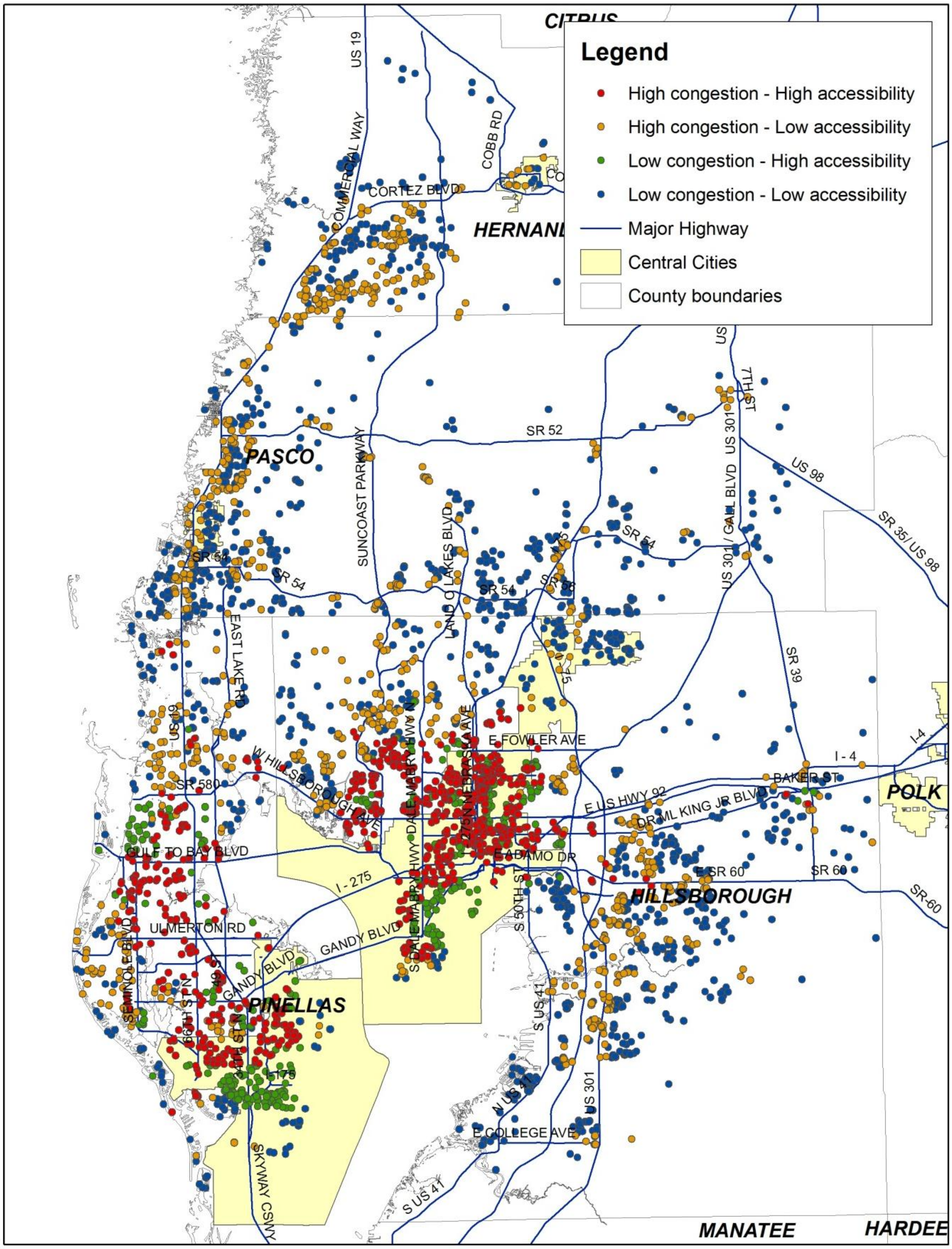

Figure 3-20. Spatial Distribution of Z-score for Neighborhood Congestion and Regional Job Accessibility in the Tampa MSA

The Z-score plot between neighborhood congestion and the neighborhood transit accessibility is shown in Figure 3-21. Compared to other pairs, range of both variables is small. Four groups are divided based on Z-scores of congestion and accessibility. The Spatial distribution of Z-score for neighborhood congestion and neighborhood transit accessibility is shown in Figure 3-22. The graph shows that high congestion-high accessibility group is mostly located in central cities and west coast of Tampa MSA where bus transit service is highly dense. But, most samples in low-congestion-low accessibility group are located in suburban areas. The graphs indicate that a large portion of single family parcels experiencing high neighborhood congestion have high transit accessibility in Tampa.

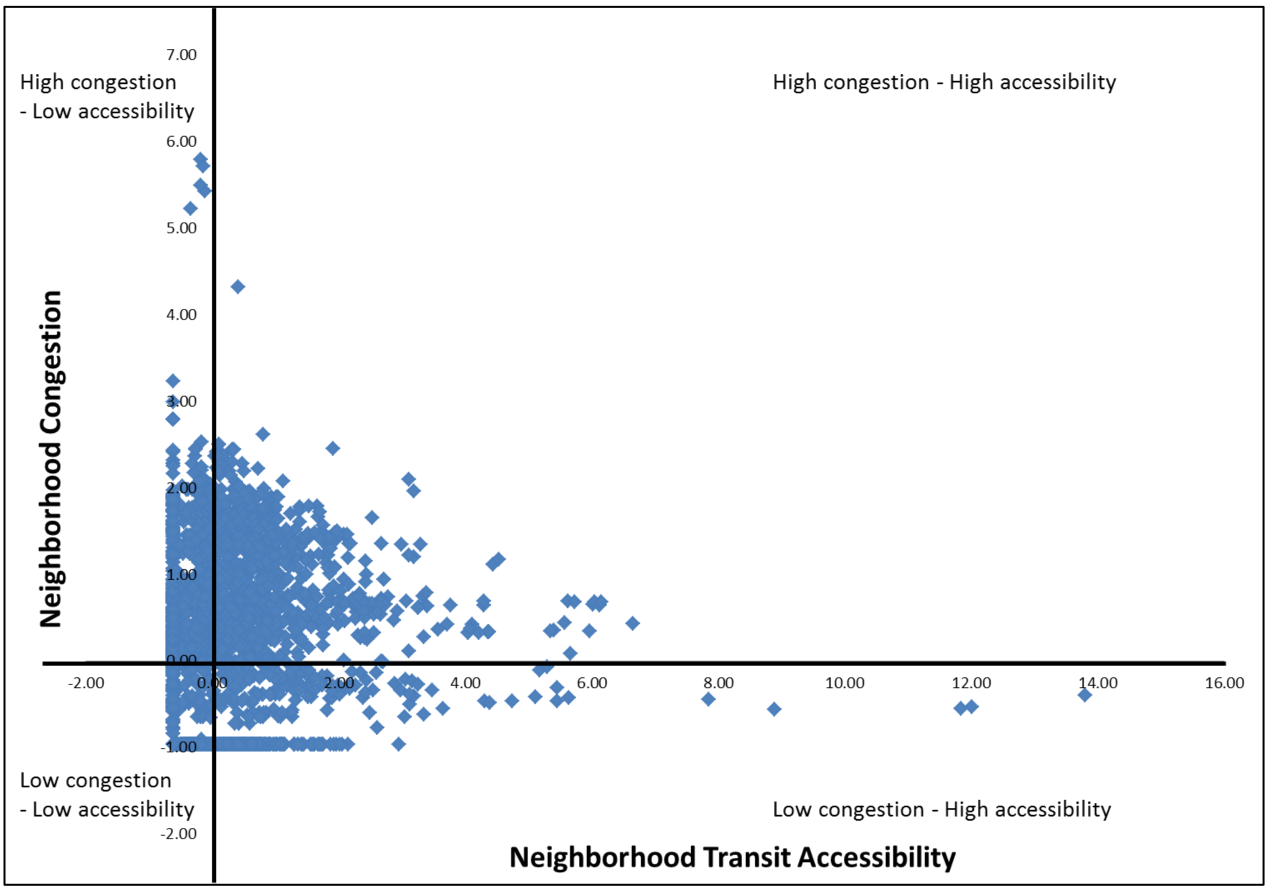

Figure 3-21. Z-score Plot Neighborhood Congestion and Neighborhood Transit Accessibility in the Tampa MSA

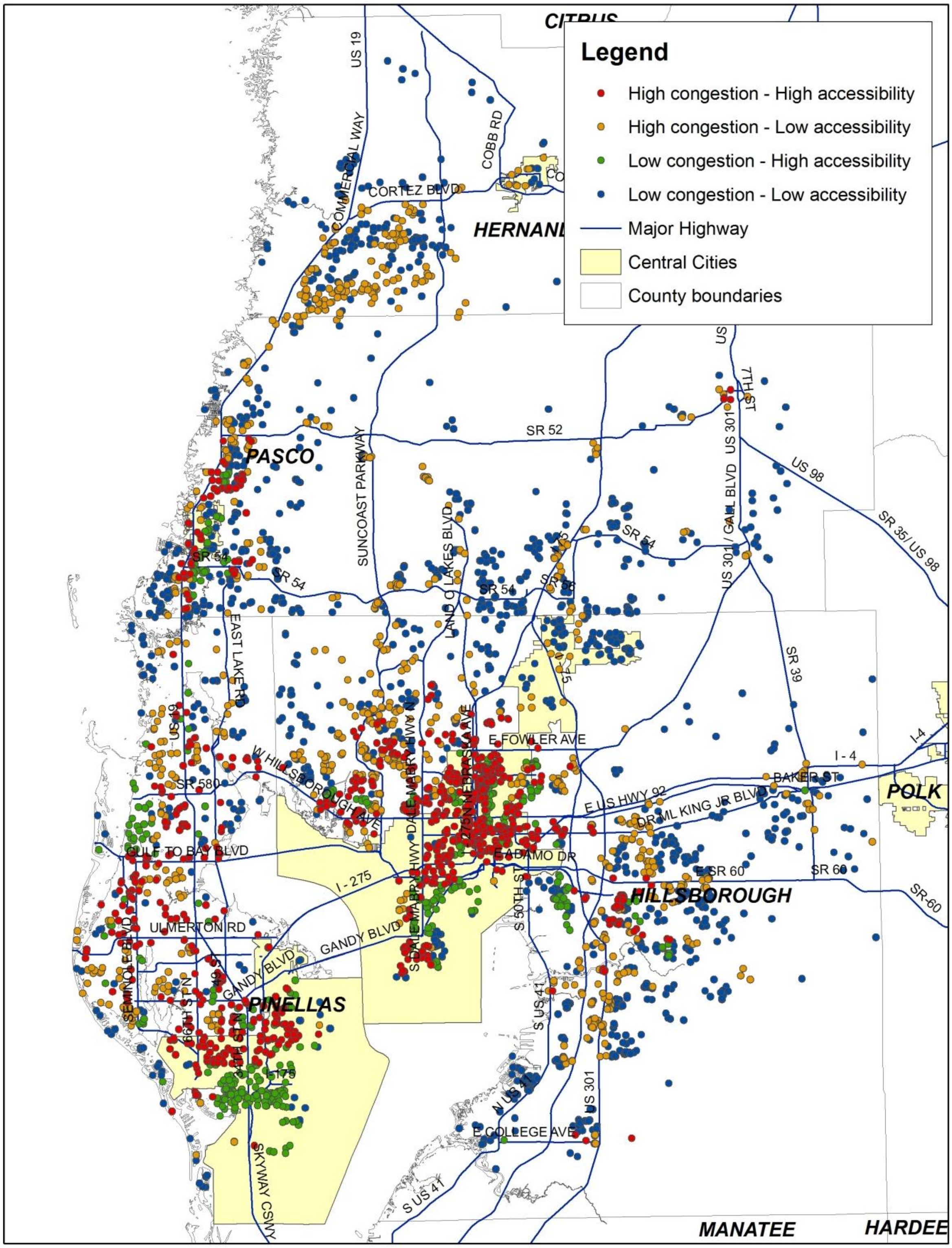

Figure 3-22. Spatial Distribution of Z-score for Neighborhood Congestion and Neighborhood Transit Accessibility in the Tampa MSA

3.1.5. SUMMARY OF FINDINGS FOR TAMPA MSA

Based on the analyses on the spatial patterns of accessibility and congestion, and their effect on property value in the Tampa MSA, this study suggests several findings. First, the spatial patterns of accessibility and congestion in the suburban counties (Pasco and Hernando) are different from those of the central counties (Hillsborough and Pinellas), specifically with respect to regional congestion and transit accessibility. Second, several trade-off relationships exist between accessibility and congestion in residential choice: neighborhood congestion and regional job accessibility, neighborhood congestion and the transit accessibility, and regional congestion and park accessibility. These pairs are positively correlated with each other and their effects are statistically significant and consistent with the hypotheses that accessibility has positive effects and congestion has negative effects. Therefore, there is possibility of trade-offs between these variables in residential location choice. It is possible that some residents live in the central city or the urban fringe because they consider job accessibility and transit accessibility to outweigh neighborhood congestion. Single family residents living in suburban areas may regard park or open spaces more important than accessibility to jobs and the associated congestion.

3.3. ORLANDO MSA

3.3.1. GENERAL OVERVIEW OF ORLANDO MSA

The general map of Orlando MSA is shown in Figure 3-23. Orlando MSA consists of Lake, Orange, Osceola, and Seminole Counties. Each county includes its own central city like Clermont in Lake County, Sanford in Seminole County, the Orlando in Orange County and the Kissimmee in Osceola County. Unlike other MSAs, land development pattern of Orlando MSA is sprawled and outwardly dispersed because there are no geographical barriers. Several major

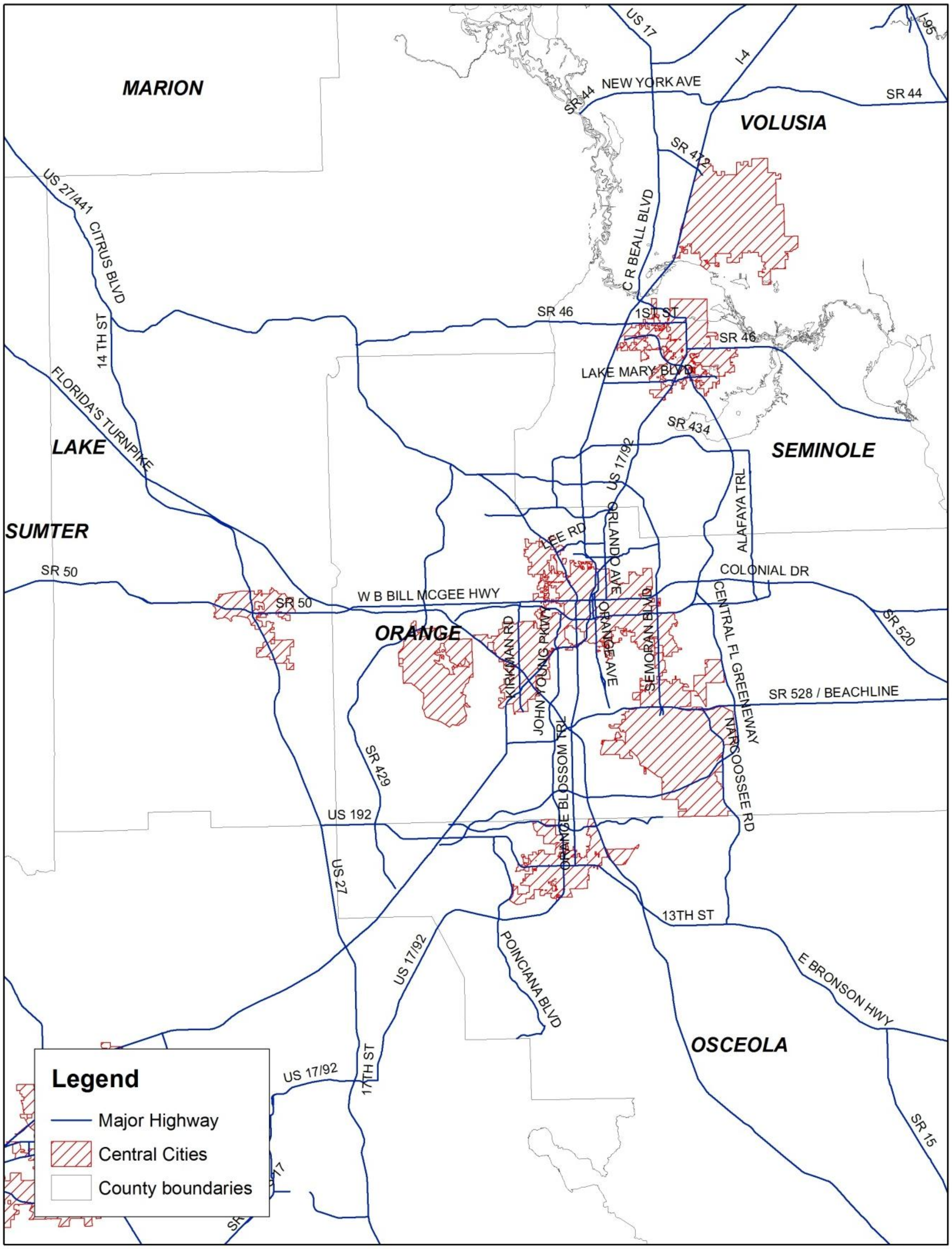

Figure 3-23. General Map of the Orlando MSA

highways run through the Orlando MSA. Florida's Turnpike, which is owned and developed by a public-private partnership, connects from South Florida to I-75 in north of Lake County. Interstate-4 runs north through the City of Orlando and southwest to the City of Tampa. The Beachline (SR 528), and East-West Expressways (SR 408), and Western Expressway (SR 429) serve from eastern to western part of Orlando MSA area. These roads are managed by Orlando-Orange County Expressway Authority.

The spatial pattern of job centers and TAZ is presented in Figure 3-24. Most job centers are located in the northeastern Orange County, the southwest to Seminole County, and by and large in the City of Orlando. The spatial pattern of regional shopping centers is shown in Figure 3-25. Most shopping centers are located near major highway like Florida's Turnpike, I-4, and SR50. Many of them are located in near the fringes of cities and suburban areas.

The spatial location of regional job accessibility and regional shopping accessibility is presented in Figure 3-26. A similar pattern of single family parcels having regional job accessibility with the ones having regional shopping accessibility is observed. Most single family housing units with high regional job accessibility and high regional shopping accessibility are located in central cities. This may be because many employment centers and shopping centers are located in Orange and Seminole Counties. Additionally, this pattern continues from the City of Kissimmee to the City of Sanford. Between these cities, Altamonte Springs, Winter Park, Casselberry, Longwood, and Winter Springs to the north of Orlando, Oak Ridge and Conway to the south of Orlando are located.

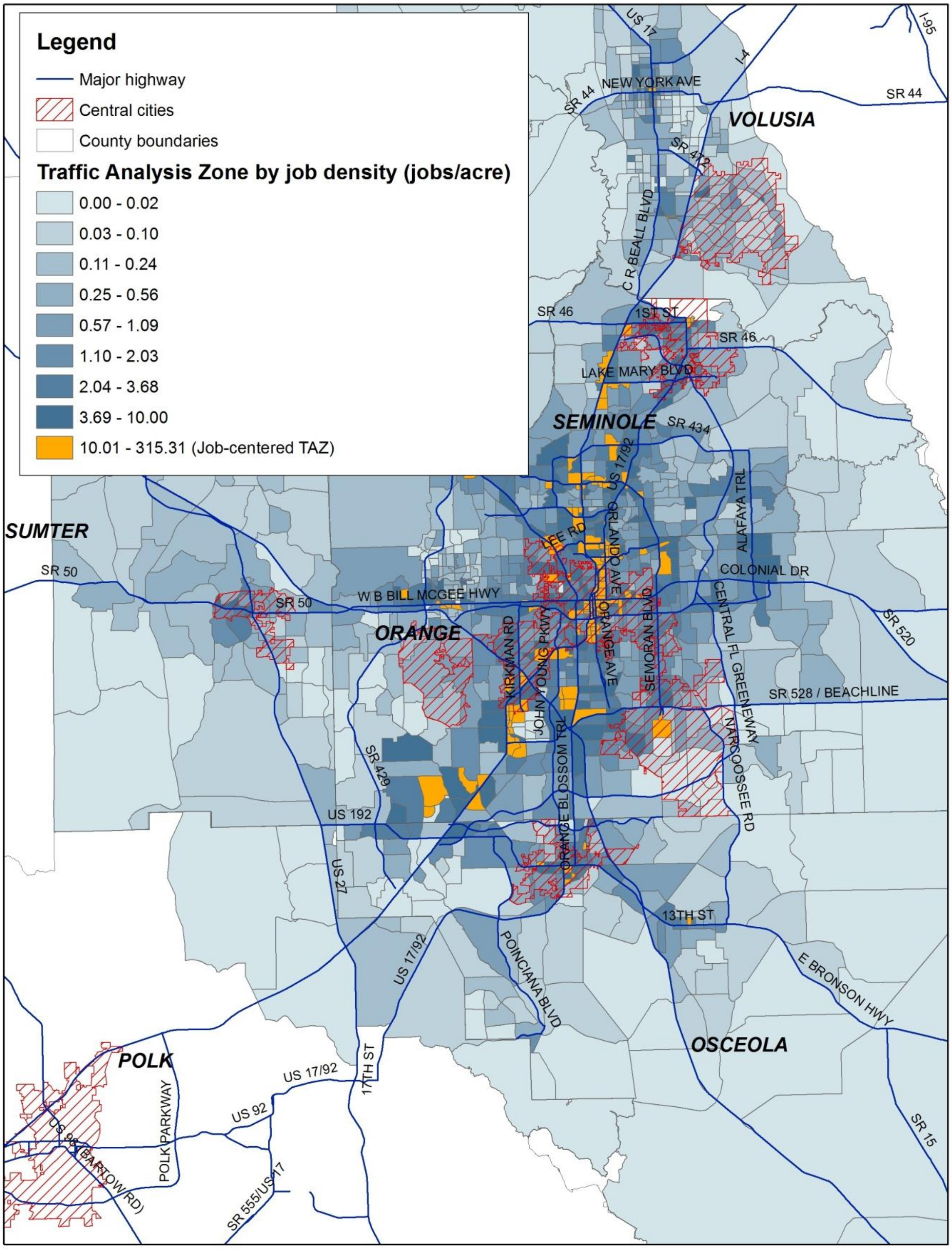

Figure 3-24. Spatial Pattern of Job Centers and TAZ in the Orlando MSA

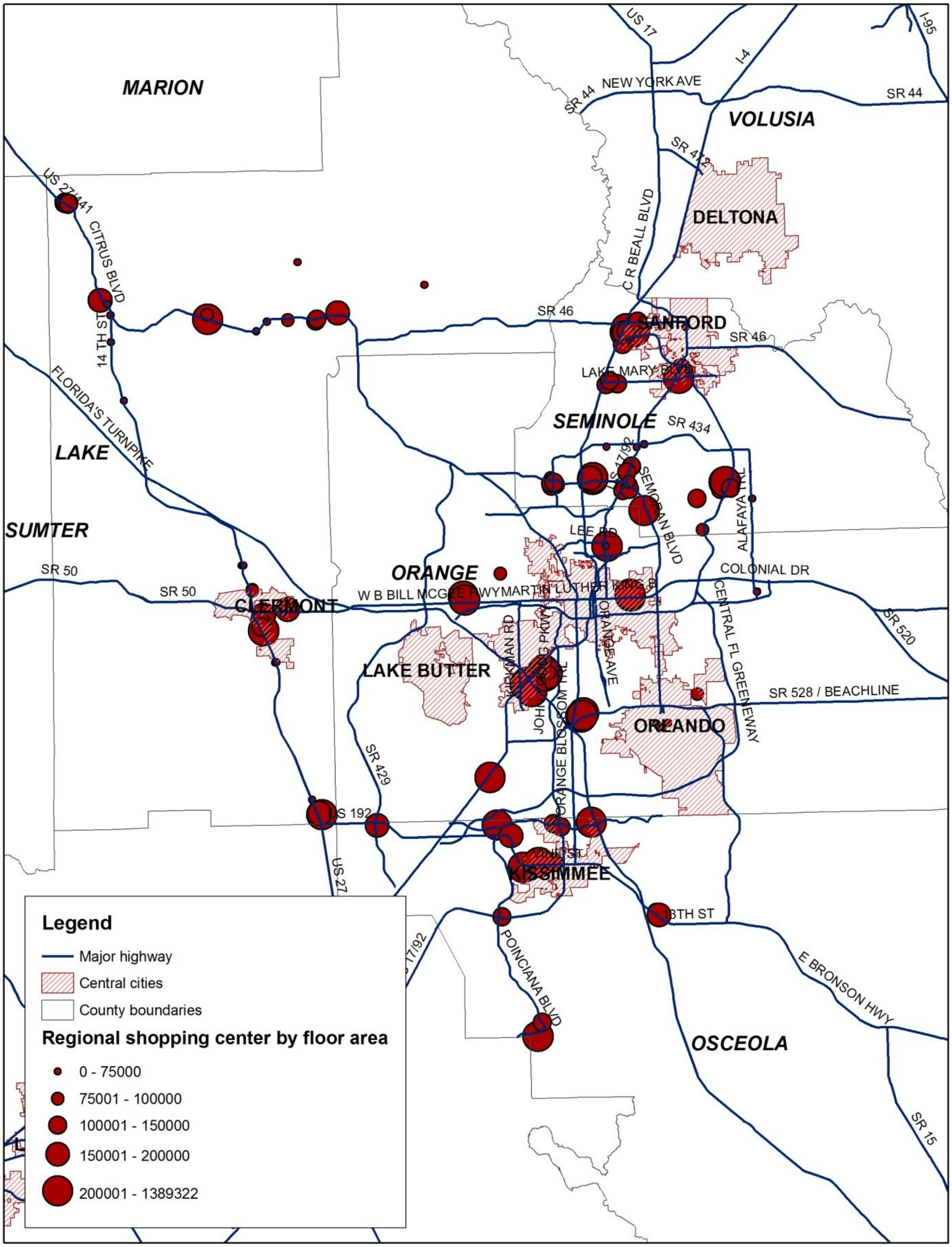

Figure 3-25. Spatial Pattern of Regional Shopping Centers in the Orlando MSA

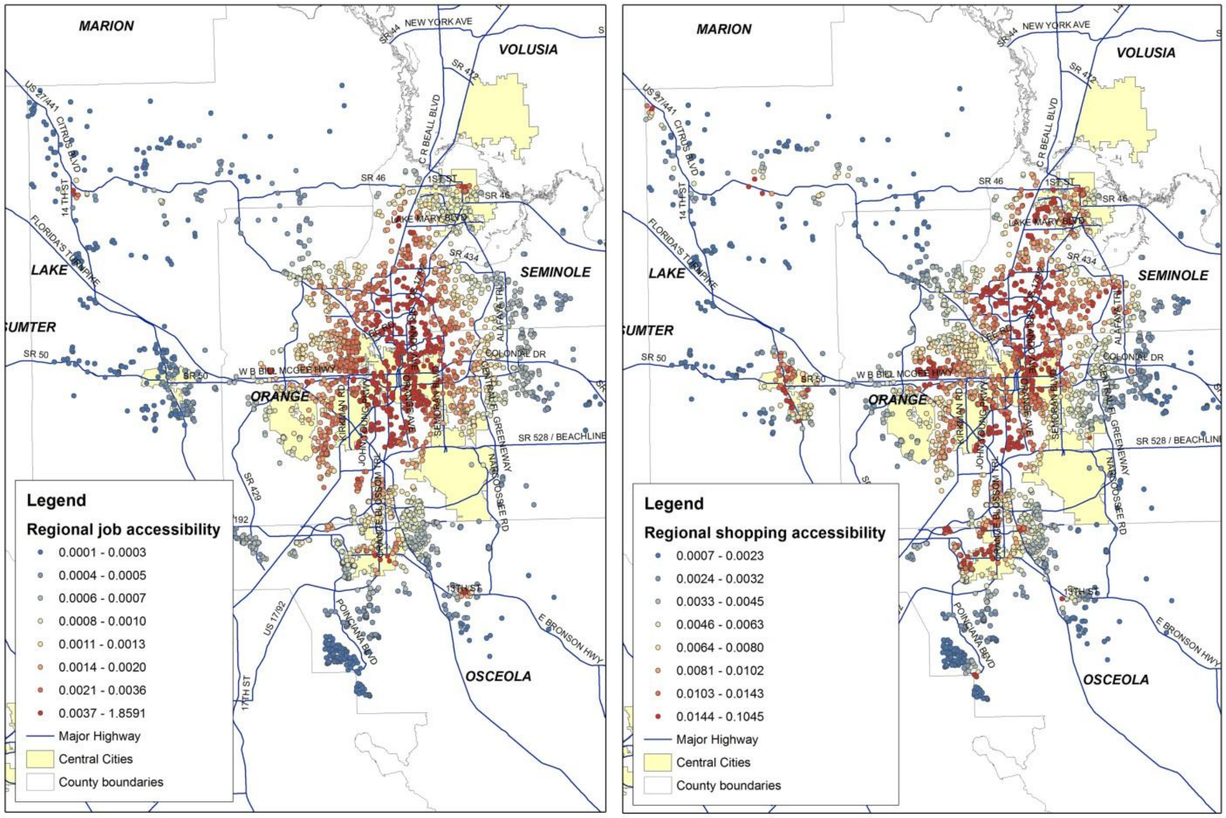

Figure 3-26. Spatial Pattern of Regional Accessibility in the Orlando MSA

3.3.1. DESCRIPTIVE STATISTICS

The descriptive statistics for the variables used in the econometric models are shown in Table 3-7. The statistics for the neighborhood accessibility shows that there is a great variability in local accessibility values. On average, minimum distance to retail services is about 0.89 mile,— the inverse of the neighborhood retail accessibility value —, and approximately 0.020 square mile of park is located within a half mile from a single family housing, as well as about 0.87 miles of transit route is located nearby single family housing.

Similar to the Miami MSA, the level of regional congestion is not high. The mean of regional congestion for the 2997 single family houses indicates that in average residents spend more than 5.3 minutes in commuting at the congested condition compared to others in free flow condition. The regional congestion ranges from 0 to 15.3 minutes. The neighborhood congestion ranges from 0 to 8.6 with a mean value of 1.5.

Table 3-7. Descriptive Statistics for the Orlando MSA

Variables	N	Mean	Std-Dev	Min.	Max.
Ln(sale price)	2997	11.936	0.550	10.094	14.581
Property age (year)	2997	15.945	15.889	0.000	123.000
Floor area (ft^2)	2997	1941.240	770.941	532.000	7123.000
Lot size (acre)	2997	0.277	0.477	0.014	8.645
Regional job accessibility	2997	0.003	0.035	0.000	1.859
Regional shopping accessibility	2997	0.009	0.009	0.001	0.104
Neighborhood retail accessibility	2997	1.129	1.179	0.080	20.545
Neighborhood park accessibility	2997	0.020	0.049	0.000	0.626
Neighborhood transit accessibility	2997	0.866	1.471	0.000	11.131
Regional congestion	2997	5.326	4.001	0.000	15.313
Neighborhood congestion	2997	1.514	1.680	0.000	8.620
Intersection density	2997	93.885	42.686	2.000	291.000
Housing density (unit/acre)	2997	2.355	2.544	0.000	36.619
Job density (workers/acre)	2997	2.273	8.906	0.000	378.220
School quality	2997	0.994	0.060	0.806	1.141
Median family income (1,000$)	2997	46.389	20.754	4.648	200.001
Poverty rate (%)	2997	0.143	0.120	0.003	1.000
Water proximity (dummy)	2997	0.000	0.018	0.000	1.000
X coordination	2997	516.971	53.120	351.107	637.491
Y coordination	2997	1520.660	64.391	1372.580	1680.510

Note: X coordination and Y coordination do not necessarily ensure to be interpreted as results of this analysis. They are inserted to the regression model to control spatial bias that could be derived from locations of single family houses.

3.3.2. CORRELATION ANALYSIS: TRADE-OFF

The results of correlation analysis in Table 3-8 demonstrate that there are several possible trade-offs between neighborhood congestion and accessibility. The regional congestion is negatively related with all accessibility measures. In contrast, the neighborhood congestion is positively associated with all accessibility variables except for the neighborhood park accessibility. Like the Tampa MSA, regional congestion and neighborhood congestion are negatively related, but the correlation is less significant.

Table 3-8. Correlation between Accessibility and Congestion in the Orlando MSA

	ln(sprice)	reg.job.acc	reg.shop.acc	retail	parks	transit	Reg_con	Nh_con
ln(sprice)	1.000							
reg.job.acc	-0.058	1.000						
reg.shop.acc	-0.083	0.098	1.000					
retail	-0.155	0.038	0.340	1.000				
parks	0.149	-0.023	-0.108	-0.074	1.000			
transit	-0.291	0.109	0.377	0.294	-0.162	1.000		
Reg_con	0.180	-0.005	-0.011	-0.158	-0.021	-0.091	1.000	
Nh_con	-0.113	0.054	0.248	0.305	-0.089	0.317	-0.022	1.000

3.3.3. SPATIAL PATTERNS OF CONGESTION AND ACCESSIBILITY

As shown in Figure 3-27, the properties having higher regional job accessibility are spatially clustered near downtown area of the City of Orlando. Several hot spots of the regional shopping accessibility are located along major highways, such as I-4 and Florida Turnpike, and near Disney World, as well as along the International Drive. Suburban areas in Lake County and Osceola County are cool zones of regional shopping accessibility.

The spatial patterns of neighborhood accessibility are shown in Figure 3-28. In general, hot spots of neighborhood retail accessibility are scattered across the Orlando MSA. The properties having higher neighborhood park accessibility are spatially clustered in suburban areas. Inner city areas of City of Orlando, Kissimmee and Sanford are the hot spots of the neighborhood transit accessibility, and suburban areas are cool zones of the neighborhood transit accessibility.

The spatial clustering of congestion is shown in Figure 3-29. The single family housing units with lower regional congestion are spatially clustered in suburban areas in Orange and Lake County, and the housing units with higher regional congestion are clustered in Osceola County and the south-side of Seminole County. Specifically, higher regional congestion is clustered in the north and south suburban areas along I-4. This may be because the congestion on the I-4 increases commuting time during congested conditions. This can be confirmed from the fact that higher neighborhood congestion is spatially clustered along the I-4. Relatively, the east and west side suburban areas may experience less regional and neighborhood congestion.

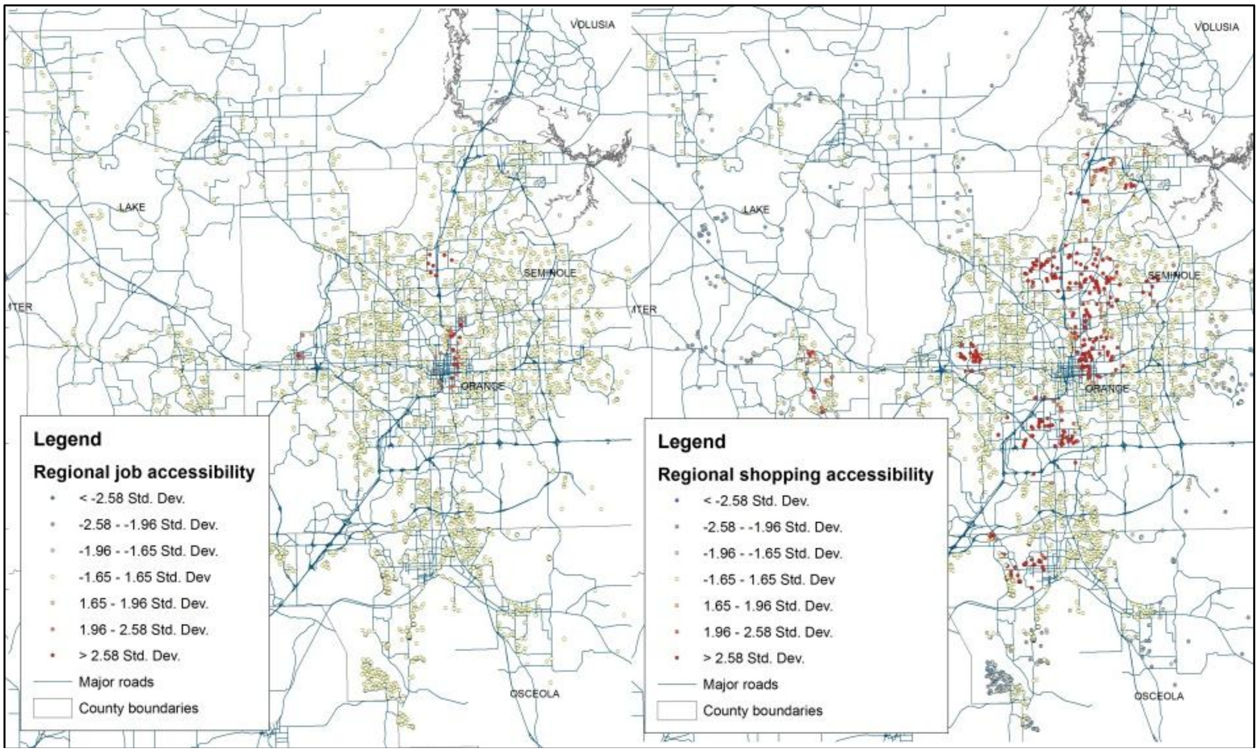

Figure 3-27. Spatial Clustering of Regional Accessibility in the Orlando MSA

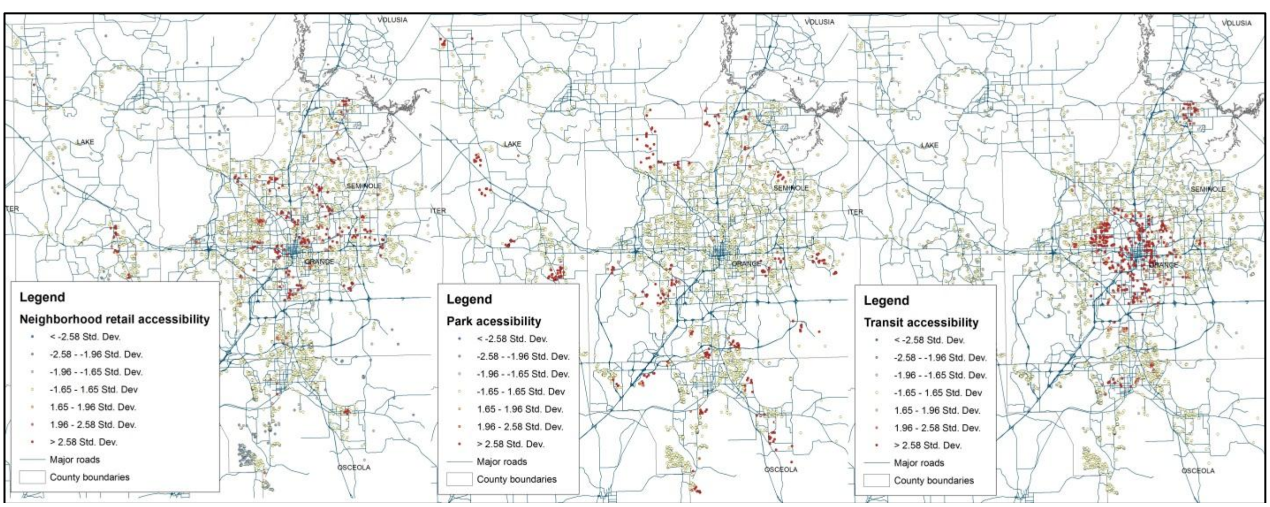

Figure 3-28. Spatial Clustering of Neighborhood Accessibility in the Orlando MSA

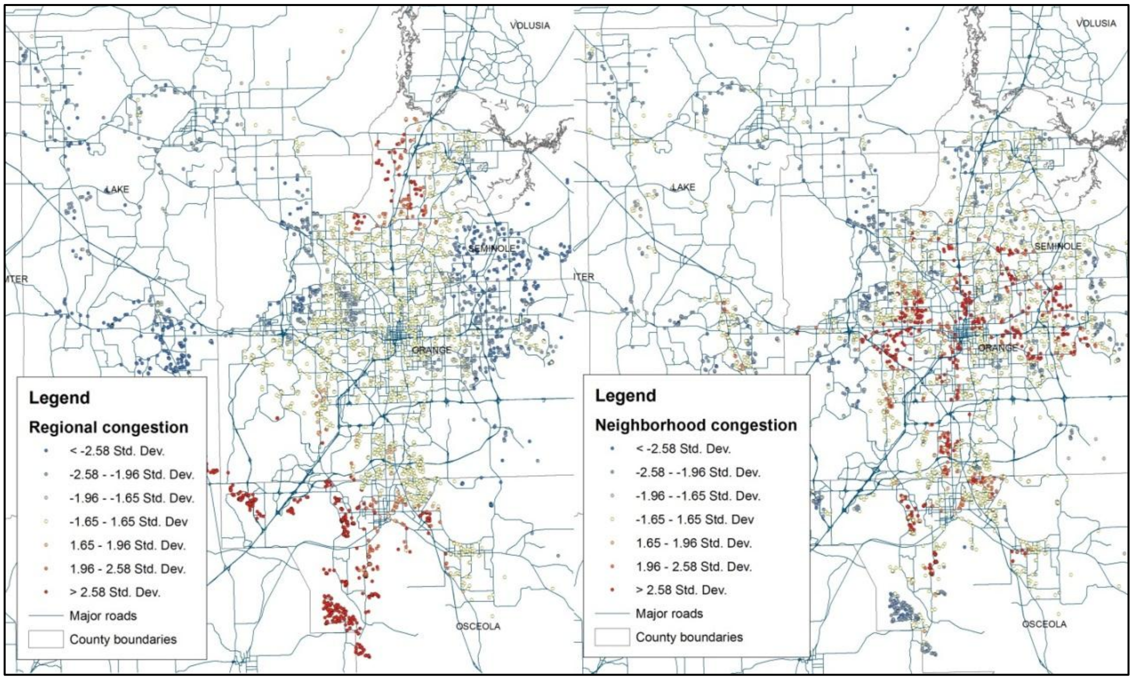

Figure 3-29. Spatial Clustering of Congestion in the Orlando MSA

3.3.4. RESULTS OF ECONOMETRIC MODELS

The results of regression analysis for the Orlando MSA are summarized in Table 3-9. Like other MSAs, the overall all direction of estimated parameters are the same regardless of the model used, but the significance of some variables differs. Similar to the Miami MSA, the multilevel regression model can address spatial autocorrelation relatively well, but all Z-scores are significant. Consequently, the spatial autocorrelation issue cannot be solved even though spatial econometric models are applied. Only the estimated result of the regional shopping accessibility is consistent with the hypothesis of this study. The congestion and accessibility variables at the neighborhood level are not statistically significant.

Opposite to the hypothesis, regional congestion has a positive effect on property values. In the Orlando MSA, expensive houses are concentrated in the southwest and northeast suburban areas in Orange County, and south suburban areas of Seminole county. This might be results that some single family parcels experiencing high neighborhood congestion have high regional job accessibility. These suburban areas are located along or adjacent to the major highways, such as I-4, Florida Turnpike, and Seminole Expressway. As a result, the higher regional congestion and higher property value coexist.

Like the Tampa MSA case, housing density has only a positive effect on single-family sale price. The average residential density of the Orlando MSA is only 2.35 housing units per acre. As noted earlier, increased density may imply increased demand without decreasing community amenities so that housing density can increase property value.

Table 3-9. Estimated Results of Regression Models for the Orlando MSA

Variables	OLS	Multi-level	SAR	SEM	SDM
Property age (year)	-0.0060**	-0.0065**	-0.0060**	-0.0062**	-0.0061**
Floor area (ft^2)	0.0005**	0.0005**	0.0005**	0.0005**	0.0005**
Lot size (acre)	0.0826**	0.0908**	0.0848**	0.0871**	0.0874**
Regional job accessibility	-0.4230	-0.5314**	-0.4286	-0.4404	-0.4395
Regional shopping accessibility	2.9041**	0.8560	2.6719**	2.6868**	2.5887**
Neighborhood retail accessibility	0.0049	0.0000	0.0052	0.0060	0.0058
Neighborhood park accessibility	0.1953*	0.2960*	0.1788	0.1704	0.1670
Neighborhood transit accessibility	0.0052	0.0050	0.0067	0.0056	0.0069
Regional congestion	0.0131**	0.0106**	0.0120**	0.0131**	0.0121**
Neighborhood congestion	0.0022	-0.0064	0.0019	0.0001	0.0008
Intersection density	0.0002	0.0002	0.0002	0.0003	0.0003
Housing density (unit/acre)	0.0082**	0.0019	0.0078**	0.0068**	0.0072**
Job density (workers/acre)	0.0006*	0.0008	0.0005	0.0005	0.0005
School quality	1.2702**	0.9080**	1.2307**	1.2822**	1.2515**
Median family income (1,000$)	0.0001	0.0002	0.0001	0.0002	0.0001
Poverty rate (%)	0.0181	0.0269	0.0139	0.0318	0.0226
Water proximity (dummy)	-0.1457**	-0.1558	-0.1542**	-0.1212*	-0.1412**
X coordination	-0.0005**	-0.0004	-0.0005**	-0.0003**	-0.0004**
Y coordination	-0.0002*	-0.0002	-0.0002**	-0.0003*	-0.0002*
Intercept	10.2468**	10.7051**	9.1422**	10.2077**	9.1433**
Rho			0.0979**		0.0945**
Lambda				0.2558**	0.1535**
Adj. R-square (Pseudo R^2)	0.6784	-	0.6868	0.6801	0.6866
Moran's I (Z-score)	0.2620 (24.47)	0.0907 (8.49)	0.2457 (22.95)	0.2234 (20.87)	0.2241 (20.94)

Note: *, ** are significant at 5% and 1% level, respectively. The results of random solution in the multilevel regression are not reported in this table.

3.3.5. SUMMARY OF FINDINGS FOR ORLANDO MSA

Based on the analyses by the spatial patterns of accessibility and congestion, and their effect on property value in the Orlando MSA, this study suggests several findings. First, the properties having higher regional job and shopping accessibility, and higher regional congestion, and higher neighborhood congestion are spatially clustered along the I-4 freeway. This pattern demonstrates that the travel for shopping and commuting may be highly dependent on traffic congestion of the I-4 in the Orlando MSA. The concentration of traffic may aggravate the congestion level on the I-4.

Second, there is no evidence of a trade-off between accessibility and congestion. The neighborhood congestion is positively related with accessibility variables, but the neighborhood congestion itself does not appear to affect property values.

3.4. JACKSONVILLE MSA

3.4.1. GENERAL OVERVIEW OF JACKSONVILLE MSA

The general map of the Jacksonville MSA is shown in Figure 3-30. The Jacksonville MSA comprises five counties: Duval County, Clay County, St. Johns County, Nassau County, and Baker County with central cities including Jacksonville, Orange Park, St. Augustine, and Fernandina Beach, respectively. Duval County was created in 1967 as a consolidated city-county government with the City of Jacksonville. Jacksonville Beach, Atlantic Beach, Neptune Beach, and Baldwin opted out of the consolidated government. Three major interstate highways cross the region: I-10, I-95, and I-295. I-10 connects from the west of the city, I-95 heads north to Washington D.C. and south to Miami, and I-295 bypasses the City of Jacksonville on the west to connect all areas of the Jacksonville MSA. US highways such as US-1, US-17, US-90, and US 301 provide major access to not only central areas but also the outskirts of Jacksonville City.

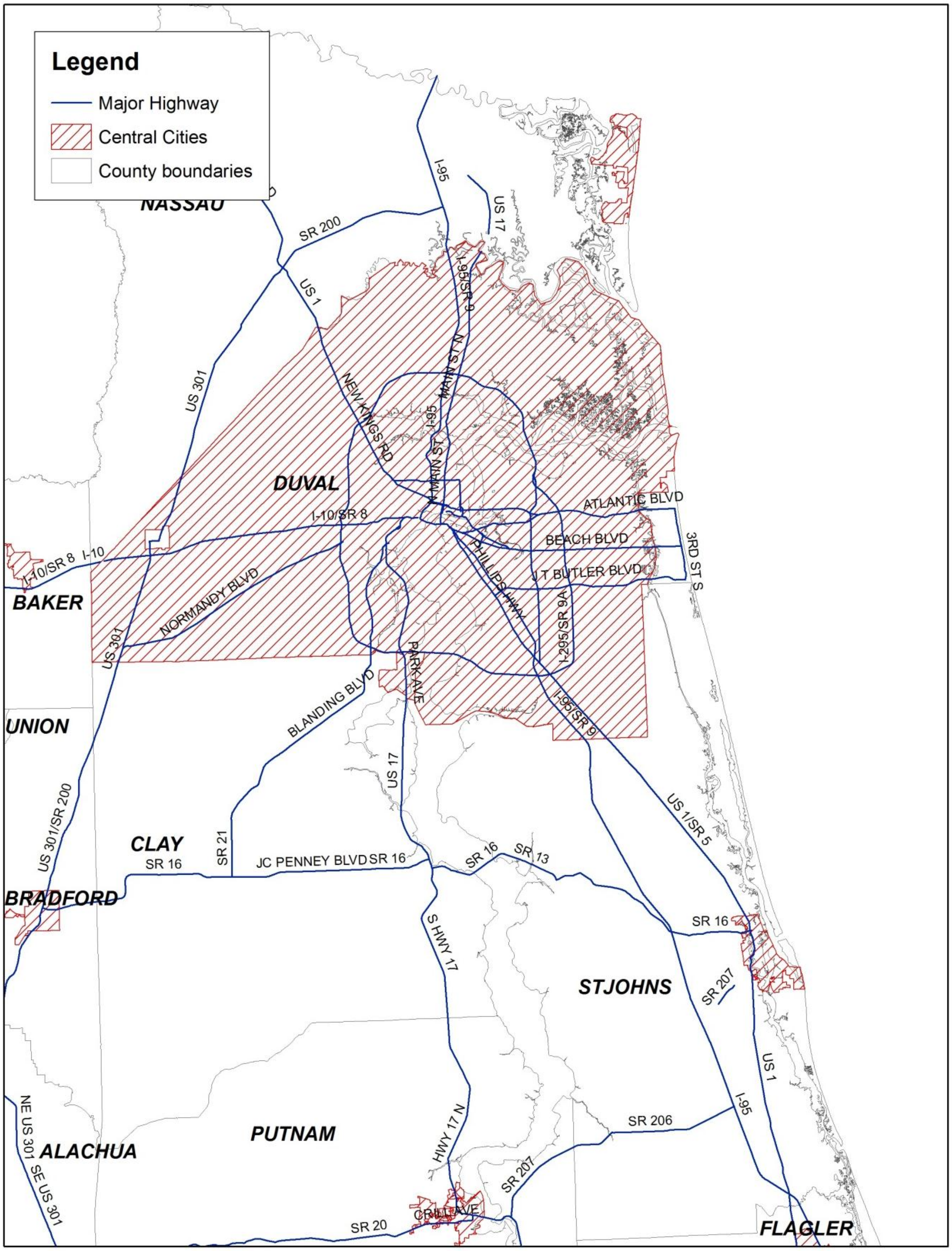

Figure 3-30. General Map of the Jacksonville MSA

The spatial pattern of job centers and TAZs is presented in Figure 3-31. Most job centers are located in the City of Jacksonville and the City of St. Augustine. The spatial pattern of regional shopping centers is shown in Figure 3-32. Most job centers are located along I-295 and I-95 within Duval County, but they are located along Blanding Boulevard outside of Duval County and along SR 207 in the City of St. Augustine.

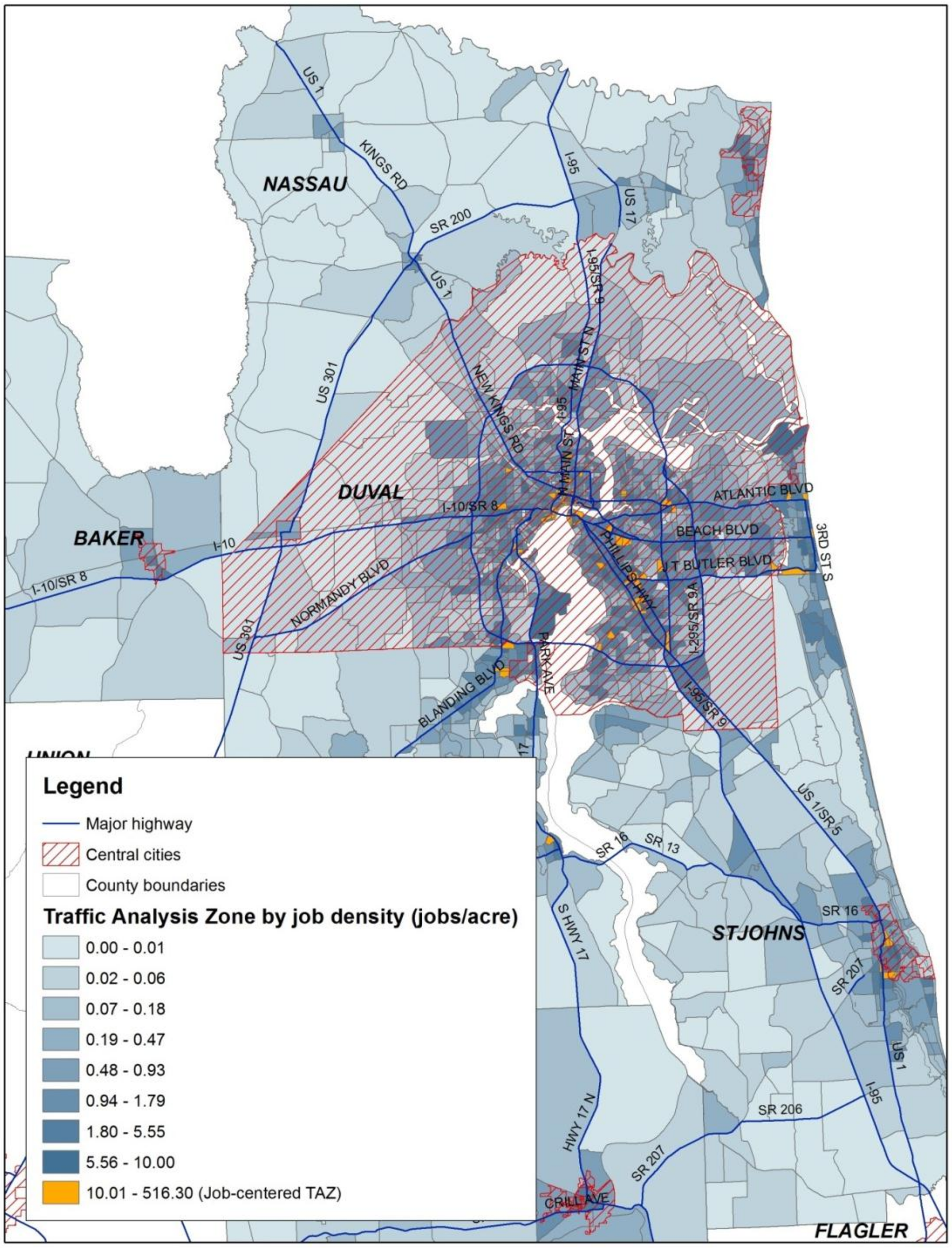

Figure 3-31. Spatial Pattern of Job Centers and TAZ in the Jacksonville MSA

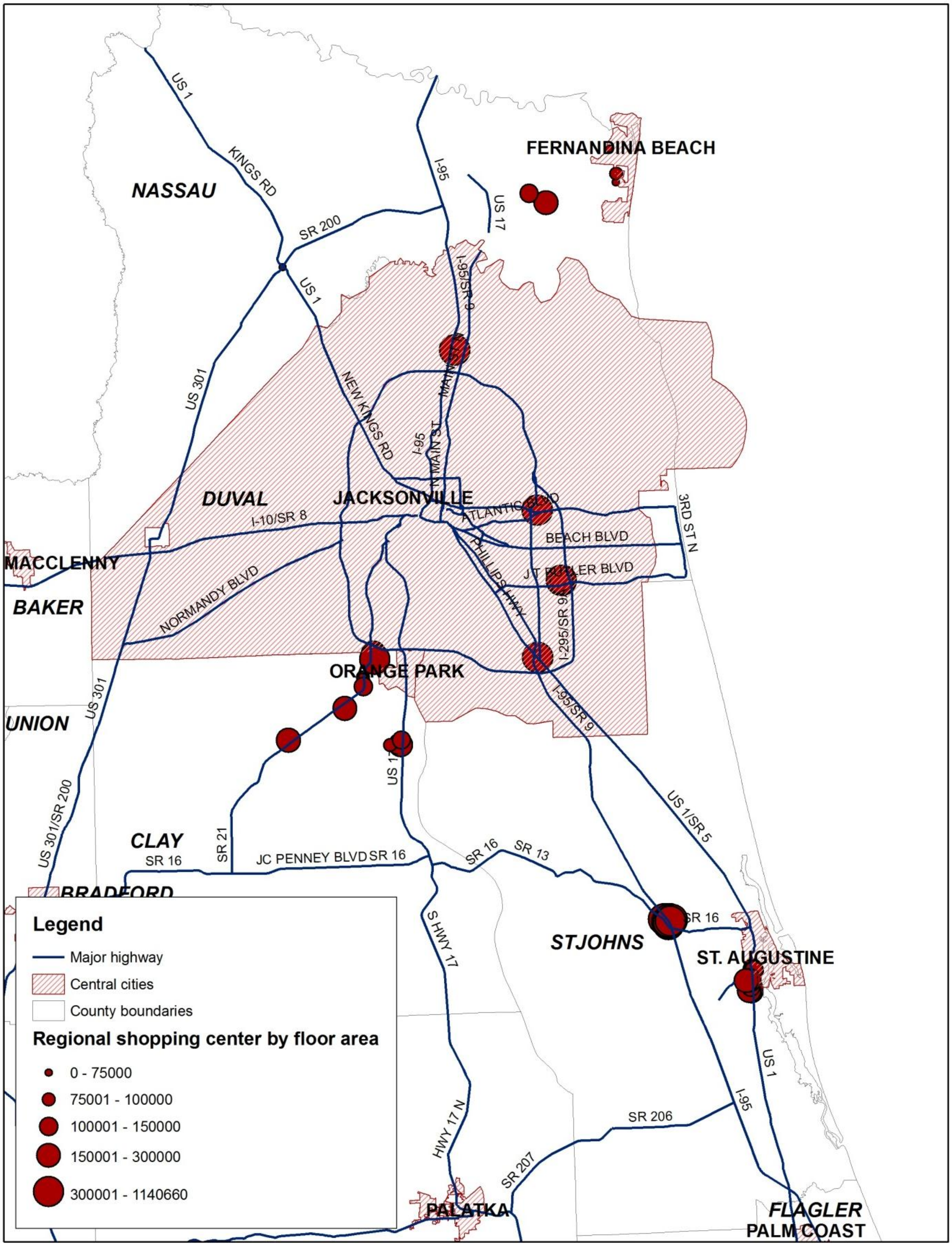

Figure 3-32. Spatial Pattern of Regional Shopping Centers in the Jacksonville MSA

The spatial pattern of regional job accessibility is shown in Figure 3-33. Single family parcels having high regional job accessibility are mostly concentrated in downtown and central areas of the City of Jacksonville. Single family homes with high regional job accessibility are located along the east coast of Duval County in Neptune and Atlantic Beach. Single family parcels having high regional shopping accessibility are largely located in southeastern part of Duval County and the City of St. Augustine. This might be because a significant number of regional shopping centers are located in Southside Boulevard which runs from north to south near I-295, Roosevelt Boulevard, and Blanding Boulevard, which bring traffic into the City of Jacksonville.

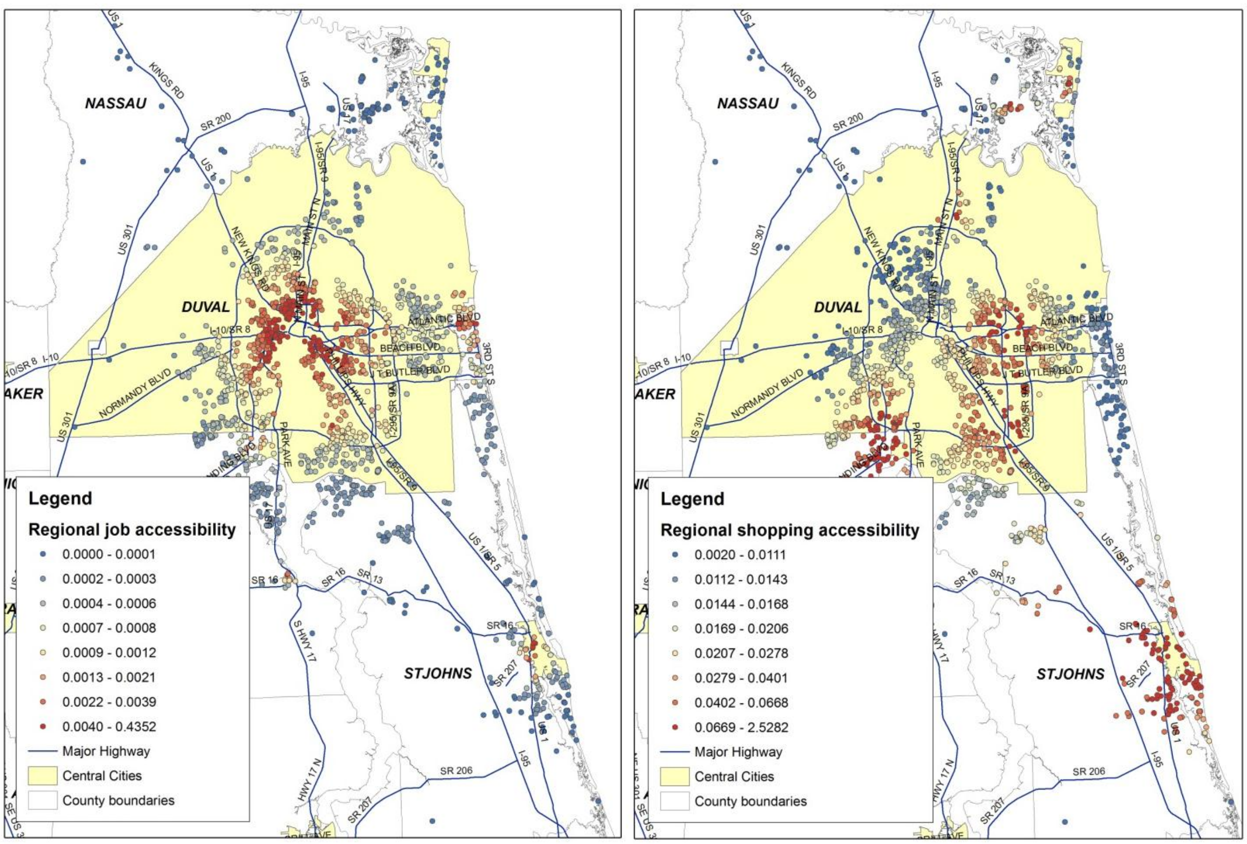

Figure 3-33. Regional Accessibility in the Jacksonville MSA

3.4.1. DESCRIPTIVE STATISTICS

Tables 3-10 shows the descriptive statistics for the variables used in the econometric models. The statistics for the neighborhood accessibility show that there is a large spectrum of local accessibility value. On average, minimum distance to retail services is about 0.576 mile, approximately 0.021 square mile of park is located within a half mile from single family housing, and about 1.3 miles of transit route is located nearby single family housing. The mean of regional congestion of the 1788 single family houses indicates that in average commuters take more than 12 minutes to go to work at the congested condition compared to other drivers travelling at free flow conditions. The neighborhood congestion ranges from 0 to 5.2 with 1.17 mean value.

Table 3-10. Descriptive Statistics for the Jacksonville MSA

Variables	N	Mean	Std-Dev	Min.	Max.
Ln(sale price)	1788	11.920	0.714	9.616	14.790
Property age (year)	1788	20.841	19.158	0.000	101.000
Floor area (ft^2)	1788	1969.660	839.112	0.000	7947.000
Lot size (acre)	1788	0.325	0.799	0.012	22.521
Regional job accessibility	1788	0.002	0.011	0.000	0.435
Regional shopping accessibility	1788	0.042	0.097	0.002	2.528
Neighborhood retail accessibility	1788	1.761	2.971	0.092	103.149
Neighborhood park accessibility	1788	0.021	0.049	0.000	0.406
Neighborhood transit accessibility	1788	1.310	2.208	0.000	14.453
Regional congestion	1788	12.708	6.243	0.000	62.615
Neighborhood congestion	1788	1.168	1.492	0.000	5.200
Intersection density	1788	100.780	52.876	1.000	377.000
Housing density (unit/acre)	1788	1.418	1.366	0.010	7.684
Job density (workers/acre)	1788	1.158	2.315	0.000	51.484
School quality	1788	1.003	0.069	0.824	1.140
Median family income (1,000$)	1788	55.618	19.863	13.036	141.869
Poverty rate (%)	1788	0.094	0.086	0.004	0.625
Water proximity (dummy)	1788	0.284	0.451	0.000	1.000
X coordination	1788	629.921	14.060	589.221	668.111
Y coordination	1788	695.669	19.937	631.758	752.319

Note: X coordination and Y coordination do not necessarily ensure to be interpreted as results of this analysis. They are inserted to the regression model to control spatial bias that could be derived from locations of single family houses.

3.2.2. CORRELATION ANALYSIS: TRADE-OFF

The results of correlation analysis shown in Table 3-11 demonstrate the possibility of trade-off relationship between accessibility and congestion. The regional congestion is positively associated with regional shopping accessibility and neighborhood park accessibility. The neighborhood congestion is positively correlated with all accessibility variables except neighborhood park accessibility. This indicates that the location of single family homes with higher neighborhood congestion tends to have high accessibility to jobs, retail shops and transit systems. The positive correlation between accessibility and congestion means that there might be a trade-off that can be monetized into property values. However, regional congestion is negatively correlated with regional job accessibility, indicating that there is no trade-off between regional congestion and regional job accessibility.

Table 3-11. Correlation between Accessibility and Congestion in the Jacksonville MSA

	ln(sprice)	reg.job.acc	reg.shop.acc	retail	parks	transit	Reg_con	Nh_con
ln(sprice)	1.000							
reg.job.acc	-0.072	1.000						
reg.shop.acc	-0.001	-0.004	1.000					
retail	-0.241	0.057	0.489	1.000				
parks	0.299	-0.031	-0.025	-0.068	1.000			
transit	-0.430	0.165	-0.098	0.271	-0.123	1.000		
Reg_con	0.104	-0.081	0.018	-0.102	0.028	-0.319	1.000	
Nh_con	-0.126	0.088	0.133	0.185	-0.085	0.345	-0.078	1.000

3.4.3. SPATIAL PATTERNS OF CONGESTION AND ACCESSIBILITY

The single family properties that have higher regional job accessibility are spatially clustered in the downtown area of City of Jacksonville. Most hot-spots of regional job accessibility are located inside of the I-295 freeway. In contrast, many of hot spots of regional shopping accessibility are located outside of the I-295. Specifically, they are concentrated in the southeast side of I-295 and the City of St. Augustine as shown in Figure 3-34.

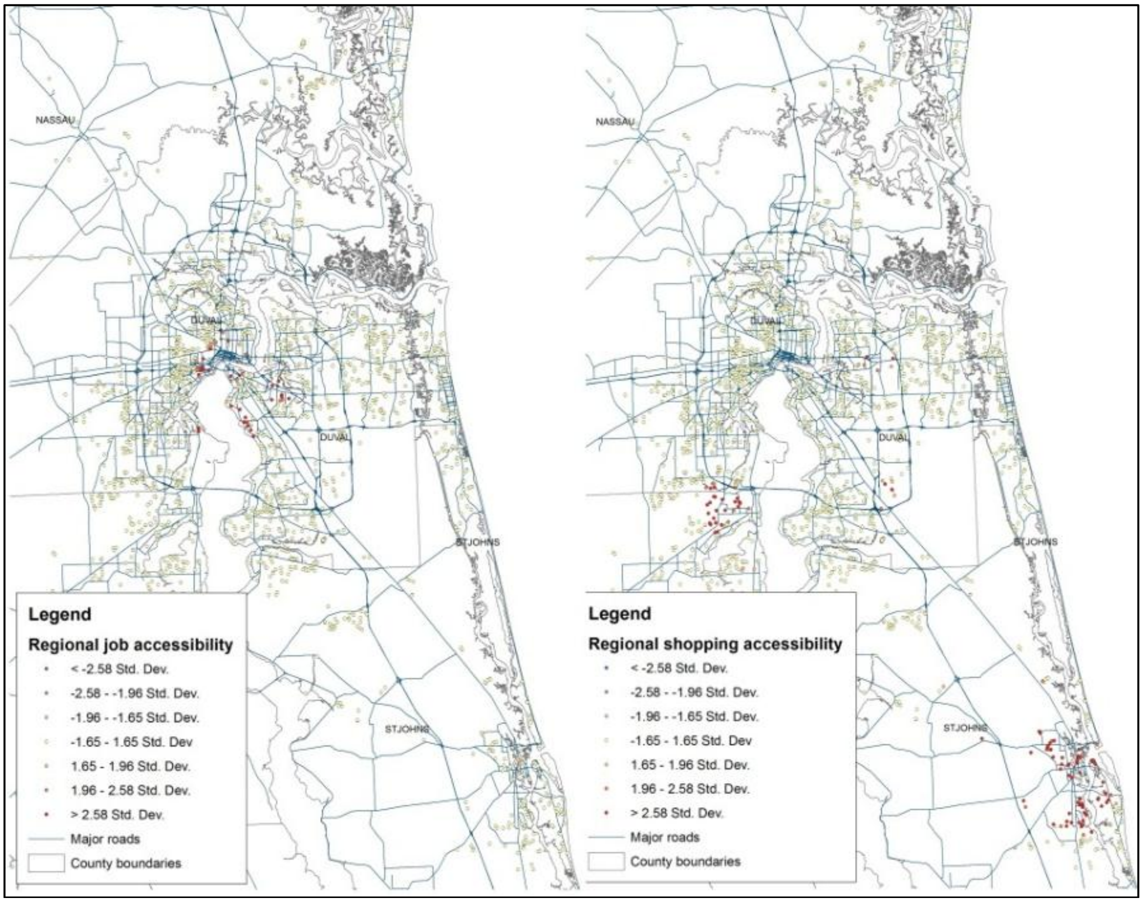

Figure 3-34. Spatial Clustering of Regional Accessibility in the Jacksonville MSA

The results of hotspot analysis for neighborhood accessibility are presented in Figure 3-35. The properties having high neighborhood retail accessibility are clustered in central areas in City of Jacksonville where many retail shopping centers are located. The hot spots of the neighborhood park accessibility are dispersed in suburban areas on the outside of the I-295. Unlike the park accessibility, hot spots of the transit accessibility are concentrated in the central areas inside of the I-295. It is important to know that Atlantic Beach and Neptune Beach which are located in the east coast of Duval County have relatively higher neighborhood accessibility compared to adjacent areas.

The hot spots of regional congestion are located in north side of Clay County and southwest part of Duval County as shown in figure 3-36. The clustered areas are suburban areas of Jacksonville MSA and the area is connected to the central city mainly by the State Road (SR)-21. As the SR-21 is highly congested, the residents in the southwest part of Duval County may experience higher regional congestion in commuting. The fact that hot spots of neighborhood congestion are also located in this area supports the explanation. In general, the hot spots of neighborhood congestion are distributed along the major roads, such as I-10, I-95, and SR-10.

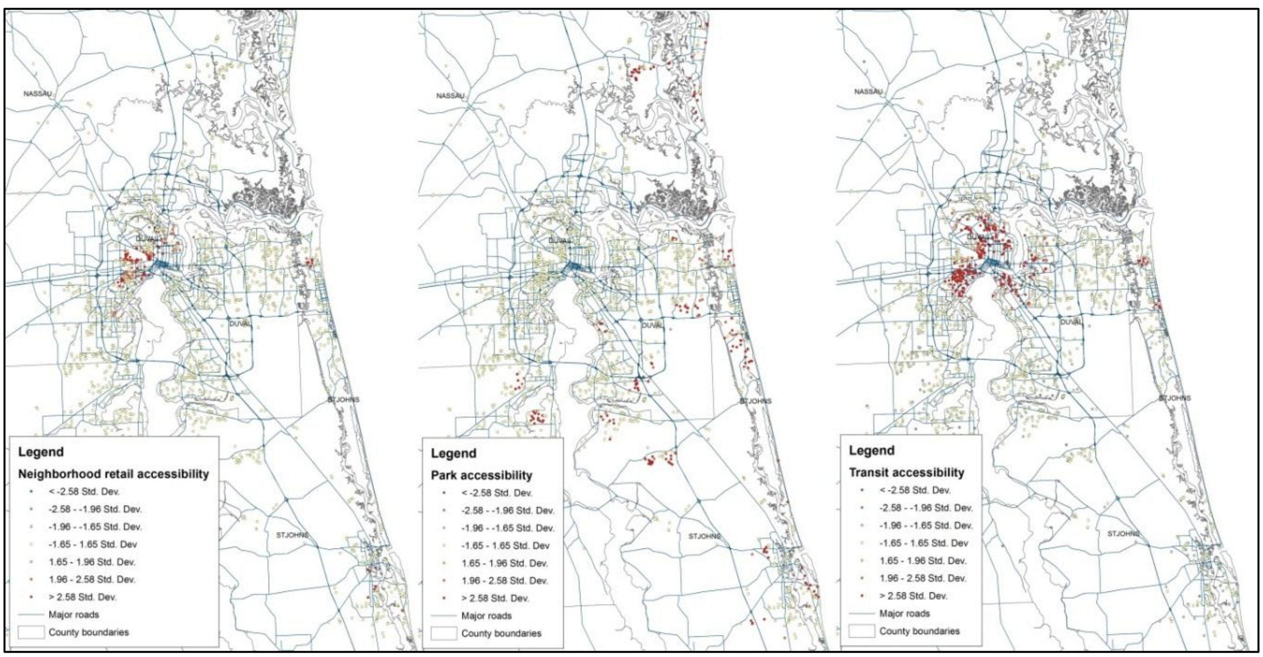

Figure 3-35. Spatial Clustering of Neighborhood Accessibility in the Jacksonville MSA

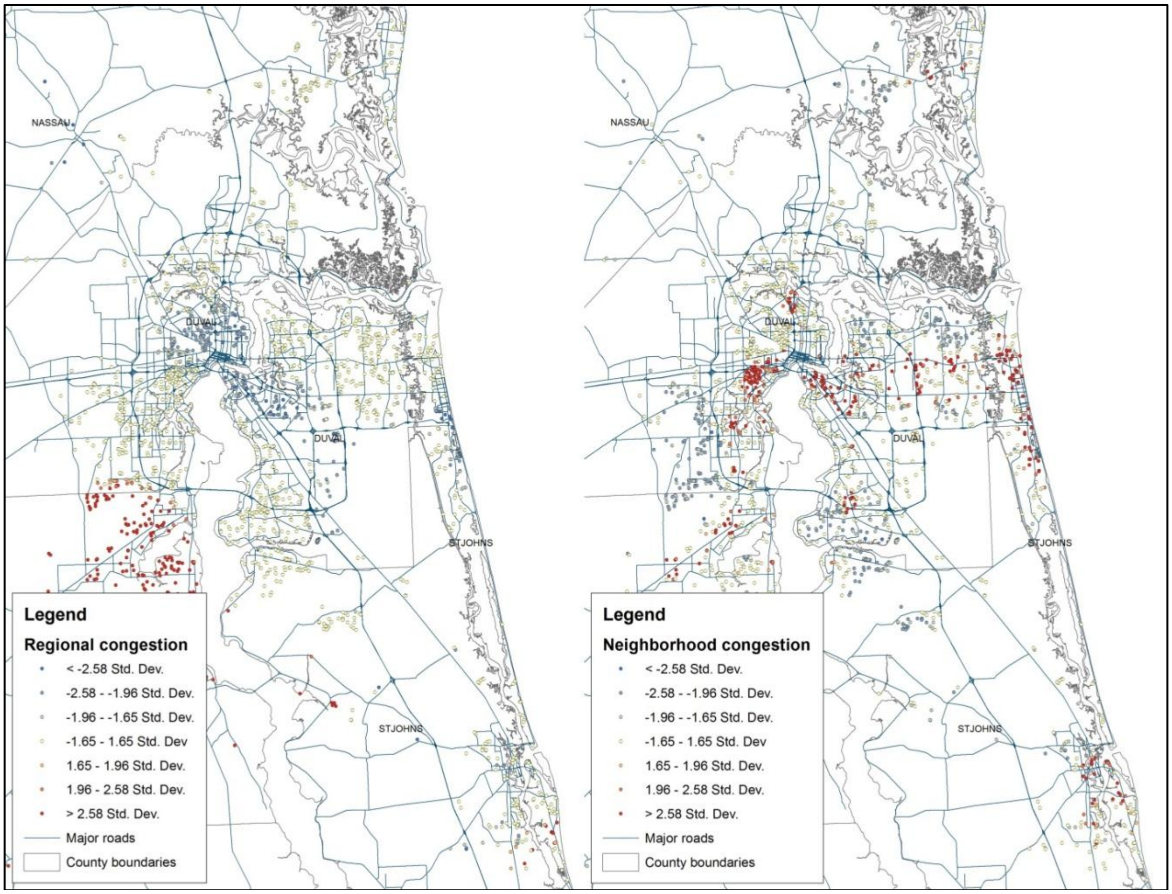

Figure 3-36. Spatial Clustering of Congestion in the Jacksonville MSA

3.4.4. RESULTS OF ECONOMETRIC MODELS

The Table 3-12 describes results of regression analysis for Jacksonville MSA. The values of the Moran's I show that the spatial autocorrelation of residuals is not reduced when the spatial econometric models are used. However, the spatial autocorrelation is alleviated in multilevel regression model. Most of estimated parameters of neighborhood accessibility and control variables conform to the hypothesis of this study. However, the regional job and shopping accessibility show counterintuitive results to the original hypothesis.

In the Jacksonville MSA, most of jobs are concentrated along the I-295 freeway and they are concentrated near the I-10 and I-295 freeway in downtown. However, inner city and downtown areas of the Jacksonville MSA are the areas of the greater central city and neighborhood decline in the state of Florida (Swanson, 2000). The regression results show that regional job and shopping accessibility have negative effects on property value. Mostly, the negative effect of the regional job and shopping accessibility is affected by the spatial autocorrelation. In fact, when the spatial autocorrelation is reduced by the multilevel regression, these negative effects of regional job accessibility are not significant. Because the autocorrelation is not completely removed from the model, the negative effect is seemingly related to the connection between locations with higher job accessibility, and locations of economically disadvantaged neighborhoods.

Like the Miami MSA, both housing density and job density show positive effects on property value. Intrinsically, density could bring about community's opposition because it can increase traffic volume, and bring more congestion into neighborhoods. However, density could positively affect property value because it is still low in Jacksonville MSA. With regard to non-linear effects of density, these positive effects imply that housing density and job density are still low, and increasing density is sufficient to increase property value without harming community's amenity. In this way, some consumers might be still willing to pay premium for relatively higher density.

Table 3-12. Estimated Results of Regression Models for the Jacksonville MSA

Variables	OLS	Multi-level	SAR	SEM	SDM
Property age (year)	-0.0104**	-0.0100**	-0.0102**	-0.0103**	-0.0101**
Floor area (ft^2)	0.0004**	0.0004**	0.0004**	0.0004**	0.0004**
Lot size (acre)	0.0541**	0.0575**	0.0537**	0.0553**	0.0540**
Regional job accessibility	-1.0489	-1.2265	-1.1461**	-1.1741**	-1.2050**
Regional shopping accessibility	-0.1423	-0.0955	-0.1717*	-0.1326	-0.1640*
Neighborhood retail accessibility	-0.0014	-0.0033	-0.0008	-0.0013	-0.0008
Neighborhood park accessibility	0.8996**	0.7412**	0.9163**	0.8887**	0.9112**
Neighborhood transit accessibility	0.0130*	0.0142*	0.0135*	0.0134*	0.0137*

Regional congestion	0.0016	0.0031	0.0013	0.0015	0.0013
Neighborhood congestion	0.0029	-0.0082	0.0026	0.0016	0.0020
Intersection density	-0.0003	-0.0004	-0.0003	-0.0003	-0.0003
Housing density (unit/acre)	0.0420**	0.0338**	0.0421**	0.0397**	0.0408**
Job density (workers/acre)	0.0186**	0.0151**	0.0188**	0.0187**	0.0189**
School quality	0.3794*	0.5167**	0.2870	0.3451*	0.2745
Median family income (1,000$)	0.0042**	0.0048**	0.0041**	0.0041**	0.0040**
Poverty rate (%)	-0.9361**	-0.7536**	-0.8907**	-0.9630**	-0.9100**
Water proximity (dummy)	0.1049**	0.1010**	0.1087**	0.1063**	0.1095**
X coordination	0.0097**	0.0089**	0.0089**	0.0097**	0.0090**
Y coordination	-0.0003	-0.0004	-0.0005	-0.0003	-0.0005
Intercept	4.7288**	5.1633**	4.5953**	4.7593**	4.5793**
Rho			0.0694*		0.0689*
Lambda				0.1554*	0.0880
				Knn14	
Adj. R-square (Pseudo R2)	0.7855		0.7908	0.7899	0.7908
Moran's I (Z-score)	0.13 (15.45)	0.04 (4.91)	0.12 (14.8)	0.12 (14.68)	0.12 (14.39)

Note: *, ** are significant at 5% and 1% level, respectively. The results of random solution in the multilevel regression is not reported in this table.

3.4.5. SUMMARY OF FINDINGS FOR JACKSONVILLE MSA

According to the hotspot analyses and econometric analyses for Jacksonville MSA, this study makes several findings. First, three distinctive areas with different spatial patterns of accessibility and congestion are identified: (1) central city areas inside of the I-295, (2) southwest suburban areas outside of I-295, and (3) City of St. Augustine area. In general, higher accessibility and congestion are clustered in central areas of City of Jacksonville. The southwest suburban area has relatively higher regional shopping accessibility, park accessibility, and regional congestion. This suburban area has good accessibility to regional shopping centers and parks, but the lack of job accessibility and higher dependence on SR-21 may result in higher regional congestion. Since the City of St. Augustine is a popular tourism destination with historic district and beaches in northeast Florida, the area has a higher regional shopping and neighborhood park accessibility. Second, trade-off between accessibility and congestion does not exist in the Jacksonville MSA because both regional and neighborhood congestion does not appear to negatively affect single-family property values. However, the residents in the southwest suburban areas of the Jacksonville MSA may experience trade-off between congestion and accessibility even though the negative externalities are not internalized into property values.

3.5. COMPARISION OF RESULTS FROM FOUR MSA AREAS

The effects of accessibility and congestion vary depending on metropolitan areas. This could be because each metropolitan area has different land use and transportation coordination. The distribution of residence, jobs and retails, and the highway networks are combined and may affect property value differently.

The mean values of accessibility and congestion are compared in Table 3-13. In general, the values of accessibility show small variance between the MSAs. The Tampa and Jacksonville MSA have higher regional congestion than the Miami and Orlando MSA. This may be because much traffic in the Tampa and Jacksonville MSA are mainly dependent on bridges to cross the Tampa Bay and St. Johns River, respectively.

Regional job accessibility varies because each individual metropolitan area has different job patterns. Because job accessibility is calculated by employment and distance to job centers, it could be a proxy of job-housing proximity. The Tampa MSA and the Jacksonville MSA show similar values of job accessibility. The Miami MSA presents the highest job accessibility, which indicates that the region has either the shortest distance to job centers or the largest employment numbers in job centers among the four MSAs. This may be because the job centers are widely distributed across the Miami MSA.

At the neighborhood level, the Miami MSA has the highest level of congestion. The level of the neighborhood congestion is related with housing density of each MSA. The MSAs, especially Miami MSA, with higher housing density tends to have higher neighborhood congestion.

Table 3-13. Comparison of Accessibility and Congestion by four MSAs

Variables	Miami MSA	Tampa MSA	Orlando MSA	Jacksonville MSA
Regional job accessibility	0.005	0.002	0.003	0.002
Regional shopping accessibility	0.028	0.009	0.009	0.042
Neighborhood retail accessibility	1.568	1.917	1.129	1.761
Neighborhood park accessibility	0.023	0.038	0.020	0.021
Neighborhood transit accessibility	3.416	1.291	0.866	1.310
Regional congestion	3.156	22.001	5.326	12.708
Neighborhood congestion	2.112	1.517	1.514	1.168

The effects of accessibility and congestion by MSAs based on econometric models are compared in Table 3-14. Since spatial autocorrelation may result in bias in estimation, the directions and significance of estimated parameters is referred from the model having lowest Z-score of Moran's I. Regional job accessibility shows mixed results by the four MSAs. This may be because people have various opinions about the job accessibility although several studies assume that their preferences are the same (Levinson, 1997). It is highly likely that people would emphasize good public services or amenities in areas (Tiebout, 1956 and Rosen, 1974) where job accessibility has a negative impact on property values. They might dislike the proximity to jobs because of lower amenities near job centers. On the other hand, some might outweigh job accessibility among other factors in deciding residential location, resulting in a positive impact on property values because shortening commuting time is the most important determinant in their residential choice. This countervailing result implies that people's preference for housing quality and the associated neighborhood attributes are spatially disaggregated throughout these metropolitan areas.

Table 3-14. Effects of Accessibility and Congestion by four MSAs

Variables	Expected results	Miami MSA	Tampa MSA	Orlando MSA	Jacksonville MSA
Regional job accessibility	(+)	N.S.	(+)**	(-)*	N.S.
Regional shopping accessibility	(+)	N.S.	N.S.	N.S.	N.S.
Neighborhood retail accessibility	(+)	N.S.	N.S.	N.S.	N.S.
Neighborhood park accessibility	(+)	N.S.	(+)*	(+)*	(+)**
Neighborhood transit accessibility	(+)	(-)*	N.S.	N.S.	(+)*
Regional congestion	(-)	(+)*	(-)**	(+)*	N.S.
Neighborhood congestion	(-)	(-)*	(-)**	N.S.	N.S.
Model		Multilevel	SEM	Multilevel	Multilevel
Moran's I (Z-score)		0.13 (16.54)	-0.027 (-2.81)	0.09 (8.49)	0.04 (4.91)

Note: *, ** are significant at 5% and 1% level, respectively.

Regional shopping accessibility also show mixed results depending on MSAs. This may be the reflection of people's preference for the low density suburban single-use residential neighborhoods rather than mixed used communities. Indeed, previous research suggests that Florida residents prefer low density housing and homogeneous community (Audirac and Smith, 1992). The neighborhood transit accessibility has also mixed effect. As transit networks tend to be concentrated in economically distressed inner city neighborhoods, transit accessibility may show up as having a negative effect on property values.

The neighborhood congestion negatively affects property value consistently, but the effects of regional congestion vary depending on MSAs. The positive effect of regional congestion can be understood in terms of job distribution and the level of regional congestion. The MSAs with higher concentration of jobs in central city areas tend to a have positive effect of the regional congestion on property value. In general, suburban areas experience higher regional congestion than inner city areas. If the level of regional congestion is not too high to have negative externalities, the location of properties having higher regional congestion are similar with that of houses with higher housing price in suburban areas. In fact, the level of regional congestion in the Miami and Orlando MSA, which has statistically significant positive effects, is low. Another explanation could be a close relation between relocation of job and movement of people. If transportation network can't handle the incoming demand for travel, more traffic is concentrated in urban fringe areas because more jobs and more people are located in the area to avoid central city traffic congestion (Gordon, Richardson, and Jun, 1991). This could be related to the positive effects of congestion on property values.

The existence of trade-off between accessibility and congestion are summarized in Table 3-15. The Tampa MSA has several possibilities of trade-off between congestion and accessibility, and the Miami MSA has trade-off between neighborhood congestion and regional job accessibility. As noted earlier, the level of neighborhood congestion is related to housing density. Therefore, residents in low density suburban communities could avoid neighborhood congestion, but they may also have low regional job accessibility. Moreover, the suburban residents may experience higher regional congestion in commuting like the southwest suburban area of the Jacksonville MSA and the northwest suburban areas in Tampa MSA. On the other hand, the areas having severe congestion could be highly accessible to job centers in central cities in Miami MSA and Tampa MSA.

Table 3-15. Trade-Offs between Accessibility and Congestion by four MSAs

	Miami MSA	Tampa MSA	Orlando MSA	Jacksonville MSA
Regional congestion	N.A.	Neighborhood park accessibility	N.A.	N.A.
Neighborhood congestion	Regional job accessibility	Regional job accessibility Neighborhood transit accessibility	N.A.	N.A.

CHAPTER 4 CONCLUSIONS AND RECOMMENDATIONS

4.1. CONCLUSIONS

This study addresses three research questions: (1) What is the relation between accessibility and congestion both regional and neighborhood level? (2) Is there a trade-off between accessibility and congestion? (3) What is the effect of accessibility and congestion on single-family property value? The spatial patterns of accessibility and congestion, and the possibility of trade-offs are analyzed using the Hot-Spot analysis and correlation analysis. The hypotheses that accessibility has a negative effect and congestion has a positive effect on property values are tested using various spatial econometric models.

The results show that the effects of accessibility and congestion vary across the MSAs. These variances may result from different land use and transportation configuration of each MSA. According to Blanco et al. (2012), the urban form of the central county of these four MSAs is different from the others as shown in Table 4-1. In particular, Miami-Dade County shows high job and housing density, but lower centrality; in this MSA the jobs and housing are dispersed across the county. In contrast, the housing and job density of Hillsborough County is low compared to other MSAs, but the job and housing are more compactly distributed. These differences in job and housing locations are likely to be associated with commuting and travel patterns, and residential location choice. For instance, the negative impact of regional job accessibility on property values in the Orlando MSA may be related to the lower job centrality. When jobs are dispersed, the variance in job accessibility is relatively low, implying less importance of job accessibility in residential location choice. As the residential location choices, with a consideration of congestion and accessibility, are connected to the land use and transportation coordination, planners need to explore which land use and transportation configuration can provide a better choice to residents in terms of less congestion and higher accessibility. Further research on the relationship between land use and transportation configuration and residential location choice should be completed using these Florida MSAs.

Table 4-1. Comparison of Urban Form of Central County of each MSA

Variables	Miami MSA (Miami-Dade)	Tampa MSA (Hillsborough)	Orlando MSA (Orange)	Jacksonville MSA (Duval)
Housing density	1,487.39	879.57	983.85	1,108.04
Job density	2,244.04	1,104.91	1,438.39	1,388.30
Housing centrality	0.768	2.517	0.803	0.877
Job centrality	0.651	1.698	0.585	0.682
Job-housing ratio	1.508	1.256	1.462	1.254

Note: Housing and job density are calculated by dividing number of housing units or jobs with developable land areas (square miles). Centrality refers to the tendency of locating closely to CBD areas. The specific definition and operationalization can be found in Blanco et al. (2012) and Galster et al. (2001).

The varying impacts of congestion and accessibility on property value may be also related with the socio- economic status of central city areas. As the socio-economic characteristics of inner city areas are changing, many MSAs experienced a back to the city movement or central city rebound (Lee and Leigh, 2005; U.S. Environmental Protection Agency, 2009, 2010). This trend means that many people begin to have a higher preference for communities with higher accessibility even though these neighborhoods have higher congestion due to concentrated traffic. Well-designed infill communities, such as new urbanism projects for neighborhood revitalization in the inner city areas, can provide residents with higher accessibility and amenities. Although people experience congestion when they commute from these communities, the decreased commuting distance may offset the negative impact of congestion, implying that congestion at the regional level may not have a proportionate impact in these areas. Consequently, the infill effort combined with a strong housing market and central city rebound may alter the traditional trade-off between congestion and accessibility by providing both greater accessibility and amenity. However, the four MSAs are in different stage of central city rebound, so the impact of congestion and accessibility on property value may vary. In fact, the City of Miami, the City of Tampa, and the City of Orlando experienced substantial growth during the 2000s (USEPA, 2010), but the inner city areas of the City of Jacksonville remained an economically distressed areas, implying that the relationship between congestion and accessibility may vary due to the diverse conditions of central city areas. As a part of the study of the connection among land use and transportation coordination, and residential choice, the location of infill projects that can offset the trade-offs between congestion and accessibility can be identified.

This study confirmed that only neighborhood park accessibility and neighborhood congestion have results that are consistent with the hypothesis. Several possibilities of trade-off between accessibility and congestion exist in the Miami and Tampa MSAs. For instance, residents living in less congested neighborhoods may have lower regional job accessibility. In other words, single family residents living in highly congested neighborhoods might expect high job accessibility or transit accessibility. Additionally, as discussed above, the Tampa MSA residents living in suburban areas who prioritize park accessibility might consider trade-off with high regional job accessibility. Therefore, home consumers should consider trade-offs between accessibility and congestion in their residential location choice.

However, the residential location choice with a consideration of trade-offs between congestion and accessibility may be limited by household income because households decide an optimal location of their housing on the given budget restriction (O'Sullivan, 2009). Higher-income households may choose whatever location they want, but lower income groups may have to consider critical congestion or accessibility factors in their residential location choice due to the very restricted income. Thus, the trade-off between neighborhood congestion and transit accessibility in the Tampa MSA could affect residential location choice of low income households more sensitively. As shown in Table 4-2, very-low-income neighborhoods, where low-income households are concentrated, have relatively higher transit accessibility and higher neighborhood congestion compared to other neighborhood types, implying the possibility of location choices to maximize transit accessibility by low income groups. This pattern reinforces the importance of transportation policies that address the mobility of low-income groups to enhance both transportation and housing choice.

Table 4-2. Mean Values of Congestion and Accessibility by Neighborhood Income Types in the Tampa MSA

Neighborhood Income Types	NH Retail access	NH Parks access.	NH Transit access.	Regional Job access.	Regional Shopping access.	Regional congestion	NH congestion
Total	1.9169	0.0383	1.2910	0.0025	0.0090	22.0011	1.5172
Very Low income NH (less than 50% AMI)	2.2634	0.0275	1.3977	0.0027	0.0096	23.2405	1.7567
Low Income NH (50% - Less than 80% AMI)	1.7507	0.0378	1.2698	0.0022	0.0086	22.1329	1.5181
Middle Income NH (80% to less than 120% AMI)	1.9555	0.0377	1.2834	0.0024	0.0089	21.4492	1.5323
High Income NH (120% to less than 150% AMI)	2.1088	0.0409	1.3155	0.0027	0.0096	22.3967	1.4271
Very High Income NH (150% AMI or more)	1.8172	0.0466	1.2856	0.0034	0.0094	22.4974	1.3970

Note: NH refers to neighborhood.

In short, the interaction among congestion, accessibility, and residential location choice are complicated issues that require further research and policy development. Homeowners, for instance, lower-income households in the Tampa MSA, may face trade-offs between congestion and accessibility. However, the residential location choice of households with a consideration of congestion and accessibility are closely related to the land use and transportation configuration and socio-economic change of central city areas. This study suggests the importance of land use and transportation configuration associated with congestion and accessibility in determining residential location choice. Based on the findings and methodology of this study, further study can sort out the complex relationship among accessibility, congestion, and urban structure. Also, the land use and transportation planning and policy that can reduce congestion and improve accessibility across metropolitan areas could be developed and implemented.

4.2. RECOMMENDATIONS AND SUGGESTED RESEARCH

This study has several limitations. First, although several models reduced the level of spatial autocorrelation, it was not possible to completely eliminate it. In future studies, more robust spatial econometric models with various spatial weighting matrix should be applied to address the spatial autocorrelation and heteroskedasticity more efficiently because finding proper spatial weighting matrix takes a significant amount of work.

Second, in measuring the regional congestion, estimation of travel time to job centers both at free flow and congested condition are based on different transportation planning model from each MSA. Different model assumptions which are applied in the building process of the transportation model may affect the value of the regional congestion variable. Thus, a more generalizable way to operationalize regional congestion should be developed in future studies.

Third, the estimated results of econometric models may vary depending on measurements of accessibility and congestion. Thus, the adequacy of measurements should be examined using different types of accessibility and congestion measures. At the regional level, for instance, this study only considered major job centers in measuring regional job accessibility and regional congestion to reflect commuting in the morning peak hours. However, commuting activities and congestion are not limited to only the traffic flow to job centers during the peak commute especially in the metropolitan areas with a dispersed pattern of employment. Thus, all jobs can be included in measuring the regional job accessibility and congestion in future studies.

At the neighborhood level, this study measures park accessibility and transit accessibility using opportunity-based indicators. However, these opportunity-based indicators may result in bias in the regression models. For instance, suburban areas having larger open spaces tend to have higher park accessibility compared to central city areas that generally have smaller pocket parks within neighborhoods. Also, the transit accessibility used in this study does not reflect the frequency and convenience of transit services and available destinations. Therefore, alternative neighborhood accessibility measurements, such as transit accessibility to major destinations like CBD and regional shopping centers, and distance based park accessibility, should be considered in future research.

Fourth, this study addresses the role of accessibility and congestion both at the regional and neighborhood level, but several important factors that can affect estimated results are missing. As noted earlier, different land use and transportation configuration, and socio-economic characteristics of central city areas may be important determinants of residential location choice. In future studies, using more cases of metropolitan areas, the role of different land use and transportation configuration can be explored. Also, at the neighborhood level, different neighborhood design, such as traditional neighborhood design and conventional suburban neighborhood design, should be included in the econometric models because residents living in different types of neighborhoods may have different attitude and preference to congestion and accessibility.

Finally, this study only addresses the effect of accessibility and congestion on property value through econometric approaches. However, the relationship among land use and transportation coordination and property value are complex and require more detailed analysis at the micro-scale. Cases studies of different neighborhood types can advance the results of this study.

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