

Chapter 3

The Study Area – The Washington, D.C. Metropolitan Area

A clear understanding of the study area is helpful for understanding the study of economic centers and household travel. In this chapter a variety of characteristics of the study area and the interaction of those characteristics will be examined to develop this understanding. First, criteria for identifying centers are determined, then applied to the study area to locate its economic centers. The criteria used to define centers influence both the size and spatial distribution of centers. A variety of criteria are applied prior to accepting any for use in the analysis. Comparing the difference in centers identified under the different criteria provide some understanding of the distribution of economic activity throughout the metropolitan area. To some degree this distribution, in and of itself, is helpful in identifying the ‘sprawl’ of economic activity in the area. The implications of the distribution of economic activity are discussed.

Demographic data concerning the area are also discussed, as they provide insights into the distribution demographic groups in the study area. Demographics are likely related to the locations of economic centers and the transportation systems that provide access to those centers. The transportation system is also considered, as it provides the critical link between housing locations and the centers.

The Washington, D.C. Metropolitan Area

The study area for this research is the metropolitan area surrounding Washington, D.C. as defined by the Washington, D.C. Metropolitan Council of Governments (COG) and the U.S. Census. The area, shown in its entirety in Figure 3A, covers approximately 5000 square miles including all of the District of Columbia and portions of the two contiguous states, Maryland and Virginia.¹ The boundary approximately 20 miles to the east and

¹ Figure 2A depicts all of the census tracts in the metropolitan area. Census tracts are included as they provide a general outline of the demographic subdivision of the area. The U.S. Census defines tracts as follows:

Census tracts are small, relatively permanent statistical subdivisions of a county. Census tracts are delineated for all metropolitan areas (MA's) and other densely populated counties by local census statistical areas committees following Census Bureau guidelines (more than 3,000 census tracts have been established in 221 counties outside MA's)... Census tracts usually have between 2,500 and 8,000

northeast of the city center is determined by the U.S. Census as the separation of the D.C. metropolitan area from the Baltimore metropolitan area. The D.C. metropolitan area extends slightly less than 60 miles to the southeast in Maryland where it borders the Chesapeake Bay. The metropolitan area's northern Maryland boundary is the Pennsylvania State border, about 60 miles from the city center. To the west the metropolitan area extends through Northern Virginia suburbs to the Blue Ridge, approximately 60 miles from the city center. The Potomac River separates Northern Virginia from the District of Columbia and from Maryland, both south and north of Washington.

persons and, when first delineated, are designed to be homogeneous with respect to population characteristics, economic status, and living conditions. Census tracts do not cross county boundaries. The spatial size of census tracts varies widely depending on the density of settlement. Census tract boundaries are delineated with the intention of being maintained over a long time so that statistical comparisons can be made from census to census. However, physical changes in street patterns caused by highway construction, new development, etc., may require occasional revisions; census tracts occasionally are split due to large population growth, or combined as a result of substantial population decline (U.S. Census, 1990).

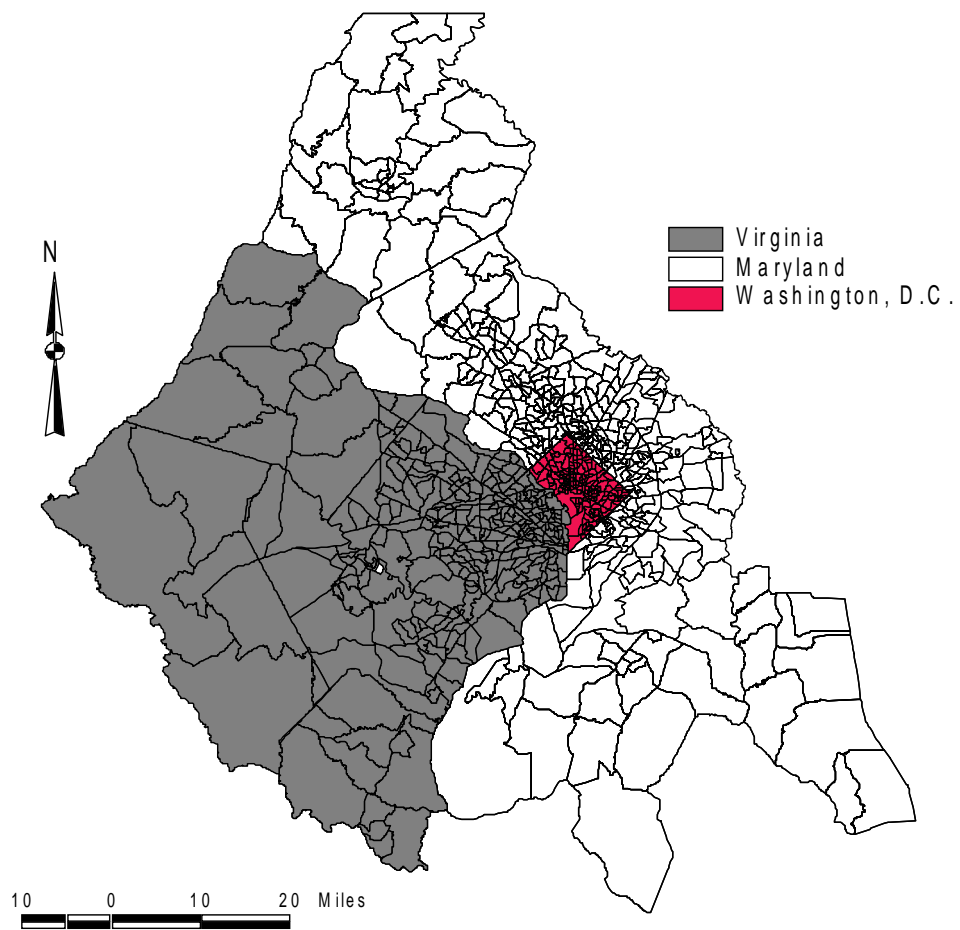


Figure 3A. Washington D.C. Metropolitan Area Census Tracts by State Jurisdiction (1990 U.S. Census)

Economists and social scientists that empirically study monocentric and limited polycentric models of cities have used a variety of criteria for identifying economic centers (Garreau, 1990; McDonald and Prather, 1994; Waddell, Berry and Hoch, 1993; Anas, Arnot and Small, 1998). In recent years, however, a consensus has emerged. Most economists rely on a simple test that identifies a center as a set of contiguous zones (most frequently transportation analysis zones) that meet a threshold employment density and collectively have employment in excess of another threshold (Small and Song, 1993; McMillen and McDonald, 1997; Anas, Arnot and Small, 1998).² The exact thresholds differ across studies, however, to be considered a center an area should have an employment concentration that is “large enough to have a potentially discernible effect on the metropolitan area” (Small and Song, 1994). In this study economic centers were identified under a variety of employment density and total employment thresholds, ranging from 7 to 20 employees per acre and from 10,000 to 20,000 total employees, respectively. The dispersal of economic activity outside not only the central business district, but also other identifiable centers, is evident from the results of this procedure. Using an employment density of 20 persons per acre and 20,000 total employees 7 centers were identified. These centers contained only one-third of the metropolitan area employment. Using the 20 employee per acre threshold the central business district contains only 15.4% of total employment. Two possible explanations exist for the high percentage of the area’s economic activity found outside of these centers. Either substantial economic activity has moved from identifiable centers or the center identification thresholds are too high. Thresholds that are too high exclude employment from centers by either identifying centers that are too small in area (omitting the employment of contiguous zones surrounding the identified centers) or by failing to identify centers of lower density employment altogether. Both of these factors appear to be present when using lower thresholds for center identification.

Using an employment density of 7 employees per acre and 10,000 total employees 26 centers were identified. These 26 centers contained 56.9% of the entire employment of

² For example, a center may be defined as any set of contiguous zones that all have over 10 employees per acre that together have over 10,000 workers.

the Washington, D.C. metropolitan area. Applying a density of 7 employees per acre the central business district was defined to have 28.1% of the metropolitan area employment. While a substantially greater share of the area's employment is found in centers when using these lower thresholds, the results continue to show that substantial economic activity takes place outside of the central business district and identifiable centers.

Table 3.1 provides a full description of the results of using the various thresholds used to identify centers. The high employment densities of the central business district and the subcenters show that substantial concentrations of employment remain in the Washington, D.C. metropolitan area. The dispersion of employment, however, is evident throughout the findings. It is perhaps most evident in that 92.9% of metropolitan area employment is within a distance of twenty miles of the central business district. This includes all but one of the centers identified using the lowest thresholds (7 employees per acre with total employment over 10,000) and all of the centers identified using higher thresholds. Depending on the threshold applied as much as two-thirds of the metropolitan employment is contained in the twenty-mile radius but is outside of identifiable centers. Also notable is the fact that over seventy five percent of the 3898 transportation analysis zones in the metropolitan area have over ten employees. So, while economic activity is densely concentrated in some centers, economic activity is clearly dispersed throughout the metropolitan area.³

Figures displaying the centers identified using the different thresholds are helpful for determining which thresholds are best for identifying centers to be used in the later analysis. These figures also aid the understanding of the spatial distribution of centers in the metropolitan area and their influence on the area's form. Figures 3B and 3C show centers identified using the extreme thresholds considered in this research; 7 employees per acre and 10,000 total employment and 20 employees per acre and 20,000 total employment, respectively. Centers identified using thresholds of 15 employee per acre and 17,500 total employment are shown in Figure 3D. These thresholds were determined to be the best for identifying centers for use in the analysis, as the centers identified at these levels are of size and concentration likely to exert a discernable influence on the metropolitan area.

³ These findings here are consistent with other studies of metropolitan employment (Anas, Arnott and Small, 1998).

Table 3.1 Economic Centers

	<i>Employment</i>	<i>Percent of Employment</i>	<i>Area (acres)</i>	<i>Percent of Area</i>	<i>Number of Centers</i>	<i>Average Density</i>
Metropolitan Area	2,207,961	100%	3,199,232	100%	NA	.7 epa
All centers						
>7 EPA >10,000 TE	1,257,253	56.9%	39,657	1.2%	25	32.1 epa
>10 EPA >10,000 TE	1,095,838	49.6%	24,076	.8%	21	45.5 epa
>15 EPA >17,500 TE	823,532	37.3%	10,532	.3%	9*	87.2 epa
>20 EPA >20,000 TE	727,291	33.0%	6,988	.2%	7*	104.1 epa
Central Business District						
7 EPA	621,315	28.1%	11,842	.4%	NA	52.5 epa
10 EPA	583,169	26.4%	7,565	.2%	NA	77.1 epa
15 EPA	504,670	22.9%	3,683	.001%	NA	137.0 epa
20 EPA	491,715	15.4%	3,162	.001%	NA	155.5 epa
Within 20 miles of Central Business District	2,051,307	92.9%	919,201	28.7%	NA	2.3 epa

EPA means employment per acre. TE means total employment.

*Two centers within one-half mile of each other are combined to form a single center in Bethesda.

Figure 3B. Subcenters Identified Using Thresholds of 7 Employees per Acre in Each Zone and Total Employment of 10,000

**Figure 3C. Subcenters Identified Using Thresholds of 20 Employees per Acre
in Each Zone and Total Employment of 20,000**

Figure 3D. Subcenters Identified Using Thresholds of 17 Employees per Acre in Each Zone and Total Employment of 17,500

As expected, the number of subcenters identified using thresholds of 7 employees per acre and 10,000 total employment are significantly larger than those identified with higher thresholds. The central business district, in the City of Washington, appears the center of the area and extends both four miles east to west and four miles north to south. A chain of several subcenters, each within one half mile of the next, extend northwest from the city proper in Maryland. In addition, several subcenters are found to the west of the central business district in the Northern Virginia suburbs, most within a mile or two of each other. The subcenters found using higher thresholds are significantly larger in area when the lower thresholds are applied. Additional subcenters appear in close proximity to those identified by the larger thresholds.⁴

The expansive central business district and the clusters of subcenters found with these low thresholds are telling for two reasons. First, in areas of high economic activity, a dense concentration of activity may be present in a central location, but economic activity is also widely dispersed, sprawling into the surrounding areas. Secondly, they suggest large areas of low density employment and economic activity, particularly in the Northern Virginia suburbs and the corridor of subcenters in Maryland. Instead of a “center”, these appear as broad “areas” of economic activity. These findings alone suggest that the area has dispersed beyond a polycentric form. In essence, economic activity has ‘sprawled’ out into the areas surrounding dense concentrations and has appeared in a low density ‘sprawling’ form in other areas.

Returning to the specific problem at issue, the large number of centers and the clusters of centers found at the low threshold is both theoretically and practically unacceptable for purposes of examining the influence of access to centers on household travel time. Both theoretically and practically, the analysis requires uniqueness of each center. Each center should have its own identity on the landscape from which its influence may be measured. Clusters of centers, in and of themselves, suggest that no centers have such a unique influence, but that influence is dispersed across a number of centers near to one another (or the area of and around those centers generally). The influence of any center

⁴ The result is illustrative of both the employment density gradients McMillen and McDonald, 1994) and the theories of decentralization favored by many urban economists (White, 1988a).

is further dissipated if a large number of centers are included in the analysis. Finding twenty-six centers in the metropolitan area alone suggests that no one center (the central business district possibly except) will be large enough to exert a significant influence on the metropolitan area. Households will instead have a wide choice of which center or centers on which to rely for their needs. Consequently, larger thresholds must be examined.

Using thresholds of 15 employees per acre and 17,500 total employment only those areas that are both densely concentrated and large enough to have a significant and discernable effect on the metropolitan area are identified as centers. Although the centers contain less than forty percent of the area's employment, employment density in centers identified at these thresholds is in excess of eighty-five employees per acre. The central business district contains only less slightly less than one quarter of the metropolitan area's employment. The dense concentration of the centers is apparent in that they comprise less than one half of one percent of the metropolitan land area. Two independent centers in the Bethesda area within one-half mile of each other were combined into a single center, as it is unlikely that their independent effects could be discernable.

The only larger thresholds considered, 20 employees per acre and total employment in excess of 20,000, resulted in the omission of concentrations of economic activity commonly identified as centers, such as Tyson's Corner (Garreau, 1990). Lower thresholds (including the ones discussed above) resulted in sprawling centers, rather than distinct geographical concentrations found with thresholds of 15 employees per acre and 17,500 total employment.

Using these thresholds nine centers (including the central business district) were identified in the Washington metropolitan area (see Table 3.2). The dispersal of subcenters is best understood by specifying their location with respect to the central business district. Travel times to the central business district from each subcenter are particularly descriptive as they provide an understanding of the accessibility of the central business district from these outlying locations. Travel times to the central business district from each subcenter and the direction of each subcenter from the central business district are included in Table 3.2 for this purpose.

The size and concentration of centers will clearly affect their influence on households. Yet, their distribution throughout the metropolitan area and their proximity to

one another will also affect their influence and differences in that influence across the metropolitan area. A brief glance at the above figures shows that using high thresholds no centers are identified on the eastern side of the central business district. At the lower thresholds only four of the twenty-six centers are located to the east of the central business district. These centers are not clustered together and therefore are unlikely to exert the broad influence of the clusters found to the west and northwest of the city. Demographic factors may aid in understanding the absence of economic centers on the eastern side of the city. A few of those factors are discussed in the next section.

Table 3.2 Metropolitan Washington Centers and their Locations Relative to the Central Business District

<i>Center</i>	<i>Travel Time from Central Business District (in hours)</i>	<i>Total Employment</i>	<i>Employment Density (employees per acre)</i>	<i>Direction from Central Business District (degrees from north)</i>
<i>Washington, D.C.</i>	NA	524,600	125.0	NA
<i>Silver Spring, MD</i>	.573	21,984	53.4	7°
<i>Alexandria, VA</i>	.533	28,942	38.6	187°
<i>Crystal City, VA</i>	.438	82,883	76.4	200°
<i>Arlington, VA</i>	.398	35,590	68.9	253°
<i>Tyson's Corner, VA</i>	.643	34,573	30.4	277°
<i>Bethesda, MD</i>	.590	48,435	83.7	343°
<i>Gaithersburg, MD</i>	.899	21,123	33.0	344°
<i>Rockville, MD</i>	.742	25,402	20.9	349°

Area Demographics

The movement of residents to suburban areas and the development of economic activity outside of the central business district may be expected to interdependent. Businesses will move to areas that will best support them with adequate bases of customers and employment. Likewise, people will move to areas most able to support them with jobs and the goods and services that they desire. A brief examination of the some demographic characteristics of the Washington, D.C. metropolitan area population is helpful to understanding the development of concentrations of economic activity in the area. Figure 3E shows the spatial distribution of median household incomes in the area. The relationship between center locations and median incomes is readily apparent. Median income levels are substantially higher in the west and northwestern suburbs, the areas with the most centers of economic activity under any of the thresholds considered.

The correspondence between median incomes and center locations, however, is very general. The broad area to the west and northwest of the city has substantially more zones in the highest income bracket. These high income zones do not appear to follow a specific pattern with respect to the centers themselves. The pattern does, however, support a conclusion that households and businesses locate jointly with each choosing a location with resources to serve it more readily available. Households located in the west and northwest are likely to realize benefits from businesses in that region as both relatively high income employees and customers. Likewise, firms in the region are able to draw employees and customers from the higher income residents of the area.

To the east of the city, where no identifiable centers are found, low income zones are relatively abundant and high income zones are relatively absent. Most noticeable is a large pocket of zones in the lowest income bracket immediately to the east of the central business district. At the simplest level, the area east of the central business district is likely to be less attractive to business development due to the lack of higher income households to support them both as employees and customers.

Figure 3F shows the distribution of nonwhite minorities in the Washington, D.C. metropolitan area. The figure raises questions concerning the disparate impact of (and perhaps motive behind) the spatial distribution of economic centers in the area. The eastern side of the city, particularly the low income area immediately to the east of the central

business district, contains many more zones with high percentages of nonwhite minorities. In contrast, the white suburbs to west and northwest are the areas in which economic centers have formed. The correspondence between low median incomes, high percentages of minorities and the absence of economic centers in the area raises concerns about the availability of good paying jobs to minorities in the area. The proximity of the central business district to these neighborhoods, however, suggests that jobs may be available to their residents. In part to determine whether this is the case, the next section presents a brief overview of major parts of the area's transportation system.

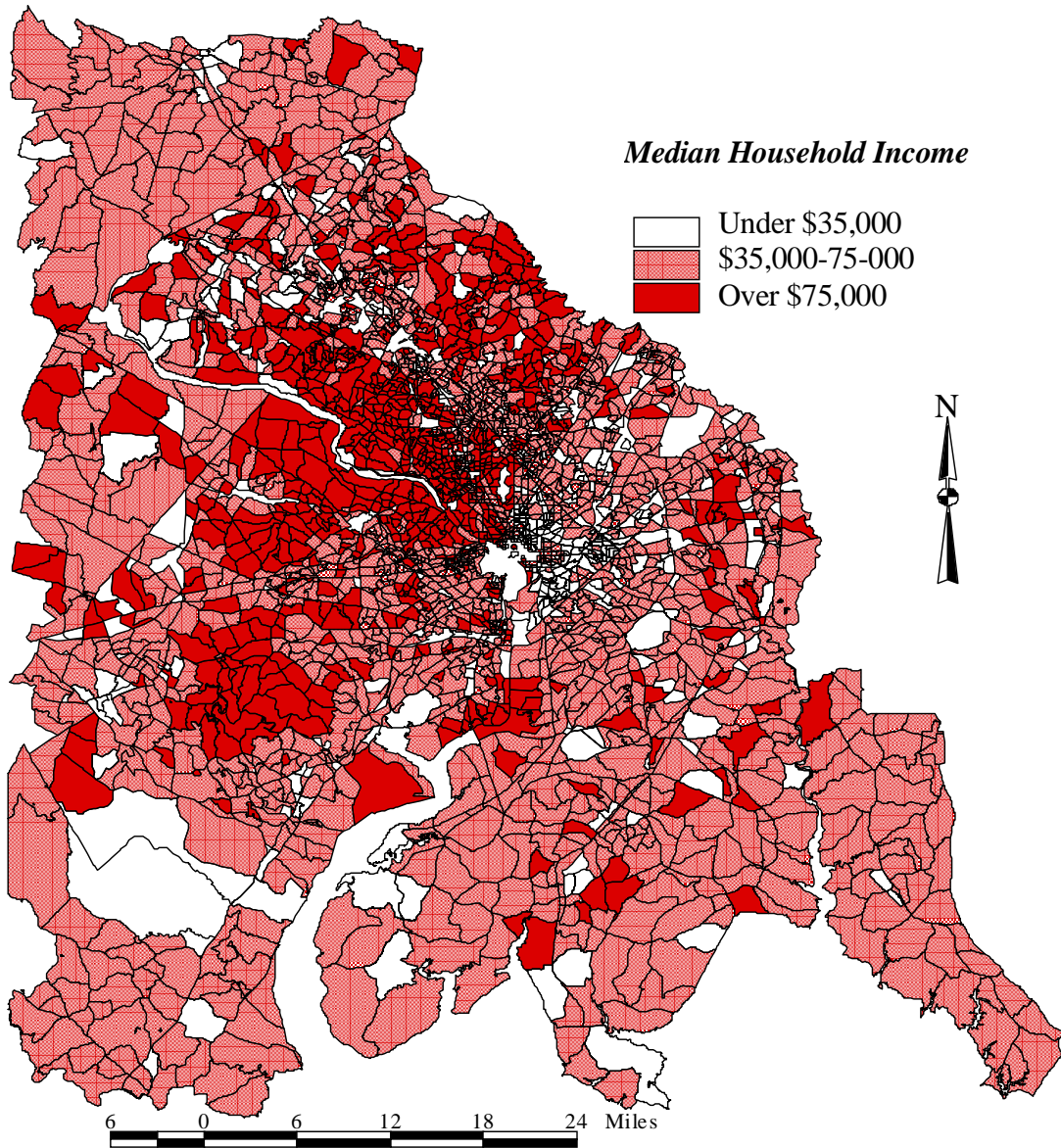


Figure 3E. Median Household Income by Transportation Analysis Zone (1990 U.S. Census)

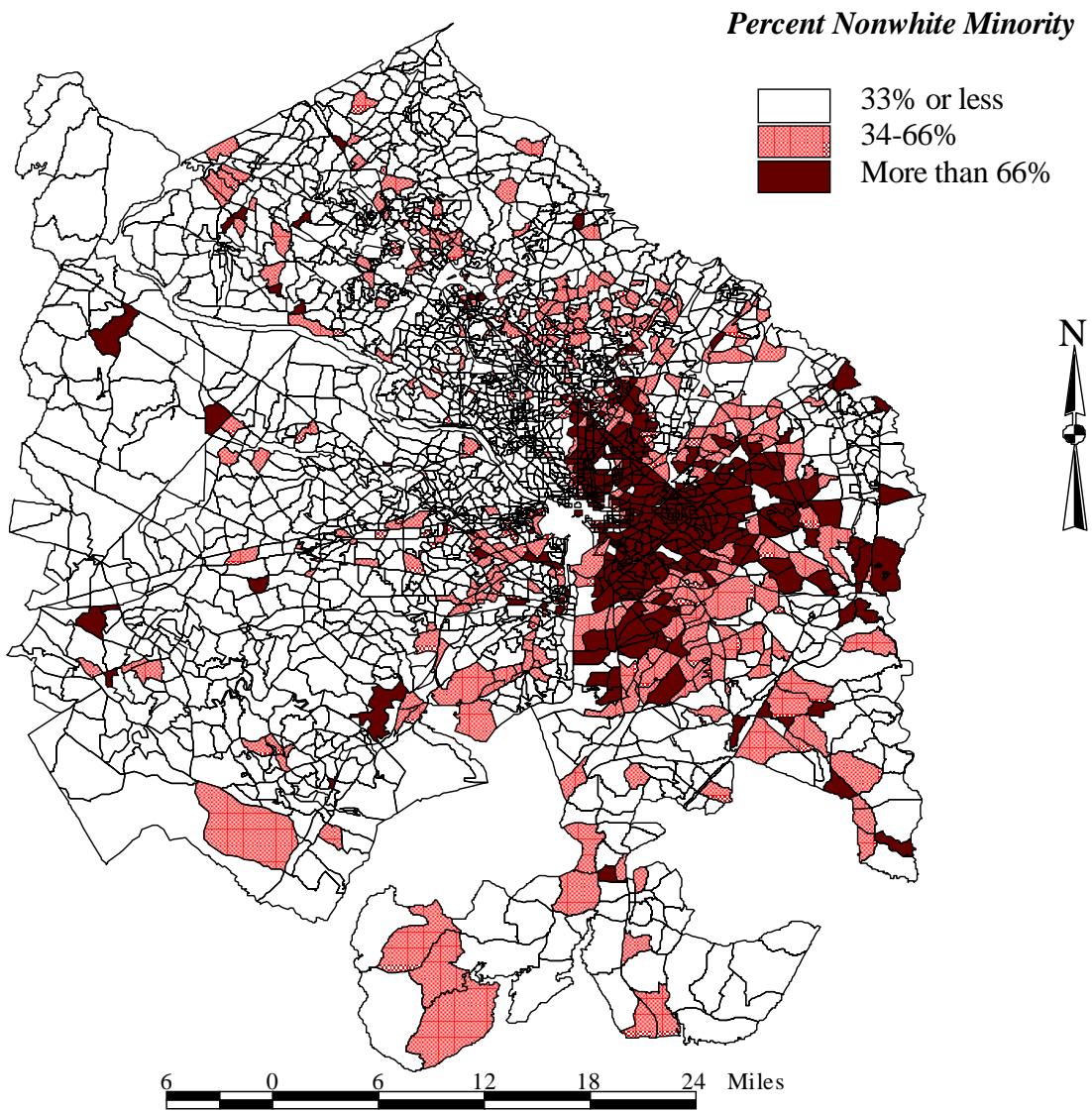


Figure 3F. Percent Nonwhite Minority by Transportation Analysis Zone (1990 U.S. Census)

The Transportation System

The transportation system provides an important link between the area's economic activity and its population. Centers of economic activity are likely to be most dependent on parts of the transportation system that are most able to carry the greatest volume of people. In the Washington, D.C. metropolitan area these are the Metro Rail system and the area's major roadways. Maps of those systems appear as Figures 3G and 3H below.

The Metro rail system appears to serve the entire metropolitan area well, but differences in a few areas are worth noting. The east appears to have more comprehensive service with more lines covering more area, particularly in the areas closest to the central business district. This suggests that the low income residents of neighborhoods in that area do in fact have good access to the central business district. Lines to the west, on the other hand, extend further into the suburbs from the central business district. To the west there are fewer stops close to the city suggesting that the primary purpose of the rail system is provide central business district access to residents of lower density neighborhoods further from the city center.

The network of major roads appears less equally distributed east to west than the metro system. To the west access to the central business district is provided from a number of major roads. The eastern half of the city is served by a number of major roads, however, only one provides access to the central business district. The imbalance may be in part because of the river to the west of the city. To enter the city from the west, therefore requires crossing a bridge. Directing major roads into the city may be a means to limit the number of bridges. Notwithstanding this possible justification for more major roads into the city from the west, major road access is critical to businesses. Major roads provide not only access for employees and customers but also for shipping of goods. The relative absence of major road access to the central business district and throughout the eastern side of the city in general is likely to further contribute to the absence of economic centers in that area.

Figure 3H. Major Roads in the Washington, D.C. Metropolitan Area

Figure 3G. The Washington, D.C. Metro Rail System

Conclusion

One can readily see the interrelation of the distribution of economic centers, demographic factors and the transportation system in the D.C. metropolitan area. Centers of economic activity are far more prevalent to the west and north of the city. Those areas also have more fully developed systems of major roadways and house a substantially wealthier population than the areas to the east of the city. Areas with concentrations of economic activity also have far lower percentages of minorities. Instead minority and lower income neighborhoods tend to be concentrated to the east of the central business district away from concentrations of economic activity and major roadways. These neighborhoods, however, do have access to the economic centers, as the metro rail system appears to serve them well. With this understanding of the study area, we can now develop a model to examine the influence of the identified economic centers on household travel. Understanding the study area will help to interpret the results of that examination and in developing policy recommendations.