IDENTIFYING CONCENTRATIONS OF EMPLOYMENT
IN METROPOLITAN AREAS*

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ABSTRACT

In recent years, large concentrations of employment have developed outside of traditional urban

cores and central business districts. Our research focuses on analyzing the changing distribution

of employment in metropolitan areas by expanding on the idea of "edge cities" (Garreau 1991),

wherein employment has moved to the urban fringe. Our approach uses tract-to-tract commuting

data from Census 2000 to identify high-employment nodes within metropolitan areas. We first

identify high-employment census tracts by comparing the number of jobs to the number of

residents in each tract and then delineate clusters of contiguous high-employment tracts based on

the density of jobs in these areas. We then compare outlying employment clusters with

traditional central business districts and contrast employment clusters of varying job densities.

Our method has several advantages over existing methods of identifying employment clusters: It

is conceptually simple, can use publicly available data, relies on a standardized unit of geography

that is applicable across the entire United States, and offers the ability to examine data from

multiple census years.

The location of employment within metropolitan areas has changed considerably over the past century, and as a result researchers have struggled to define concentrations of employment outside of traditional central business districts (CBDs). Any successful methodology for identifying employment clusters needs to be flexible enough to be applicable not only in all metropolitan areas without yielding nonsensical results for idiosyncratic areas, but also across multiple years of data. This paper describes a methodology of identifying clusters of high-employment census tracts in both CBDs and outlying areas that fulfills these criteria. It is intuitively straightforward, although it does require a great deal of data preparation and processing. This approach promises to provide a sound means for organizing and tabulating the wealth of data available for these areas.

Employment areas that have developed on the urban fringe within the past few decades have begun to take on many of the high-order functions once exclusively located in downtown areas, such as entertainment, commerce, and services. Though researchers have formulated a number of theories of urban form to explain these changes, no model has yet proven to be universally applicable.[1] Typically, analyses of the new areas have relied on examining the built environment, using characteristics such as square footage of available office space or retail space to define their extent (Garreau 1991, Lang 2003). We base our approach, however, on an analysis of where employed persons actually work. This research analyzes clusters of adjacent census tracts to identify zones of high employment within metro areas and examines various

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[1] The federal government has also struggled to account for the complexity of multinucleated urban regions. Since 1910, the Census Bureau had used the term "central city" to identify metropolitan economic centers, even though some metropolitan areas, such as Dallas-Fort Worth, have always had multiple economic centers and therefore multiple central cities. In 2003, the Bureau changed its definitional criteria, and those places identified as significant population and employment centers in metropolitan areas are now referred to as "principal cities." This change in terminology was designed in part to acknowledge that the model of a metropolitan area centered on a single population and employment nucleus had become outdated because in recent years large concentrations of employment have developed outside of the urban core of many metro areas.

characteristics of the workforce in these employment clusters. Our analysis reveals the complexity of employment distribution in large metro areas.

Theories of Urban Form

The social theory that dominated early scholarly inquiry into urban development was what is now referred to as "classical" urban ecology or human ecology, which originated at the University of Chicago in the first decades of the twentieth century. Members of the "Chicago School" shared the belief that the physical environment directly affected social behavior. Using principles borrowed from the natural sciences, they pictured the urban environment as a mosaic of interdependent communities, each with its own function and a distinct set of cultural patterns, which together form a complex whole (Park 1952). The city expands outward through a process of invasion and succession, whereby existing areas within the city will expand into territory vacated by other communities or functions as they move into the newly developed areas on the urban fringe (McKenzie 1925).

Burgess codified these ideas in the Concentric Zones Theory (CZT), which argues that social and economic changes in the city are reflected in changing spatial patterns, as manifested in concentric rings of development radiating from the urban core (Burgess 1925). According to CZT, the central business district (CBD) is the city's principal commercial and retail district, forming the nucleus of the city. The ring surrounding the CBD is the factory zone, where manufacturing is located. Radiating outward from the center is a series of residential zones, with the newest, biggest, and best housing stock located on the metropolitan periphery in the commuter zone. Thus, CZT predicts that the city's employment is concentrated almost entirely

in the CBD and the factory zone; the other zones are almost wholly residential, with little or no commercial activity.

Although classic ecology dominated urban studies for more than a generation, it proved to be an easy target for criticism, as detractors pointed out the many exceptions to the rule of a CBD surrounded by a neat series of concentric zones. To begin to address deficiencies in CZT, researchers began to offer alternative theories of urban growth and form, such as Hoyt's (1939) sectoral model, which argues that metropolitan areas were organized not in rings but in pie-shaped wedges, usually running along transportation arteries and spreading outward from the CBD. Recognizing that many cities contained more than one center with commercial activity, Harris and Ullman (1945) proposed a multi-nucleated model that showed the city still focused around a CBD but with additional business districts developing elsewhere in the metropolis.

For the several decades following the development of these alternatives to the classic Concentric Zones Theory, relatively little scholarship proposed wholly new forms of urban growth and development; scholars such as the political economists (Logan and Molotch 1987; Molotch 1976) instead tended to focus on the forces driving growth and development rather than the form that development would take. The next new theory of urban form came from the proponents of the "Los Angeles School," who claim that Los Angeles and cities like it represent not an exception to modern models of city structure, but rather a new paradigm of urban form wherein the traditional city center no longer controls the hinterland – in fact, the reverse is true, resulting in a kind of "keno capitalism" wherein different land uses are scattered across a metro area (Dear 2002).

Possibly the most influential addition to this body of literature came from journalist Joel Garreau, who coined the term "edge cities" to describe new commercial areas that had developed

along the edges of the metropolis, well away from downtowns. Edge cities are mixed use areas that "have it all" – shopping, entertainment, and jobs, with a focus on white-collar employment rather than manufacturing. Garreau defined edge cities as those that: 1) contain 5 million or more square feet of leasable office space; 2) contain 600,000 square feet or more of leasable retail space, about the size of one shopping mall; 3) have more jobs than bedrooms; 4) are perceived by the population as one place, the end point of trip rather than the starting point; and 5) are built on land that had been undeveloped as recently as 30 years ago. Using these criteria, Garreau identified 45 downtowns, 119 edge cities, and 73 emerging edge cities in 35 areas in the United States (Garreau 1991, pp. 425-438).

Responding to Garreau, Robert Lang argues that metro areas are not edge cities but are in fact largely "edgeless cities," with much employment in offices that are not located in high-employment areas (Lang 2003). Instead, much of the city has become a "form of sprawling office development that does not have the density or cohesiveness of edge cities" (p. 1). Lang points out that most office space is in high-density downtowns or low-density edgeless cities, while only 25 percent of office space is actually in edge cities. Lang posits three types of edgeless city developments: 1) "In-towners," which are in denser parts of metro areas, including central city and older suburbs; 2) "In-betweeners," which are in the general vicinity of other clusters like edge cities or secondary downtowns; and 3) "Outposts," the largest category, which are at the edge of the region, often in lowest-density part of the metro area.[2]

In the past few decades, urban scholarship has reflected a growing awareness that suburbia has undergone a transformation, and the suburbs are no longer dependent – either

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[2] In addition to "edge cities" (Garreau 1991) and "edgeless cities" (Lang 2003), academics, researchers, journalists, and others have coined a wide array of other terms to describe the movement of employment away from the CBD towards the suburbs, such as "technoburbs" (Fishman 1990) and "boomburbs" (Lang 2007; Lang and Simmons 2001).

economically or culturally – on the central city to the extent that they once were. For example, in southern California, the independence of the county from the city of Los Angeles signals the dawn of a "post-suburban" era (Kling, Olin, and Poster 1991); similar developments have occurred in Oakland County, Michigan; St. Louis County, Missouri; DuPage County, Illinois; and Long Island (Teaford 1997).

Much of this research focuses on job location. Traditionally, jobs were thought to be primarily located in the CBD, while suburbs were mostly if not entirely residential. Thus, the primary commuting pattern involved a flood of people who went from residential suburbs to commercial CBDs in the morning and back at night. This clichéd image, however, has not been wholly accurate for several decades. As far back as the 1970 census, research found that "[s]uburban rings of metropolitan areas show[ed] only a slight tendency to be disproportionately places of residence" (Guest 1976, p. 58). By 1980, suburb-to-suburb commuting had become the "dominant pattern" (Pisarski 1987, p. 38; Baldassare 1992).

More recently, a suburban hierarchy has emerged (Hughes 1993), wherein suburbs with diverse economies have become attractive destinations in their own right and draw commuters from nearby suburbs. Census 2000 showed a continuation of this pattern, with suburb-to-suburb commuting accounting for 46 percent of journeys to work in metro areas; commuting from the central city to a suburb accounted for 9 percent of journeys to work, while 26 percent of commuters went from central city to central city. The "traditional" suburb-to-central-city commute accounted for only 19 percent of journeys to work in metro areas (Pisarski 2006, p. 52). Currently, almost half of employees in the top 98 metropolitan areas work at least ten miles away from the traditional city center, a form of "job sprawl" that has been steadily increasing (Kneebone 2009).

As these new commuting and employment patterns have become more evident, analysts have applied a number of sophisticated methodologies to delineate employment zones in metro areas. A clustering approach has been used in number of studies (Anderson and Bogart 2001; Bogart and Ferry 1999; Giuliano and Small 1991), although most of these have been limited in scope, focusing only on a single metro area or small set of areas such as Los Angeles (Giuliano and Small 1991) or Cleveland (Bogart and Ferry 1999), usually because the methodology is so labor intensive (Anderson and Bogart 2001). These analyses require visual inspection of maps and tend to rely on "local knowledge" to determine the extent of specific employment zones, limiting the application of the methodology.

Alternative approaches have employed statistical methods to identify employment nodes. For example, Redfearn (2007) uses a topographical, nonparametric approach to identify metropolitan "subcenters" because of the irregular shape and location of metropolitan employment centers. Similarly, McMillen (2003) uses contiguity matrices to delineate employment zones in metro areas. These studies are more sophisticated methodologically than their predecessors, but the results are less intuitive.

Data and Methods

We advocate a simpler approach that produces similar results. Our research has three goals: 1) to identify employment zones within metro areas, 2) to develop a typology for these areas, and 3) to do so simply and intuitively. We use census tracts as the basic geographic unit because they are small, standardized units with a variety of available data; this approach is also consistent with earlier work (McMillen 2003; Redfearn 2007), which both use census tracts as the unit of analysis despite their differing methods.

Our simpler approach to identifying a metropolitan area's employment centers employs tract-to-tract commuting data from Census 2000 to identify high-employment census tracts and then to delineate clusters of tracts with similar job densities around these cores. Specifically, the necessary inputs for carrying out this analysis are each tract's population, land area, and total jobs, as well as a complete list of adjacent census tracts. The population and land area of each census tract are readily available through American Fact Finder, the U.S. Census Bureau's standard data dissemination tool.[3] We calculated the number of jobs in each tract using the internal microdata from the Census 2000 long form.[4] The long form questionnaire asked respondents who had worked in the previous week to provide their primary employers' addresses, which were then coded to the tract level.[5] Using this information, we were able to determine the approximate number of jobs in each census tract.[6] We established census tract adjacency using the TIGER/Line files;[7] we considered a pair of census tracts to be adjacent if they shared a line segment anywhere along their boundaries.

Two measures are key to this study: 1) the ratio of jobs to residents in the census tract and 2) the job density, calculated as the number of jobs per square mile of land area in the tract. The first measure is important because a significant component of Garreau's definition for edge cities was that these places must have "more jobs than bedrooms" (Garreau 1991, p. 7).

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[3] http://factfinder.census.gov/home/saff/main.html?_lang=en

[4] Estimates from Census 2000 come from a sample of the population. For information on confidentiality protection, sampling error, nonsampling error, and definitions, see the technical documentation for the Census 2000 long form at http://www.census.gov/prod/cen2000/doc/sf3.pdf.

[5] In other analyses (not shown), we obtained similar results using the publicly available Census Transportation Planning Package (CTPP) data, which also contains tract-level employment information. The CTPP is available from the Department of Transportation at http://www.fhwa.dot.gov/ctpp/tract.htm.

[6] The number of jobs is necessarily an approximation. Because the long form only asked about workers' primary employers, our results do not include second jobs or vacant jobs; neither do they include jobs held by employees who were away from work for whatever reason (e.g., vacation, medical leave, etc.) during the entire preceding week. In the remainder of the discussion, we use terms like "workers," "jobs," and "employment" as shorthand for "the primary job of workers who worked in the previous week."

[7] http://www.census.gov/geo/www/tiger/tiger2k/tgr2000.html

Therefore, we consider a high-employment census tract to be one that has more jobs than residents (jobs/residents > 1.0).[8] The second measure, job density, is important to identify nodes of employment concentration and to ensure that the distribution of employment in the tract is at least at an urban density. The minimum population density that the Census Bureau uses to define urbanized areas is 500 persons per square mile.[9] Given that all census tracts in an employment cluster must have more jobs than residents, we use a minimum employment density of 500 jobs per square mile to delimit employment clusters.

We developed a Perl program to identify all high-employment census tracts and then to delimit clusters of these census tracts based on job density. To do this, the program ranks all census tracts in descending order of job density and then analyzes those census tracts that are adjacent to each high-employment tract. Each high-employment census tract can serve as the core of an employment cluster. The program then begins building a cluster around that core by adding to the cluster all of the adjacent tracts that are above the job-density threshold. As the qualifying adjacent census tracts enter the cluster, the cluster expands outward, and the list of census tracts that the program examines also expands, to include those census tracts adjacent to the most recent additions to the cluster. In other words, the program starts with a core census tract. It then looks at all qualifying census tracts that are adjacent to the core, and then all qualifying census tracts that are adjacent to *those* census tracts, and so on, moving outward from the core of the cluster. The program continues examining high-employment census tracts and building the cluster out around them until all adjacent census tracts meeting the job-density threshold have been exhausted.

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[8] Some of the jobs in the commuting data do not have a tract location specified, although they do have a county location. There are two ways of handling these jobs: ignoring them entirely or assigning them proportionally to the tracts within the county. We have chosen the latter approach in our analysis, to retain as many jobs, and therefore to form as many employment clusters, as possible.

Note that in theory there could be an unlimited number of adjacent tracts radiating outward from the central tract, so long as they were above the job density threshold. However, in most of the clusters, the job density of the tracts drops below the threshold within two or three tracts from the central tract of the cluster. In the other clusters, it can take additional passes through the data to determine the full complement of adjacent census tracts that meet the job-density threshold. The cluster centered on Midtown Manhattan, for example, takes 12 passes to complete.

Once the program determines the extent of the cluster of contiguous high-employment census tracts, it calculates the number of jobs located in the cluster; if the number of jobs is at least 25,000, then that area qualifies as an employment cluster. We chose a job threshold of 25,000 because it corresponds roughly to another of Garreau's criteria for identifying edge cities: that they contain at least "five million square feet of leasable office space" (Garreau 1991, p. 425). Since a typical office building provides between 175 and 250 square feet per employee, five million square feet of office space translates to about 25,000 employees.[10]

When the employment cluster's borders are finalized and the number of jobs calculated, the program moves to the next high-job-density census tract and commences identifying the next employment cluster. Employment clusters do not overlap. That is, a census tract can only belong to one employment cluster, so once a census tract has been assigned to a cluster, it cannot be included in any other cluster.

To delineate the basic employment clusters, we could just run through the set of tracts once, but the program makes five iterations through the list, using a successively lower job density threshold each time. The first iteration handles the highest job density tracts, those in the

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[9] http://www.census.gov/geo/www/tiger/glossry2.pdf, page A-22.
[10] http://www.officefinder.com/how.html

top decile of high-employment census tracts, which includes those that have a job density at or above approximately 22,600 jobs per square mile. Subsequent iterations through the data examine the same set of census tracts, in the same manner as in the first iteration, but with lower job-density thresholds. While the first iteration includes the top decile of census tracts in terms of job density, the successive job density thresholds, as given in Table 1, are quartiles. The second iteration includes all census tracts in the top 11 percent to 25 percent of census tracts in terms of job density. The remaining three iterations each add a full quartile of high job-density census tracts. The job-density quartile thresholds for the high-employment census tracts are at approximately 9,100, 4,400, 2,300, and 500 jobs per square mile. The job densities in the top decile of census tracts are characteristic of those present in large CBDs, while the lower job densities are more readily associated with outlying employment areas.

[Table 1 about here]

Using this multiple-iteration approach reveals a great deal about the structure of employment clusters. We can distinguish, for example, a very dense, tightly bounded area from a geographically extensive region with a high-density core. In our typology, we classify each area by the highest job density at which the area qualifies as an employment cluster. If, for example, an employment cluster contains a tract with at least 22,600 jobs per square mile, then we classify this area in the top decile in terms of job density regardless of how extensive the contiguous area above 500 jobs per square mile is.

This method also allows us to separate employment clusters that have grown together. In the early passes through the data, there are times when we identify separate core areas that subsequently merge into a single employment cluster during passes through the tracts with lower densities. In these cases we break up this large area into separate employment clusters. In some

other cases, a census tract is adjacent to a pair of employment clusters and is therefore eligible for inclusion into either one. In this situation, we assign the census tract to the cluster with the higher number of jobs. While this approach favors larger clusters and is admittedly arbitrary, it is also rare, occurring only 22 times in the Census 2000 data.

As with the employment clusters centered on census tracts in the top decile of job density, when a census tract joins a cluster in the subsequent passes, the list of tracts that the program examines expands to take into account those adjacent to the most recent addition to the cluster. Figure 1, showing the O'Hare airport area of Chicago, provides a graphical example of this process. The navy blue and royal blue tracts represent the second and third quartiles, respectively, of job density, while the light blue represents the bottom job-density quartile. The gray areas represent tracts outside of any employment cluster. The hatching in the figure represents the pass in which each tract joined the employment cluster. In this case, the tract at the intersection of Interstates 90, 190, and 294 is the basis tract of the cluster; O'Hare itself joined the cluster in the second pass, and subsequent passes added the tracts along I-90.

[Figure 1 about here]

The final step is to examine the list of employment clusters to determine which encompass CBDs and which have formed outside of CBDs, whether inside the central city or on the urban fringe. The location of jobs within the metropolitan area is an important characteristic because we want to compare employment clusters that emerged in the post-World War II, auto-dependent era with traditional centers of employment. For our analysis, we define a CBD as a group of high-employment census tracts in the downtown area of a city (specifically, a city classified as a central city of a Standard Metropolitan Statistical Area in 1960). We chose to consider only those cities that were designated as central cities of metropolitan areas by 1960

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because these cores were established before the development of the Interstate Highway System. By this definition, there are potentially 268 CBDs in 186 metropolitan statistical areas (MSAs), although a few smaller cities have no census tracts that meet our criteria to be considered a high-employment census tract. Among the 50 most populous MSAs as defined in 2003, all but one (Riverside-San Bernardino-Ontario, CA) have a high-job-density census tract in the CBD, and a number of large metro areas have multiple CBDs. Table 2 shows a complete list of employment clusters for the 50 largest metro areas.

[Table 2 about here]

The Distribution of Employment Clusters

Table 3 shows the distribution of employment by cluster type by the population size category of the metro area. In general, a larger proportion of employed people works in employment clusters – particularly in those with higher job densities – in metro areas with at least four million people. Approximately 37 percent of employment is located in these clusters in large metro areas, whereas in medium-size MSAs (those with 1-4 million people) the proportion is roughly 34 percent, and in small MSAs (those with fewer than one million people) the proportion is under 25 percent. The percentage of employed people working in CBDs generally declines with the population of the metro area, although this decline is not monotonic. The second category, which contains the Los Angeles metro area, is a notable exception: While a relatively high percentage of people work in high-job-density employment clusters in the Los Angeles metro area, only about seven percent of employed persons work in or around downtown Los Angeles.

[Table 3 about here]

A minority of workers are employed in employment clusters in all but four metro areas. The percentage of people working inside of any employment cluster decreases with metropolitan

population, and 191 metro areas have no employment clusters by our definition, but all of these are among the least populous metro areas. All metro areas with at least 800,000 inhabitants have at least one employment cluster. That most people work outside of employment clusters gives some support to Lang's (2003) argument that most metro areas have become "edgeless cities," where employment is scattered among a variety of locations throughout the region. Even in the New York City area, with its high-employment CBDs (over 1.5 million people work in either downtown or midtown Manhattan) and extensive network of employment clusters, over 60 percent of workers are employed outside of any employment cluster. Still, a substantial percentage of people work in employment clusters, particularly in large metro areas. Also, CBDs, though they may have declined in relative terms, certainly have not lost their status as significant areas of employment, particularly within larger metro areas. Despite a large amount of "job sprawl" (Kneebone 2009), the CBD is still the largest single area of employment in several metro areas, particularly the most populous metro areas.

Figure 2 shows the location of the 11 employment clusters in the Chicago metro area, which is in the third population category. As is the case in most metro areas, most employment clusters outside the CBD are built near major airports and along radial corridors on the Interstate highways that converge on Chicago. Each Interstate highway in the area (I-80, I-88, I-90, and I-94) has a large employment cluster just outside of the city of Chicago, with a particularly large cluster in the O'Hare area along I-90.

[Figure 2 about here]

The most common locations of employment clusters – outside of CBDs – are along beltways and radial highway corridors, particularly near airports. Figure 3 shows the employment clusters in the Washington, DC, and Baltimore metro areas, in the third and fourth

size categories, respectively. There are 14 clusters in Washington and 6 in Baltimore. In addition to the CBDs, each area has localized high-job-density employment clusters that lie just within the beltway, Bethesda in the Washington area and Towson in the Baltimore area, each of which is designated as a principal city in the current metro area definitions. Washington has additional high-job-density employment clusters in Rockville, MD, and Arlington-Alexandria, VA, which are all also principal cities in the current metro area definitions. The low-job-density employment clusters near Baltimore follow radial highway corridors, while in Washington employment clusters at highway crossroads are more common, most notably Tyson's Corner just outside the beltway (I-495) along Route 7 and Route 123. Employment clusters are also located in two satellite cities in this region, Frederick and Annapolis, MD, and these clusters continue to follow major highway corridors. An employment cluster is located next to each of the major airports in this area, low-job-density employment clusters near Baltimore-Washington International (BWI) Airport and Dulles International Airport (IAD), and a high-job-density employment cluster near Reagan National Airport (DCA), which is close to downtown Washington, DC. The area also features extensive low-job-density employment clusters along I-95 and the Baltimore Washington Parkway, the major corridors between Washington and Baltimore.

[Figure 3 about here]

The Los Angeles area has a similar reputation as a sprawling, car-dependent region, yet our analysis reveals that it also has several high-job-density employment clusters. Figure 4 shows that the Los Angeles area, the sole metropolitan area in the 10-15 million population size category, has a decentralized distribution of employment to accompany its complex highway system, with 25 employment clusters scattered throughout the metropolitan area. High-job-

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density employment clusters and low-job-density employment clusters are scattered throughout the area. Though the MSA, which comprises Los Angeles and Orange counties, has a number of radial lines and bypass routes, this area does not have the same clear-cut core/periphery pattern that most of the smaller metro areas evince. Still, the largest single employment cluster, perhaps surprisingly, is downtown Los Angeles, although it accounts for only about six percent of the jobs in the metro area.[11] Los Angeles County has several other high-density employment nodes, including one in Pasadena and one in the western part of the county. An employment core has also emerged in Orange County, albeit at a somewhat lower job density than is evident in Los Angeles County. Contrary to the claims of the Los Angeles School (Dear 2002), this region is unique in terms of the layout of the highway system and the resulting distribution of jobs throughout the area and does not appear to represent a new paradigm of metropolitan organization.

[Figure 4 about here]

The largest metro area in the United States is also one of the most complex areas in terms of the distribution of employment. Figure 5 shows the New York metro area, which contains 26 employment clusters. With the exception of downtown Newark, all of the high-job-density employment clusters are located in the city of New York. Low-job-density employment clusters are distributed throughout the region, including near each of the major airports in the area (JFK, LaGuardia, and Newark International Airport). Long Island has a number of low-job-density employment clusters along the radial highways leading into New York City, and large low-job-density employment clusters are located in Westchester County and the outlying areas of New Jersey along the major highways of the region.

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[11] Table 3 shows that 7.1 percent of employment in the Los Angeles metropolitan area is in CBDs, but this figure includes a smaller CBD in Long Beach. Six percent of the area's employment is in downtown Los Angeles.

[Figure 5 about here]

The Composition of the Workforce in Employment Clusters

After determining where employment tends to cluster within metropolitan areas, our next task is to examine the composition of the workers who hold the jobs that make up the clusters. Because jobs tend to cluster, it is logical to assume that similar jobs will cluster together, which in turn would mean that employment clusters would tend to host a relatively homogenous population of employees. And, in fact, the evidence supports this assumption. The workforce in CBDs and high-job-density clusters is disproportionately made up of those in professional and managerial occupations. Figure 6 shows that in the larger metropolitan size classes (4 million and up), CBDs and high-job-density clusters have larger percentages of professional and managerial jobs than other areas, although in New York the third and bottom-density quartiles have a higher percentage of professional/managerial jobs than does the top decile.[12]

[Figure 6 about here]

Figure 7 shows the distribution of workers in professional/managerial jobs in all metro areas with a population of over 4,000,000 (the top three size categories in Figure 6). The majority (almost 60 percent) of these workers have jobs located outside of any employment cluster, illustrating the decentralization of jobs (Kneebone 2009) and lending support to Lang's (2003) argument that metro areas are largely "edgeless cities," areas that are too spread out ever to coalesce into discrete places. Although only about 16 percent of professional/managerial jobs are located in and around traditional CBDs of large cities, CBDs are still the next-largest location of these jobs, illustrating their continued relevance to an area's economic life. The remainder of

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[12] In this and subsequent figures, the "CBD" category refers to CBD employment clusters that can be of any density. The remaining categories all refer to non-CBD employment clusters of the density given.

professional and managerial jobs are scattered about the metropolitan area in clusters of various densities.

[Figure 7 about here]

Continuing this pattern, people who work in finance, insurance, and real estate (FIRE) jobs commonly work in CBDs, as illustrated by Figure 8. This is especially true in New York City, with its large financial district. Over 20 percent of the jobs in the CBDs of New York are FIRE jobs, compared with well under 10 percent of jobs outside of employment clusters. In fact, for cities of all sizes, FIRE jobs are relatively infrequently located outside of clusters – these jobs, more than those in other industries, seem to gain something by clustering together.

[Figure 8 about here]

The density of employment can also affect the means by which employees get to work. Figure 9 shows the percentage of workers who drive alone to work, as opposed to carpooling or using other means to get to work, such as mass transit or walking. In the majority of metro areas, those working in CBDs typically have the lowest percentages of workers driving alone to work, particularly in the New York metro area, where only about 13 percent of workers employed in one of the CBDs in the New York area drive alone to work. Among metro areas with more than 4,000,000 inhabitants, a minority of workers employed in CBDs drives alone to work, with the notable exception of Los Angeles, where almost two-thirds of employees in CBDs drove alone. With the exception of CBDs, large majorities of most workers in all cluster types tend to drive alone. Given how many employment clusters are located along highway corridors or at highway junctions, this is perhaps not a surprising result.

[Figure 9 about here]

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Conclusion

Current definitions of metropolitan areas do not recognize the extent of multinucleation in metro areas, a shortcoming that our approach rectifies. In the 12 metro areas with populations larger than four million people (as of Census 2000), our method identifies 149 employment clusters, a pattern that is also evident in the 12 metro areas with populations between 2,000,000 and 4,000,000, in which we find an average of 5.5 employment clusters. Even considering only job-density employment clusters in the top quartile, 27 metro areas have multiple employment nodes. The 95 high-job-density employment clusters in these 27 metro areas are a considerably larger set than what the current metro area definitions recognize. This approach also reveals differentiation among the various types of employment clusters. In general, the low-job-density employment clusters are more car-dependent and service-oriented than high-job-density employment clusters, which have greater mass transit use and a concentration of FIRE jobs. These differences are more apparent in larger metro areas, but the pattern is evident in small metro areas as well.

While most metropolitan areas still contain a recognizable central business district, the CBD is no longer the dominant economic center of most metropolitan areas that it once was; the location of jobs within a metro area has diversified considerably, and so it becomes ever more important to be able to identify the location of concentrations of jobs both easily and accurately. In this paper we have presented a method for doing precisely that. Our method has several assets that we believe make it a useful addition to the urban researcher's toolbox. First, it is conceptually simple, relying on intuitive ideas about what constitutes an employment cluster. Second, all of the data necessary to apply the methods described in this paper are publicly

available, so researchers can adopt our methodology even without access to the confidential internal data at the Census Bureau or other agencies. Although in this paper we have focused on results from Census 2000, the method is also applicable to data sets other than decennial censuses, such as the five-year American Community Survey (ACS) data, which also contain census tract-to-census tract commuting data. Third, it uses census tracts as its unit of analysis, so it relies on a standardized, statistical unit of geography that is applicable across the entire United States. Fourth, this approach is also flexible enough to be adaptable to other geographic levels, enabling analysis of employment clustering at the county or block group levels, should tract-level analyses prove insufficient. Finally, this flexibility also offers the ability to examine data from multiple census years, allowing longitudinal analyses to address questions of changing employment location over the years.

Several further avenues for research present themselves. Our next step will involve applying this methodology to data from the 1970, 1980, and 1990 decennial censuses to see how mobile employment has been over the past thirty years and how the changing location of employment has reshaped the metropolitan area. Related to this, we are also interested in examining the effect of employment clusters on the commuting sheds of MSAs. Lang (2003) argues that as edgeless cities develop, especially on the urban fringe, they inexorably expand the area from which commuters are drawn ever farther into the hinterland. And as settlement expands into the hinterland, these new exurbs will invariably have a different composition than closer-in suburbs. Will the exurbs become the new "old" suburbs – purely residential areas feeding commuters either to suburbs or to central cities? Or will they become the new "new" suburbs – areas with diverse economies and a mixture of jobs and residents?

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Table 1: Job Density Thresholds for Delineating Employment Clusters, 2000

Category	Jobs per Square Mile	Rank Among High-Employment Tracts
Very High Density	22,595.8	Top decile
High Density	9,086.8	Remainder of top quartile
Moderately High Density	4,424.1	Second quartile
Moderately Low Density	2,318.4	Third quartile
Low Density	500.0	Bottom quartile

Source: Census 2000

Table 2: Employment Clusters, Metropolitan Divisions, and Edge Cities in the 50 Most Populous Metropolitan Statistical Areas, 2000

Metropolitan Statistical Area	2000 Population	Employment Clusters				Metropolitan Divisions 2003 OMB Definitions	Edge Cities (1991)		
		1970	1980	1990	2000		Downtowns	Edge Cities	Emerging Edge Cities
New York-Northern NJ-Long Island, NY-NJ-PA	18,323,002	6	12	18	26	4	4	17	4
Los Angeles-Long Beach-Santa Ana, CA	12,365,627	6	23	27	25	2	2	15	6
Chicago-Naperville-Joliet, IL-IN-WI	9,098,316	2	7	11	11	3	1	4	0
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	5,687,147	2	3	8	9	3	1	3	0
Dallas-Fort Worth-Arlington, TX	5,161,544	2	5	8	8	2	2	4	3
Miami-Fort Lauderdale-Miami Beach, FL	5,007,564	2	5	5	8	3	2	1	2
Washington-Arlington-Alexandria, DC-VA-MD-WV	4,796,183	1	3	10	14	2	1	16	7
Houston-Baytown-Sugar Land, TX	4,715,407	1	7	8	9		1	9	2
Detroit-Warren-Livonia, MI	4,452,557	3	10	8	9	2	1	5	3
Boston-Cambridge-Quincy, MA-NH	4,391,344	2	7	8	8	4	1	5	5
Atlanta-Sandy Springs-Marietta, GA	4,247,981	1	4	8	10		1	4	3
San Francisco-Oakland-Fremont, CA	4,123,740	2	6	10	12	2	2	5	5
Riverside-San Bernardino-Ontario, CA	3,254,821	1	3	2	3		0	1	2
Phoenix-Mesa-Scottsdale, AZ	3,251,876	0	2	7	10		1	3	4
Seattle-Tacoma-Bellevue, WA	3,043,878	2	4	6	8	2	2	1	3
Minneapolis-St. Paul-Bloomington, MN-WI	2,968,806	2	6	8	10		2	1	1
San Diego-Carlsbad-San Marcos, CA	2,813,833	1	3	4	4		1	3	2
St. Louis, MO-IL	2,698,687	1	4	5	7		1	2	1
Baltimore-Towson, MD	2,552,994	1	2	6	6		1	3	4
Pittsburgh, PA	2,431,087	1	3	3	1		1	1	1
Tampa-St. Petersburg-Clearwater, FL	2,395,997	0	2	3	4		2	1	2
Denver-Aurora, CO	2,157,756	1	1	3	3		1	1	1
Cleveland-Elyria-Mentor, OH	2,148,143	1	4	6	6		1	1	1
Cincinnati-Middletown, OH-KY-IN	2,009,632	1	2	3	4				
Portland-Vancouver-Beaverton, OR-WA	1,927,881	1	2	2	3		1	1	1
Kansas City, MO-KS	1,836,038	1	1	3	5		1	1	3
Sacramento--Arden-Arcade--Roseville, CA	1,796,857	1	1	1	3		1	0	2
San Jose-Sunnyvale-Santa Clara, CA	1,735,819	2	4	3	4		0	2	0
San Antonio, TX	1,711,703	1	1	2	4		1	2	1
Orlando, FL	1,644,561	0	1	3	3		1	1	2
Columbus, OH	1,612,694	1	3	3	5				
Providence-New Bedford-Fall River, RI-MA	1,582,997	1	4	2	2				
Virginia Beach-Norfolk-Newport News, VA-NC	1,576,370	0	1	5	4				
Indianapolis, IN	1,525,104	1	1	2	2				
Milwaukee-Waukesha-West Allis, WI	1,500,741	1	2	3	4		1	2	0
Las Vegas-Paradise, NV	1,375,765	0	2	1	2		1	0	1
Charlotte-Gastonia-Concord, NC-SC	1,330,448	1	2	2	2		1	1	0
New Orleans-Metairie-Kenner, LA	1,316,510	1	1	1	2				
Nashville-Davidson--Murfreesboro, TN	1,311,789	1	1	1	3				
Austin-Round Rock, TX	1,249,763	0	2	2	2		1	1	0
Memphis, TN-MS-AR	1,205,204	2	2	4	3		1	1	1
Buffalo-Niagara Falls, NY	1,170,111	1	1	2	2				
Louisville, KY-IN	1,161,975	1	2	3	2				
Hartford-West Hartford-East Hartford, CT	1,148,618	1	3	4	2				
Jacksonville, FL	1,122,750	1	1	2	2				
Richmond, VA	1,096,957	1	1	1	2				
Oklahoma City, OK	1,095,421	1	2	2	2				
Birmingham-Hoover, AL	1,052,238	1	1	1	2				
Rochester, NY	1,037,831	1	2	3	3				
Salt Lake City	968,858	1	1	1	2				

Source: Decennial census data (1970-2000); Garreau (1991)

Table 3: Employment by Metropolitan Population, 2000

Metropolitan Population Category	MSAs in Population Category	Total Population	Total Number of Jobs	Employment Clusters Containing CBDs		Outlying Employment Clusters		All Employment Clusters	
				Jobs	Percent	Jobs	Percent	Jobs	Percent
Over 15,000,000	1	18,323,002	8,113,588	1,815,400	22.4	1,187,246	14.6	3,002,646	37.0
10,000,000-15,000,000	1	12,365,627	5,367,406	380,160	7.1	1,611,223	30.0	1,991,383	37.1
4,000,000-9,999,999	10	51,681,783	24,855,743	3,666,905	14.8	4,660,919	18.8	8,327,824	33.6
1,000,000-3,999,999	37	66,853,655	32,021,645	5,928,207	18.5	5,075,565	15.9	11,003,772	34.4
500,000-999,999	39	26,992,438	12,504,774	1,942,975	15.5	986,045	7.9	2,929,020	23.4
Under 500,000	274	56,363,435	36,532,891	2,000,576	5.5	1,756,893	4.8	3,757,469	10.3
Total	362	232,579,940	119,396,047	15,734,223	13.2	15,277,891	12.8	31,012,114	26.0

Source: Census 2000

# Figure 1. Census Tract Densities in the Chicago O'Hare Area, 2000

Job Density

- Outlying
- High Job Density
- Remainder of top job-density quartile
- Second job density quartile
- Third job-density quartile
- Bottom job density quartile

Number of Passes

1
2
3
4
5
6
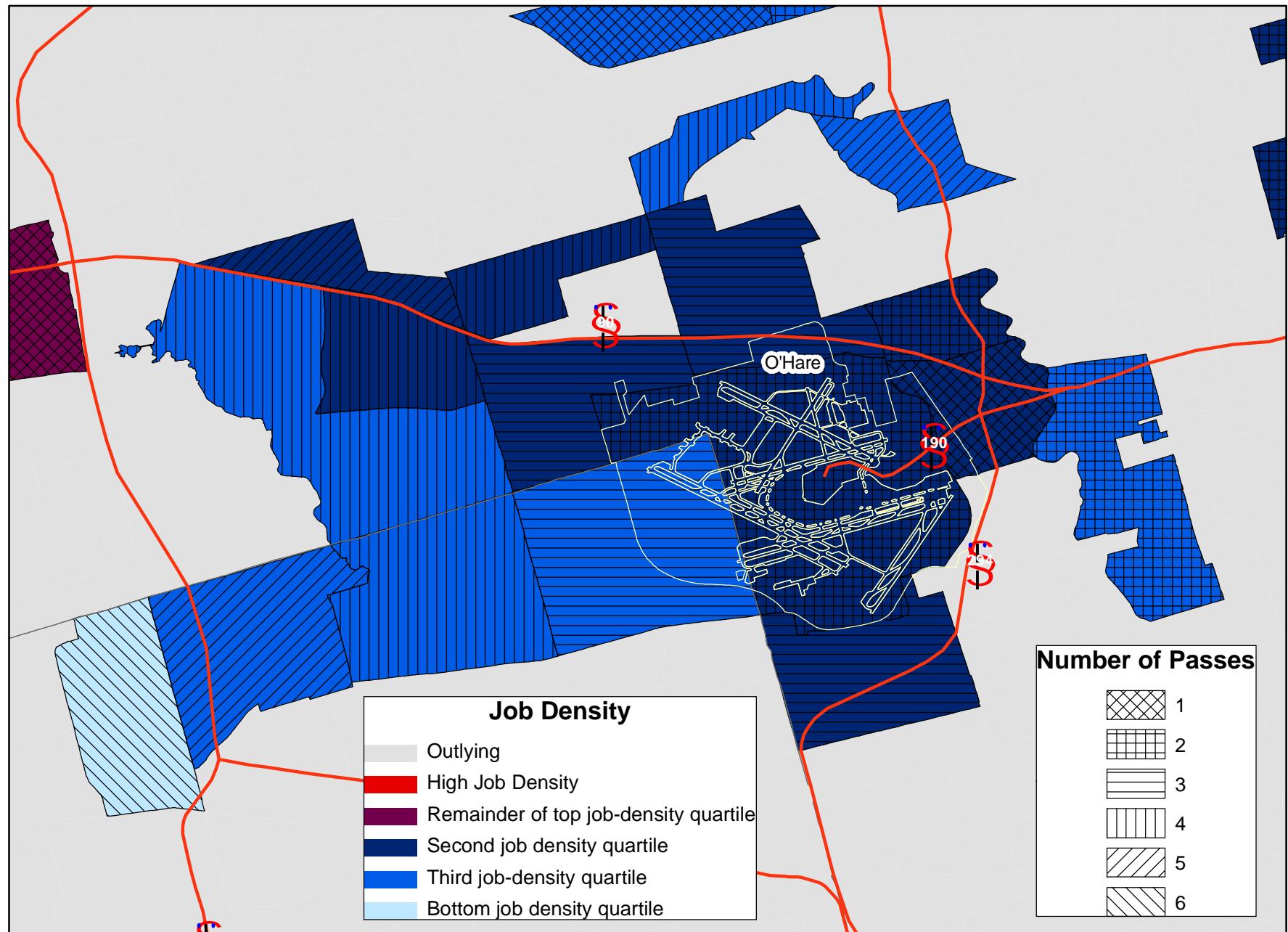
Figure 2. Employment Clusters in the Chicago Area, 2000

**Employment Clusters 2000
Job Density**

- Outlying
- High Job Density
- Remainder of top job-density quartile
- Second job density quartile
- Third job-density quartile
- Bottom job density quartile
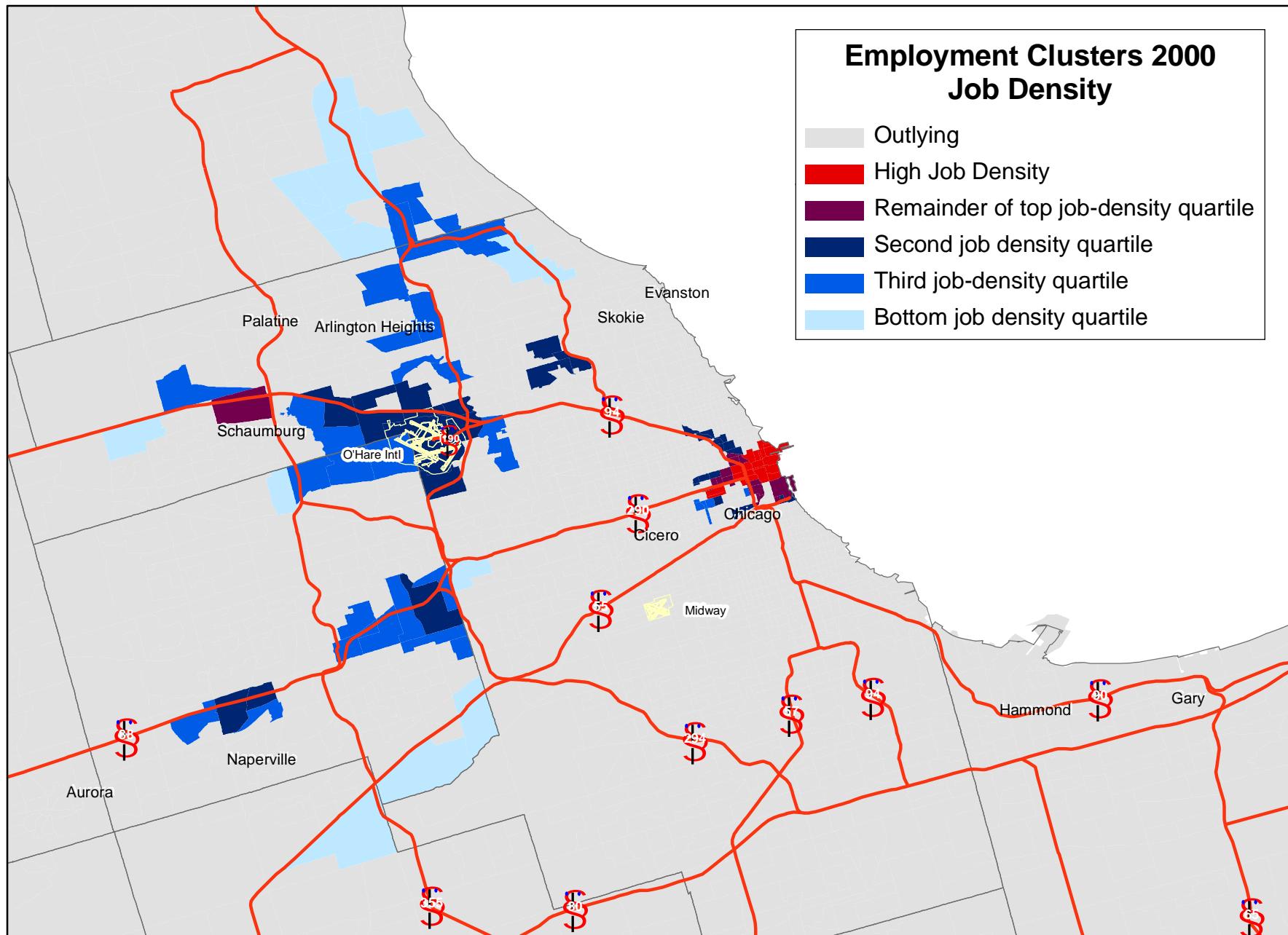
Figure 3. Employment Clusters in the Washington-Baltimore Area, 2000

**Employment Clusters 2000
Job Density**

Outlying

High Job Density

Remainder of top job-density quartile

Second job density quartile

Third job-density quartile

Bottom job density quartile
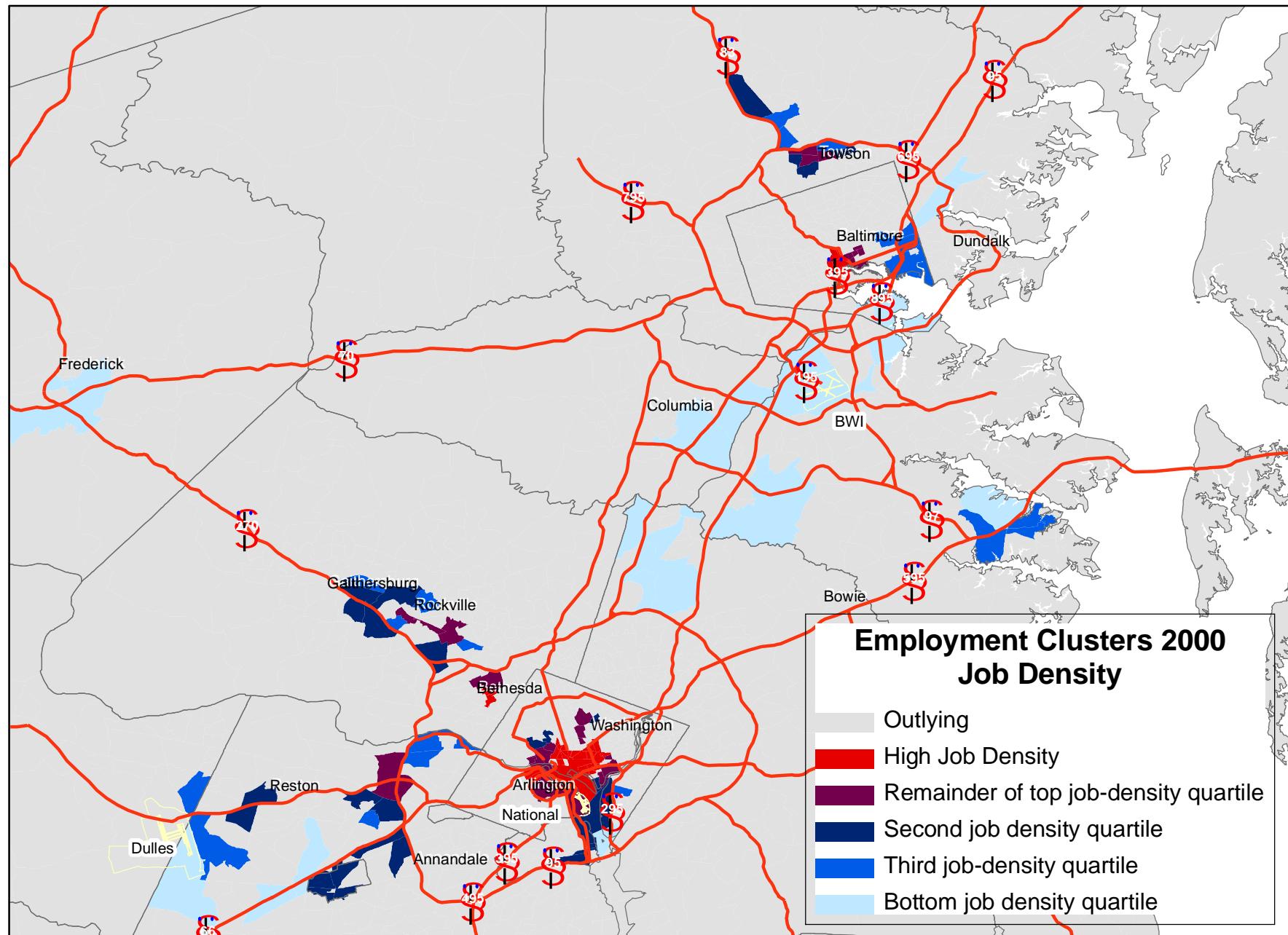
Figure 4. Employment Clusters in the Los Angeles Area, 2000

**Employment Clusters 2000
Job Density**

- Outlying
- High Job Density
- Remainder of top job-density quartile
- Second job density quartile
- Third job-density quartile
- Bottom job density quartile
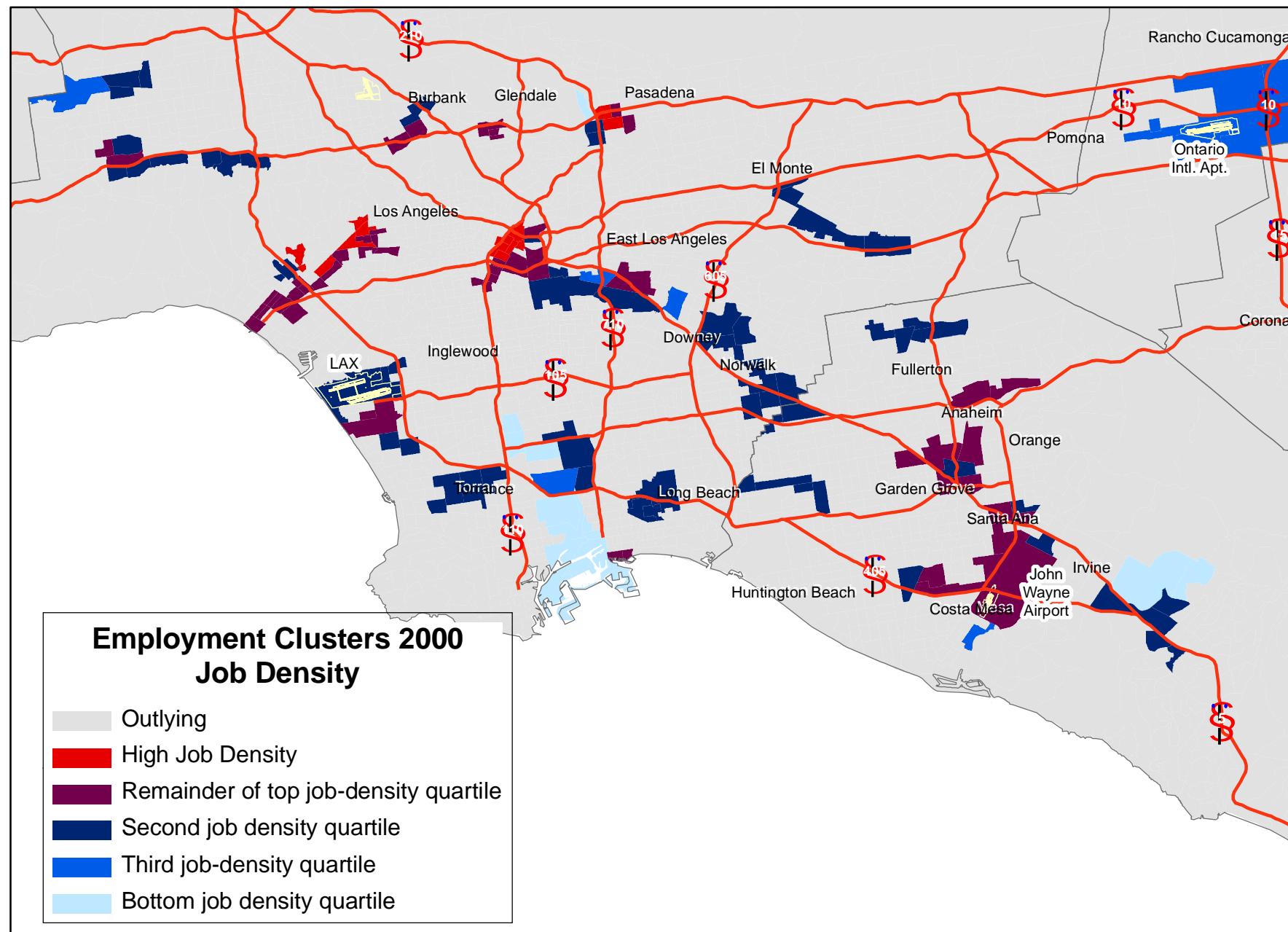
Figure 5. Employment Clusters in the New York Area, 2000

**Employment Clusters 2000
Job Density**

- Outlying
- High Job Density
- Remainder of top job-density quartile
- Second job density quartile
- Third job-density quartile
- Bottom job density quartile
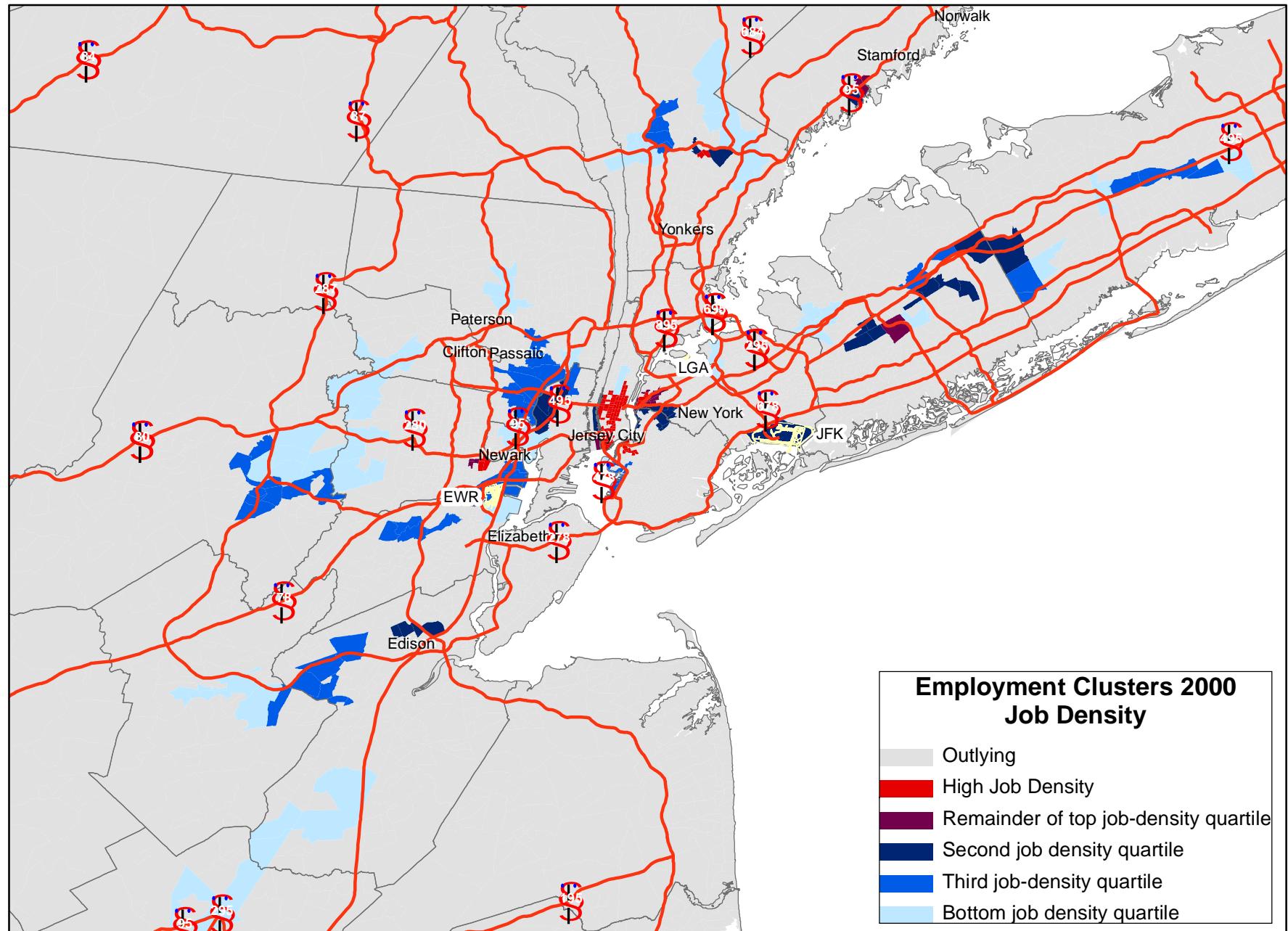
Figure 6. Professional/Managerial Employment by Area Type, 2000
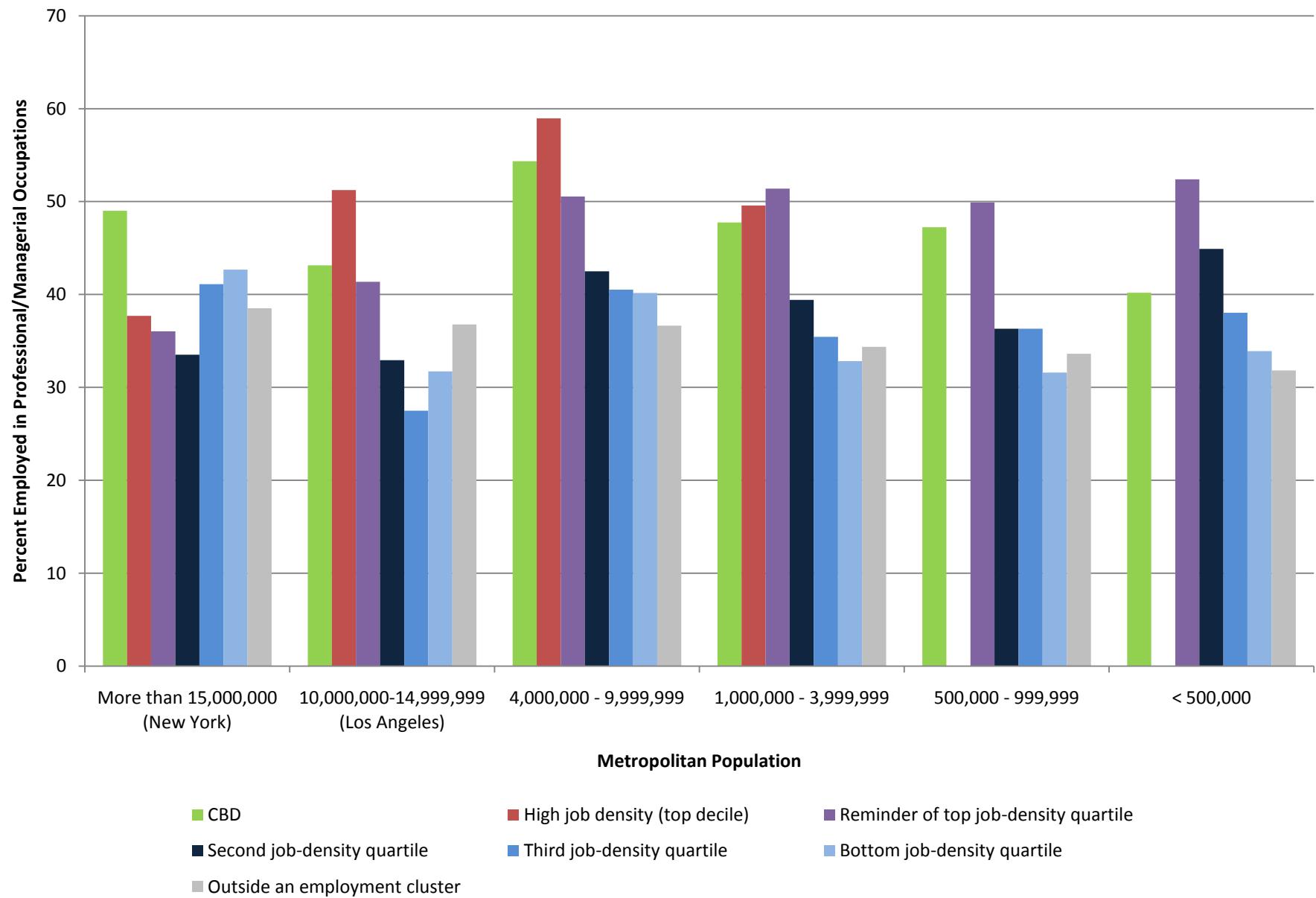
Figure 7. Professional/Managerial Employment in Large Metro Areas, 2000

- 15.6% — CBD
- 2.3% — High job density (top decile)
- 5.6% — Reminder of top job-density quartile
- 8.0% — Second job-density quartile
- 4.3% — Third job-density quartile
- 4.7% — Bottom job-density quartile
- 59.6% — Outside an employment cluster

Legend:
- CBD
- High job density (top decile)
- Reminder of top job-density quartile
- Second job-density quartile
- Third job-density quartile
- Bottom job-density quartile
- Outside an employment cluster

Figure 8. Finance, Insurance, and Real Estate Employment by Area Type, 2000
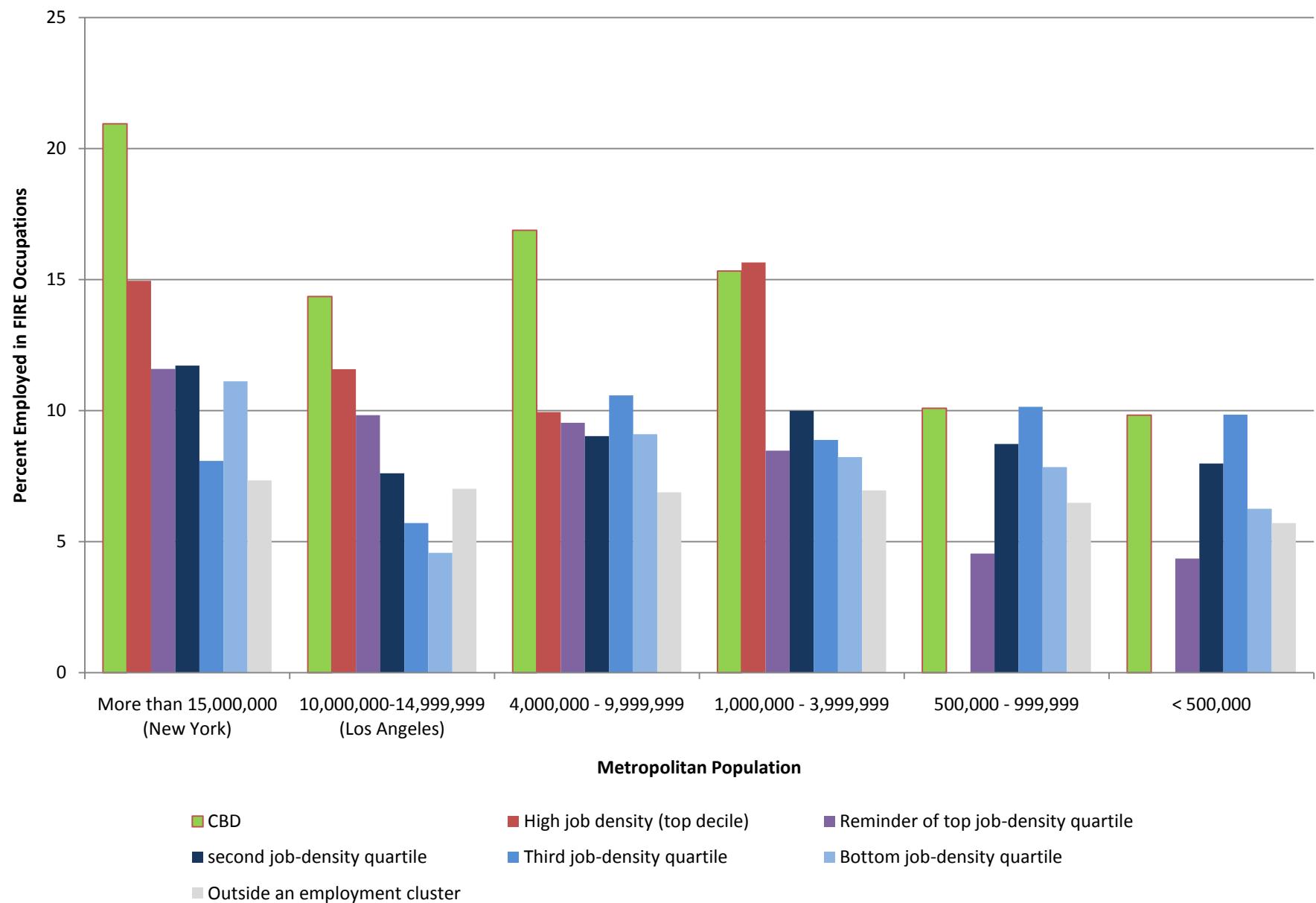
Figure 9. Commuters Driving Alone to Work by Area Type, 2000