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Metropolitan Spatial Trends in Employment and Housing

Literature Review

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This paper provides a critical review of the literature on recent spatial trends in US metropolitan areas. Postwar trends to 1980 are extensively documented; population and employment growth decentralized; central business districts (CBDs) declined while new employment concentrations outside the CBD emerged; and metropolitan densities decreased. The question is whether these trends have continued. Economic restructuring, public policies to revitalize cities and concentrate new development, rising urban congestion and many other factors may affect spatial patterns. We find that these broad trends have continued, but that these trends mask variation within and between US metropolitan areas. We address this second question of intra-metropolitan structure, and how it may influence travel and energy consumption relationships. Recent research indicates that urban spatial organization varies: some CBDs have retained employment share while others have not; some metro areas are more polycentric than others. We present a case study of the Los Angeles region to illustrate the type of research that would improve our understanding of changing spatial structure.

1. INTRODUCTION

The purpose of this paper is to provide a critical review of the literature on recent spatial trends in US metropolitan areas. Contemporary metropolitan areas are characterized by decentralized population and employment, extensive suburbanization, decline of the central business district (CBD), and the emergence of employment concentrations outside the CBD. There is an extensive literature on the evolution of metropolitan areas (e.g. Muller, 1981, 2004; Baerwald, 1982, Jackson, 1985; Chinitz, 1991; Castells and Hall, 1994). Explanations for changing urban form include public policy (e.g. housing, transportation policy), technological change and economic restructuring, rising per capita income, dominance of the automobile, preferences for low density living environments, and social/racial segmentation.

Within this broad consensus of overall trends, there is less agreement on whether the polycentric urban region is giving way to a dispersed urban region, e.g. whether the benefits of proximity have declined so much that employment clusters are becoming an increasingly less significant aspect of the urban landscape. Have technological changes and other factors so reduced the value of proximate location that the costs of aggregation (congestion, land prices) exceed benefits at ever lower levels of concentration? Have agglomeration benefits been transformed such that external benefits accrue at the regional level, or at even broader scale (state, national)? If so, today's metropolitan areas should be less concentrated (whether the city is mono- or polycentric) than those of 20 or 30 years ago.

Alternatively, it may indeed be that the net forces for agglomeration in *production* are

declining, but concentration may still persist due to rising forces of agglomeration in *consumption* (Glaeser et al 2001). It may be that the rationale for the existence of cities is undergoing another transformation as it has in the past. Over a long history, cities have been places for civil defense, central markets, and – with the rise of industrialization – places of production. This focus on employment distributions as concentrated in downtowns reflects the century of densification of urban areas following the Industrial Revolution. Now, in an era of falling communication and transportation costs, when manufacturing no longer provides a rationale for dense urban areas, the question becomes what now – and in the future – explains urban form.

Our interest is urban spatial evolution in the past 20 years. During this period structural changes in the economy resulting from technological advances in information and communications technologies (ICT) have been extensive, and many of the arguments regarding spatial trends are based on the shift to an information economy. Others rest on the relative elasticities of demand for space and consumption amenities as incomes rise – the former working for dispersion, the latter working for concentration. There are also theories suggesting that work rules and taxes are important determinants of urban form. Finally, transportation costs for both passengers and goods have implications for urban form.

Suburbanization and decentralization have generated both extensive concerns about impacts and numerous policy prescriptions on how to halt or reverse these trends. Concerns include those associated with urban sprawl: increased dependence on private automobiles, inefficient land use patterns, environmental pollution, spatial segmentation by race and class, decline of the central city, etc. Public policy efforts to reverse these trends are numerous. Central cities throughout the US have active redevelopment programs, and public transit systems have been rehabilitated and expanded. Some metropolitan areas have used land use controls to limit suburban development and encourage infill. Conformity and other provisions of regional transportation planning have led to a shift in investment priorities away from highways. And practicing urban planners have embraced "smart growth" and "transit-oriented development" as the solution to transportation and environmental problems. It is therefore appropriate to ask whether longstanding decentralization trends continue, or whether new spatial forms are emerging.

A central part of informing this discussion will be making use of new tools to reconsider the question of what spatial trends are actually occurring. That is, there is some sense in which "standard" models and the empirical methods based on them may not provide clear evidence on any but the broadest trends – masking important dynamics within metropolitan areas. It is the spatial patterns within metropolitan areas that may have the greatest influence on travel and its related energy consumption.

This report is organized as follows. We begin with an overview of factors affecting metropolitan growth since 1980. These include structural economic change and the rise of the information economy, changing demographics, and changes in transport policy. Our discussion is structured around urban economic theory, and we consider these major trends in the context of theoretical expectations. The next sections discuss the empirical literature. We discuss major population and employment trends at both national and metropolitan levels. Following the literature review, we provide a case study of the Los Angeles region based on our own empirical work. The paper concludes with a discussion of implications regarding future development patterns.

2. FACTORS AFFECTING METROPOLITAN GROWTH PATTERNS

There are two related literatures that are directly relevant to this research. The first body of work addresses the forces for and against the concentration of economic activity; the second applies these forces to the mechanics of clustering within metropolitan areas. The overlap between the two areas is substantial, and understanding both is important for placing our results in context.

2.1 Concentration vs. Dispersion

The central tension in determining urban structure is the relative strength of economies and diseconomies of agglomeration. Cities exist because they are a more efficient organization of economic activity. Urban economics has traditionally focused on which factors influence firm and household location choice, and, by extension, aggregate urban structure. The traditional element that determined city shape has been transportation costs, but much more has been introduced to the discussion in recent years.

2.1.1 Arguments for Concentration

Most recently there has been a new interest in the role of the Internet and the rise of a "new economy" on urban structure. There are several reasons why the so-called "new economy" may be as dependent on agglomeration economies as the old economy. First, although ICT reduces the cost of information flows and hence reduces the effect of physical distance, the complexity of many aspects of knowledge-based activity and the important role of complex information creates the need for face-to-face communication. The enormous volume of information exchange and the increasing time-sensitivity of information generate the need for expert managers to control and direct information flows from central locations. In the tradition of Jane Jacobs (1961), research on creativity and innovation indicate that such activities are dependent upon dense informal networks, serendipitous exchanges and a rich "creative milieu." All of these factors suggest a strong tendency toward agglomeration (Graham and Marvin, 1996, Castells and Hall, 1994).

Second, it is argued that the historic development of major cities establishes a pattern of concentration that is self-reinforcing. Large cities have the most diverse labor force, the most highly trained experts, and the largest numbers of workers, creating a significant competitive advantage. Romer's (1986) endogenous growth model posits that more ideas beget even more ideas – that cities are fertile ground for innovation and economic growth. Duranton and Puga (2001) characterize some cities as "nurseries" for growth, enhancing idea production due to their industrial diversity. Large cities also have the densest transport networks and generally best access to global transport networks. As highways followed the paths of earlier roadways, the communications infrastructure has in large part followed the transportation infrastructure. Moreover, since large cities have the greatest demand for communications services, suppliers take advantage of scale economies, offering more, better and cheaper service in the largest cities (Graham and Marvin, 1996).

Third, industry restructuring favors agglomeration. As vertical disintegration proceeds, contract providers may locate in close proximity to client firms, as has been demonstrated in case studies of high technology industries and the motion picture industry in Southern California (Scott, 1988). In a world of flexible production, subcontractors must be in continuous contact

with existing and prospective customers to compete for and secure business. Contractors benefit from this clustering by having access to a competitive supply of potential subcontractors.

Fourth, labor pooling benefits may be important. Increased numbers of temporary jobs, owner-operated business, and decreased job stability imply that workers must constantly seek new business and attempt to balance out the variability in demand for their services. Therefore, as workers absorb greater risk in employment, we should expect workers to seek locations in areas with high job accessibility. At the same time, firms benefit from a large and diversified labor supply (Giuliano, 1998).

Fifth, it is argued that major cities have the advantage of being cultural and educational centers as well as destinations for consumption activities. All of these may contribute to a dynamic environment that attracts highly educated workers. To the extent that such workers prefer the excitement of city life, firms will locate to attract them (e.g. Florida, 2002; Kotkin, 2000). Major cities may also be "beautiful cities," attracting affluent, highly skilled individuals to pleasing architecture or other amenities (Storper and Manville, 2006).

Finally, some argue that changing demographics will lead to more concentration. As baby boomers age and have more difficulty driving, they will be motivated to relocate to places with more walk and transit access. Immigrant households, an increasing share of the US population, have preferences for higher density development; hence as this population continues to grow, so will demand for urban housing (Myers and Gearin, 2001). Moreover, as incomes rise, the demand for all normal goods rises. And where this has been one of the primary drivers of suburbanization for well over a century (Jackson 1985), it may also imply a return to downtowns as baby boomers -- no longer needing suburban schools for their children – move back to downtowns for better consumption amenities. Forces for concentration imply 1) continued growth of large metropolitan areas, 2) increasing metropolitan densities, and 3) clustering of activity at the sub-metropolitan level.

2.1.2 Arguments for Dispersion

The arguments for dispersion are also well known. Reduced costs of information transmission and processing reduce the value of physical proximity (Kloosterman and Musterd, 2001). To the extent that physical flows can be substituted for virtual flows, the value of proximity declines even more. Reduced communication and transportation costs allow firms to exploit comparative advantage of different locations, no matter how distant from one another. Reduced communications costs have enabled vertical disintegration, out-sourcing and the emergence of networked firms. Hence firms may locate their "control center" in a center, while dispersing back-office activities to less costly suburban or rural locations. As the value of agglomeration declines, the costs of agglomeration become a deterrent to further concentration.

Some observers argue that ICT will eventually eliminate cities altogether; physical space will be replaced with electronic space (e.g. Castells, 1989, Cairncross, 1997; Mitchell, 1996). And as "dematerialization" proceeds – the transformation of physical flows to virtual flows – agglomeration economies will disappear. In this world of uniform accessibility there is no value to concentration, hence concentrations (cities or centers) will disappear. A less extreme view is that dematerialization reduces the value of agglomeration, hence we should expect decentralization and dispersion to continue.[1] Finally, it is argued that people's preferences for

[1] Note that agglomeration refers to physical proximity. Communication networks benefit from economies of density – intensive utilization of the network.

low density living environments will motivate continued dispersion. As work becomes more mobile, workers have more choice in where to live. Telecommuting, home-based work, and mobile working make it possible to live further from the office or from one's clientele. The expert knowledge worker has particular mobility, as such workers increasingly serve regional, national and even international markets. Such workers can more easily act on their preferences and choose their residence location accordingly (Beyers 2000). Moreover, since labor force availability is a key factor in firm location choice (Gottlieb, 1994; Schmenner, 1982), residential preferences of workers may draw firms to decentralize. Finally, to the extent that quality of life factors enter into firm location choice and these factors are associated with suburban or exurban location, quality of life factors may also foster job decentralization (Gottlieb, 1995).

In sum, changes in the structure of the economy, ever faster and cheaper information and communications technologies, and the dispersion of the labor force have changed the nature of agglomeration economies Agglomeration benefits may have become regional in scope, and, if so, employment within urban regions should disperse (e.g. Castells, 1989; Gordon and Richardson, 1996a Lang and Lefurgy, 2003). Forces for dispersion imply 1) shift of growth to small metropolitan areas or non-metropolitan areas, 2) possible decline of the largest metropolitan areas, and 3) declining densities in metropolitan areas.

2.2 Determinants of Urban Spatial Structure

We turn now to theories of urban spatial structure, or the distribution of employment and population. There is extensive literature explaining the evolution of metropolitan spatial structure in economic terms (for example, Mills, 1967; Fujita 1989). Existence of an employment center, such as the central business district (CBD), is explained on the basis of economies of scale in production (agglomeration economies) and diseconomies in transportation and congestion. It is argued that firms locate inside employment centers to benefit from external economies of scale, both pecuniary and technological, of locating in spatial proximity to other businesses, for example access to a large skilled labor pool, knowledge spillovers, and input sharing.

The standard urban model assumes a single employment center, and distributes households based on trade-offs between housing and commute costs (see Anas, Arnott and Small, 1998 for a summary; Fujita, 1989 for a comprehensive synthesis). The model predicts declining and constantly decreasing population density with distance from the city center. Population density declines with distance, because unit housing costs decline as transport costs increase, and therefore households consume more housing. The model also predicts commuting patterns: the average commute trip distance is equal to the mean distance of total population to the center. If housing demand elasticity varies across households, those with stronger preferences for housing will locate further away from the center. And if these preferences are positively related to income, lower income households would locate closer to the center while higher income households would consume more housing and locate further away.

The four basic factors that determine city size in the standard urban model are population, income, transport costs, and agricultural land value. A population increase will increase city size but not affect the density gradient. An increase in income generates more housing demand per household and thus will increase city size and decrease density. If transport costs decline, more housing is consumed, the city expands, and the density gradient declines. If the price of agricultural land increases, city size will be reduced and the density gradient will increase.

Stylized comparative statics are illustrated in Figure 1 and Table 1. We use a conventional negative exponential density function to generate peak density and city size. Case 1 is the base case. In case 2 the total population is held constant and the gradient is reduced by 25%, representing a reduction in transport costs and/or increase in household income. City size increases by one third, and peak density decreases by 43%; density decreases throughout the city as households consume more housing. In case 3 population increases by 25% and the gradient is held constant. In this case peak density increases by 25% and city size by just 10.9% the additional population is accommodated by raising density throughout the city.. In Case 4, the combination of increased population and decreased gradient yields a 30% reduction in peak density and 50% increase in city size. It can be seen that urban growth accompanied by increased household income and decreased transport costs can lead to large increases in city size.

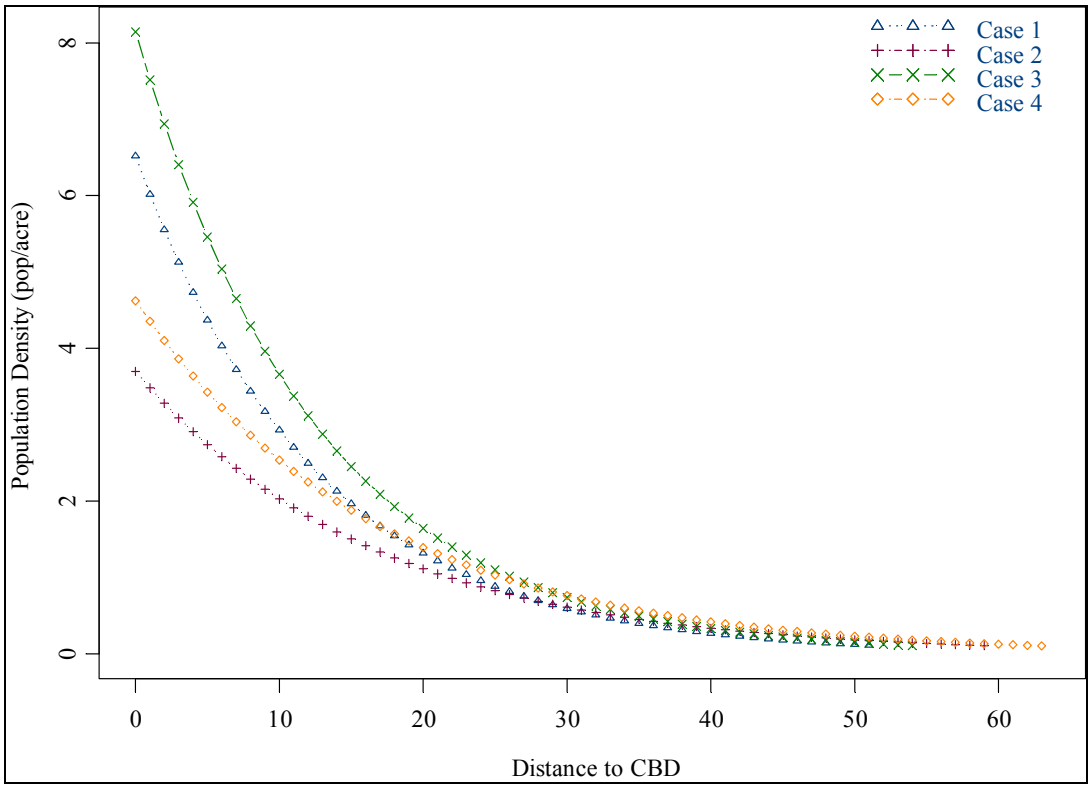


FIGURE 1 Population density gradients for four city forms.

TABLE 1 Four City Forms

Case	Population	Peak den.	Gradient	Edge	City area	% change
1 Base	4 million	6.5	0.08	51.8	8,413	
2 Pop constant, gradient down 25%	4 million	3.7	0.06	59.8	11,216	33.3%
3 Pop up 25%, gradient constant	5 million	8.1	0.08	54.5	9,331	10.9%
4 Pop up 25%, gradient up 25%	5 million	4.6	0.06	63.5	12,668	50.6%

Over the past several decades per capita income has increase and real transport costs have declined. Empirical evidence tends to support standard theory. Population density does decline with distance from the city center, and the population density gradient has declined over time (Anas, Arnott and Small, 1998; see section 3.2 below). The spatial extent of metropolitan areas has increased, as documented by several studies of urban sprawl (Galster et al, 2001; Ewing et al 2002; Glaeser and Kahn, 2003). Lower income households tend to live near the city center and have shorter commutes, while higher income households are more likely to live in the suburbs (Mieskowski and Mills, 1993).

2.2.1 Employment Centers

One of the major criticisms of the standard model is that metropolitan areas are no longer monocentric. Some argue that contemporary metropolitan areas are polycentric; others argue that they are best described as dispersed, or without significant employment concentrations. Whether or not employment concentrations exist depends on the extent of agglomeration economies and the scale at which they work. If agglomeration economies exist at the sub-metropolitan level, we should observe one or more clusters of employment, which we will call employment centers.

What are the factors that lead to multiple employment center formation? To the extent that agglomeration benefits outweigh agglomeration diseconomies, such as traffic congestion, high land rents, etc., firms would continue to locate inside the existing centers. Over time, however, an existing center may grow to a point where the negative externalities of locating inside it outweigh the benefits, at least for some firms. As firms seek locations outside the existing centers, agglomeration benefits could lead to the emergence of employment centers at other locations. Indeed formation and growth of employment centers can be expressed as an outcome of the interplay between the centrifugal forces of decentralization and the centripetal forces of agglomeration (Anas et al 1998). Indeed these forces may vary widely by industry and function. London and New York may concentrate as globalization progresses and more headquarters seek to locate near other headquarters. At the same time, second tier metropolitan areas may experience declining concentration as both manufacturing and front-office activities relocate to other areas.

Researchers have suggested several theories regarding emergence and growth of employment centers subsequent to the CBD. One set of theories is based on traditional arguments of economies of scale in production and diseconomies in transportation and congestion (Helseley and Sullivan, 1991). Chen (1996) proposes that an exogenous change in transportation technology that lowers transport cost, and a drop in agglomeration economies that loosens ties to the CBD may lead to the formation of an employment center.

Another view is that employment centers emerge as a result of the decision making of local governments, including tax policy and land-use policy (Fujita, 1989; Sullivan, 1986; Zhang and Sasaki, 1997, 2000). A competing view is that private developers facilitate migration of firms, and hence play an important role in the creation of employment centers (Henderson and Mitra, 1996). Private developers may enlist the support of the city (Wieand, 1987), or their independent decisions may lead to center formation (Brasington, 2001).

Some theorists ascribe center formation to location decisions of large firms. According to Fujita and Thisse (2002) an employment center may emerge when a large firm moves to a distant location away from the CBD. The large firm moves far enough to take advantage of

lower land rents and cheaper labor, but close enough to the CBD to take advantage of information flows and other urbanization economies. Additionally, location of a firm may also depend on idiosyncratic preferences of entrepreneurs, knowledge-workers, chief executive officers, or others involved in decision making (Anas et. al. 1998).

2.2.2 Population and Housing

As noted above, the standard model predicts population decentralization and lower densities as a result of lower transport costs and higher per capita real income, a process described by Mieszkowski and Mills (1993) as "natural evolution." Natural evolution theory is grounded in urban economics and is driven by the market forces: the process of population suburbanization is explained on the basis of limited land supply in central cities, abundant supply of relatively cheap land at the periphery, and increasing demand for new housing. As land inside the city gets filled in, development moves outwards to suburban locations. Suburbanization is aided by innovations in transport technology which lower the travel cost. Affluent households, who can afford new homes built in the suburbs, migrate leaving behind less-expensive housing stock, which trickles down to the lower income households. Decentralization of people is in turn followed by decentralization of jobs.

A competing "fiscal-social" explanation for suburbanization is driven by public policy: central cities tend to have higher taxes, lower quality public schools and other government services, racial tensions, crime, congestion, and low environmental quality" as compared to suburbs (Mieszkowski and Mills 1993, page 137). These fiscal-social problems of central cities lead to suburbanization of affluent households, which creates wealthy suburbs and lower-income inner cities. The fiscal-social theory explains suburbanization as an outcome of public policy rather than market forces. While suburbanization cannot be ascribed to any single policy, two are worth mentioning: exclusionary zoning policies at local level and the federal housing policy.

The fiscal-social divide between suburbs and central cities has been exacerbated by exclusionary zoning, zoning regulations that implicitly exclude the poor, as for example large minimum lot size requirements. A key motivation for enactment of such zoning regulations was preservation of property values by excluding conflicting land uses that may potentially undermine the residential property values (Fischel 2001, 2004). The term "conflict" has been construed as anything that was detrimental to the property values including not only slaughterhouses and tanneries but also apartments and multi-family units.

Federal housing policy has perhaps had the most profound influence on population suburbanization in the twentieth century (Jackson 1985). The subsidies available to homeowners, e.g. tax exempt interest on mortgages, and the various government backed mortgage insurance programs (that have greatly improved households' access to home loans) have resulted in unprecedented levels of homeownership in the U.S., which exceed those of comparable developed nations (Nivola 1999). The Federal Housing Administration (FHA) policies that have traditionally favored "homogeneous subdivisions over industrial, aging, or heterogeneous neighborhoods have also in effect moved mortgage funds from cities to suburbs aiding population suburbanization (Jackson 1985, page 215).

Changing demographics of the US population may also affect urban population and housing patterns. Overall, the U.S. population is aging, the number of single person households has increased significantly, and legal immigration to the U.S. has fed the country with a supply of relatively young workforce and has contributed to the growth of both large and medium size

metropolitan areas. Impacts of an aging population depend on whether households choose to age in place, relocate to lower cost rural or exurban areas, or relocate to urban core areas in order to take advantage of local amenities and reduce reliance on private vehicle travel. Dominant trends to date are aging in place and relocation to lower cost areas (Longino and Bradley 2003). Increased numbers of single person households suggests demand for smaller household units and hence higher densities, all else equal. Immigration implies greater demand for metropolitan location, if existing immigrant location choice trends continue. See Appendix A for a brief overview of major US population trends.

3. EMPIRICAL EVIDENCE

We summarize the existing literature around the following questions: 1) what are the trends in share of metropolitan and non-metropolitan population and employment; 2) what are the spatial trends in metropolitan population and employment?

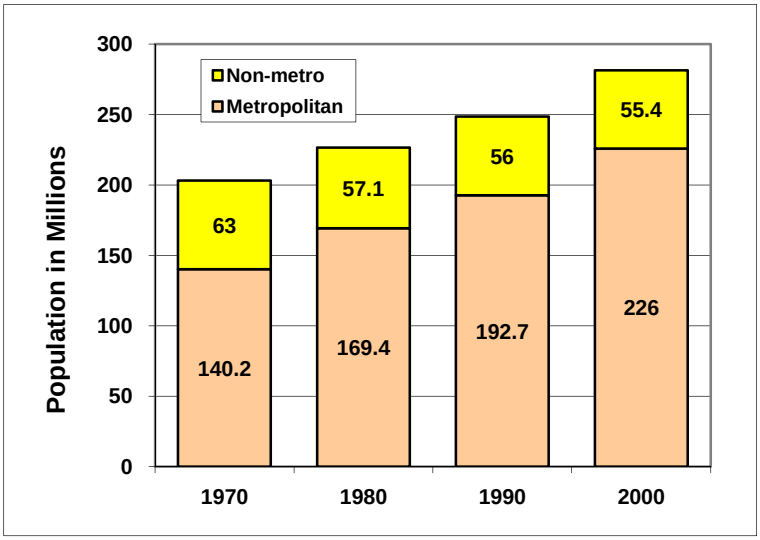
3.1 Metropolitan Versus Non-Metropolitan Trends

In this section we discuss population and employment trends.

3.1.1 Population

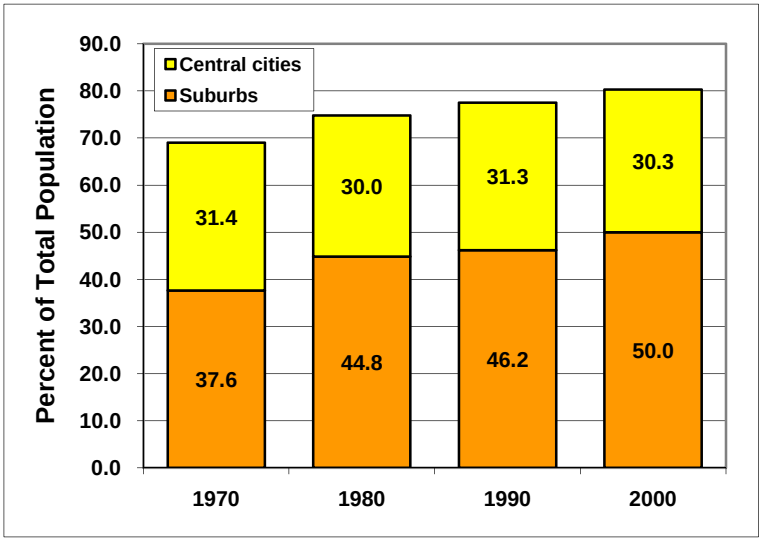
The US census provides the most comprehensive picture of population trends. Population continues to urbanize and suburbanize: an increasing share of population resides in metropolitan areas, and within metropolitan areas an increasing share resides in the suburbs. It bears noting that the census definitions for central city and suburbs are based on political boundaries, and hence are rather limited indicators of spatial trends (See Appendix B for US Census definitions). The 2000 Census shows that urbanization continues: metropolitan population increased by 61.4% from slightly over 140 million in 1970 to 226 million in 2000, while non-metropolitan population decreased from 63 million in 1970 to 55.4 million in 2000 (12.6% decline). As a share of total population, metropolitan population increased from 69% in 1970 to 80% in 2000 while non-metropolitan population decreased from 31% in 1970 to about 20% in 2000 (see Figure 2).

Furthermore, metropolitan population continues to suburbanize –between 1970 and 2000 total central city population share declined from 31.4 to 30.3 percent while the suburban population share increased from 37.6 to 50 percent (Figure 3). In relative terms, the share of central city population (as percent of total metropolitan population) declined from 45.5 % in 1970 to 34.7 % in 2000 while the share of suburban population increased from 54.4% in 1970 to over 62% in 2000. As of 2000, 50% of the total population resides in suburbs.



Source: Hobbs, F. and N. Stoops (2002)

FIGURE 2 Total population by metropolitan status 1970–2000 (millions).



Source: Hobbs, F. and N. Stoops (2002)

FIGURE 3 Population in central cities and suburbs as share of total population: 1970–2000.

3.1.2 Employment

The empirical literature on employment trends is more limited, mainly because of data limitations. The Bureau of Economic Analysis (BEA) has collected county level employment data since 1969. Commuting data was collected by the US Census starting in 1960 as part of the

long form survey. The Census Transportation Planning Package (CTPP) uses the commuting data to generate estimates of jobs by local area (transportation analysis zones or census tracts). Longitudinal empirical comparisons of employment patterns across metropolitan areas use one of these data sources.

Peter Gordon and Harry Richardson have used the BEA data in a series of papers. For example, using 1982-87 BEA data and 1976, 1980, and 1986 data from the Wharton Urban Decentralization Project, Gordon and Richardson (1996) calculated average annual employment growth rates for 54 US metropolitan areas for 1976 - 1980 and 1980 - 1986. Areas were segmented into CBD, remainder of the central city, and the remaining metropolitan area excluding the central city. In all cases, growth rates were highest in the suburban county. Similar results were found using annual employment data by county (Gordon, Richardson and Yu, 1996).

Gordon and Richardson have extended their work to 2004 (Gordon, Richardson and Kim, 2008). They have compared average annual population growth and private employment growth across various classifications of US counties, time intervals, and regions of the US (the BEA data also provides annual population estimates). Table 3.1.1 summarizes their data on population and employment growth by geographic groupings for 1969 and 2004. These are based on the new Office of Management and Budget (OMB) metropolitan classifications, which use the 2000 census population and commuting data. These "core-based statistical areas" are defined based on the total commute shed. For example, a large metropolitan area includes not only those counties that meet the population criteria for "urban," but also any adjacent counties that contribute substantially to the commute flow. The geographic groupings are constant, so the shares are for the same areas.

Table 2 gives population and private employment shares by the 2000 OMB classifications. Since all counties were classified based on 2000 status, the 1969 data are based on the 2000 categories. For example, a large metro area may not have reached 1 million population in 1969, but is included in that group in both years. The table shows that metropolitan areas gained share in both population and employment between 1969 and 2004, with the gain in population coming from both large and small metro areas, and the gain in

TABLE 2 US Population and Private Employment Shares by Geographic Groupings (% shares)

Geographic Location	Population		Private Employment	
	1969	2004	1969	2004
Large metro area 1M pop or more	52.37	53.52	57.33	57.00
Small metro area less than 1M pop	28.33	29.65	27.28	29.13
Subtotal	80.70	83.17	84.61	86.13
Micro area adjacent to large metro	1.81	1.82	1.61	1.52
Micro area adjacent to small metro	5.62	5.10	4.89	4.24
Micro area not adjacent	3.60	3.15	3.06	3.02
Subtotal	11.03	10.07	9.56	8.78
Non-core	8.26	6.77	5.84	5.08

Source: Adapted from Gordon, Richardson and Kim (2008), pp 29 – 30

employment coming from small metropolitan areas. Micropolitan areas (those with an urban area of 10,000 to 50,000 population in 2000) and non-core areas (those with population of less than 10,000) lost share in both population and employment. At the national scale, these numbers do not suggest dispersion of either population or employment. Growth of non-core and micropolitan areas not adjacent to metropolitan areas would be an indicator of dispersion, but this is not observed in the BEA numbers. Classifying based on 2000 status undercounts adjacent micro areas, as those that grew most rapidly would be part of metro areas in 2000. The reduced share in non-core areas is consistent with continued urbanization.

3.2 Intra-Metropolitan Trends

This section summarizes population and employment trends within metropolitan areas. Spatial organization may be described in terms of the following attributes. Density measures the intensity of land use in terms of population, housing units, or jobs per land area unit. Centralization refers to the degree to which population or jobs are concentrated around the center of the metro area. Concentration measures the degree to which activities are located within a small proportion of the metro area. A metro area may have a high level of job concentration, for example, but also be highly decentralized. Proximity measures the relative distributions of population and jobs or other activities.[2] Dispersion refers to the degree of spatial organization. A dispersed job distribution would be one with jobs randomly distributed, neither concentrated nor centralized.

3.2.1 Population Distribution

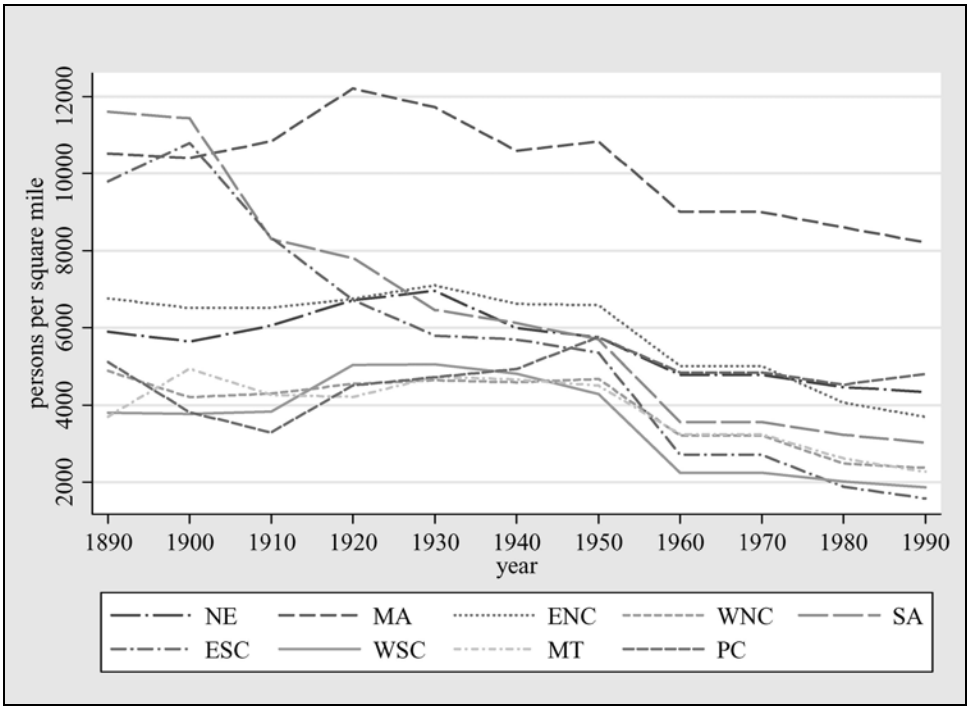
The most commonly used empirical measure of urban spatial structure is population density. This is largely due to data availability, since population statistics at the county and city level exist over many decades. Urban economists have used population density to test the standard model and to examine changes in metropolitan structure over time. Despite the many criticisms of the model (see for example Giuliano, 2004), it remains a commonly-used tool for comparing spatial trends over time or across metropolitan areas. While reasonable for capturing broad trends in urban form, there is reason to believe – for all the reasons laid out above – that monocentric models and average measured density gradients mask internal dynamics that may be more useful in ascertaining the evolution of population and employment distributions within metropolitan areas. In other words, suburbanization can occur with or without rising density in the suburbs – aggregate statistics on a crude center/suburban taxonomy cannot speak to the change in the organization of economic activity within either. These issues are illustrated in the case study below.

Population density functions have been estimated for cities around the world and for time periods dating back to the 19th century. The consistent result is lower average density and flatter gradients over time, consistent with reduced transport costs and rising per capita income (see McDonald, 1989 for a summary). One recent study is illustrative. Kim (2007) uses population data for all cities of greater than 25,000 population, from 1890 – 2000 to examine changes of population density over time. He finds that average population density of cities increased to 1940 and decreased thereafter. Average density is associated with city age; while all city groups show the general trend of rising then falling average density, the average density is highest and

[2] This typology is adapted from Cutsinger et al, 2005.

remains highest throughout for the oldest cities (those incorporated prior to 1800), and the average is lowest and remains lowest for the newest cities. The post 1940 decline in density is greatest for the oldest cities; that is, variation in average density has decreased. Finally, the trend has notably attenuated 1980 to 1990. See Figure 4. Differences related to city age reflect historical development patterns: the long life of capital infrastructure tends to set the fundamental structure of cities early in their development.

Kim assumes a monocentric city and estimates density gradients over time. Table 3 shows results for a consistent set of 87 cities and their metropolitan areas, for 1940 to 2000. Metropolitan areas outside New England are fixed at the 1950 metropolitan area definition; those in New England use the 2000 definition. The table gives both absolute and percent change for each measure. Note that the rate of decline in these measures is lower in the later decades. The share of central city population and the estimated density gradient has declined consistently over time. Average metropolitan density increases from 1940 to 1950, then decreases until 1990. Kim's research suggests that the long term trend in declining population density is attenuating, even as the central city share of population continues to decline.



Source: Kim S. (2007) "Changes in the Nature of Urban Spatial Structure in the United States, 1890–2000" *Journal of Regional Science*, Vol.47 (2), page 279,
By permission from Wiley-Blackwell, publishers.

FIGURE 4 Density of cities by dates of incorporation, 1890–1990.

TABLE 3 Urban Population Spatial Trends, 1940–2000, 87 US Cities

Year	Central City/Metro Population Ratio			Average Metro Density			Density Gradient		
		Chg	%		chg	%		chg	%
1940	0.61			8654			-0.72		
1950	0.57	-.04	-6.5	8794	140	1.62	-0.64	-0.08	-11.1
1960	0.50	-.07	-12.2	7567	-1227	-14.0	-0.50	-0.14	-21.9
1970	0.46	-.04	-8.0	6661	-906	-12.0	-0.42	-0.08	-16.0
1980	0.42	-.04	-8.7	6111	-550	-8.3	-0.37	-0.05	-11.9
1990	0.40	-.02	-4.8	5572	-539	-8.8	-0.34	-0.03	-8.1
2000	0.38	-.02	-5.0	5581	9	0.2	-0.32	-0.02	-5.9

Source: Adapted from Kim, 2007, p. 283

3.2.2 Case Studies of Population and Employment Trends

Another method of examining spatial trends is with case studies of specific metropolitan areas. Comparative case studies are limited to widely available data, which means either US Census data or the BEA data. The BEA data are available only at the county level, so the Census is the only source of data at the sub-county level. The Public Use Microdata Sample (PUMS) gives individual data, but limits spatial disaggregation. The CTPP data, which provide information on workers, jobs and commuting, are based on the long-form Census data. Since it is the only source of data on jobs by place of employment across US metro areas, it is widely used for that purpose. The CTPP data are subject to several sources of error: the long-form sample is based on population characteristics, not employment; place of work responses may be unclear or incomplete; reported travel times or distances may be inconsistent, methods for aggregating the sample to the regional population may have problems, etc. In our own work on the Los Angeles region, for example, we found the CTPP data to be inconsistent with county and regional totals based on information from the state Economic Development Department. Therefore we suggest considering studies based on CTPP with some caution.

Lee, Seo and Webster (2006) examine employment trends, specialization and commuting patterns of 12 US CMSAs to investigate historical changes in metropolitan spatial structure, 1980 – 1990. The metro areas are Buffalo, New York, Philadelphia, Chicago, Cleveland, Detroit, Houston, Los Angeles, Denver, Portland San Francisco, and Seattle. Using the US Census PUMS data, they divide each CMSA into central city (CC) and not central city (NCC).

The highest growth CMSAs had the highest employment growth, and growth occurred across all 5 employment sectors (note it is not clear how employment data are obtained from PUMS). Employment shares in CC vs NCC differed, as did employment shares by sector, but in all cases the total CC share declined. For example, in all CMSAs where manufacturing jobs declined, the decline was greater in the central city than outside. Only Los Angeles experienced an increase in manufacturing, and the increase outside the CC was greater than inside.

Table 4 summarizes employment trend results. Since the data are based on cities, the central city share depends on how large the central city is in relation to the total CMSA. It can be seen that some central cities have fared better than others. New York and Chicago had minor share losses, while in Denver the central city share dropped by 10 percentage points. Cleveland and Detroit reflect the "hollowing out" phenomena; with redistribution of jobs resulting in employment losses for the central city.

TABLE 4 Employment Trends, Inside and Outside the Central City, 1980–1990

		Northeast			Midwest			South	West				
		Buff	NY	Phil	Chicago	Cleve	Det	Hous	Den	LA	Port	SF	Sea
% Change	Total Emp	13.2	26.7	28.6	20.3	9.1	19.1	34.9	30.9	48.8	34.8	42.1	48.8
	CC	1.2	22.2	7.7	13.3	-4.0	-6.9	22.4	4.0	32.7	23.8	23.3	21.8
	Not CC	21.0	30.5	37.2	25.3	14.7	29.2	61.3	56.2	58.4	43.4	46.8	66.5
CC Share	1980	39	46	29	41	30	28	68	49	37	44	20	39
	1990	35	45	25	39	26	22	62	39	33	41	17	32

Buff = Buffalo; NY = New York; Phil = Philadelphia; Cleve = Cleveland; Det = Detroit; Hous = Houston; Den = Denver; LA = Los Angeles; Port = Portland; SF = San Francisco; Sea = Seattle

Source: Adapted from Lee, Seo and Webster (2006), pp. 2528, 2532-2534

The authors (Lee Seo and Webster 2006) used an entropy index to measure changes in specialization. Although the authors conclude that specialization decreased over the time period, and decreased more inside CC, statistical tests of differences between years or groups were not provided.. On commuting, flows reflect the decentralization of jobs, with the share of suburb to suburb commuting increasing and all other shares decreasing. South and west CMSAs had the greatest increase in commute flows, reflecting their more rapid growth. In the northeast and Midwest CMSAs, longer travel times for suburb to suburb commutes were offset by shorter travel times in other categories, attenuating the increase in the metropolitan average. All western cities except Denver had net increases in average travel time, with the largest increases in suburb to suburb commutes. Overall, results reflect differences in high growth vs slow growth cities (with the notable exception of Houston), as well as the different trajectories of central cities.

Horner (2007) uses CTPP data for 1990 and 2000 to examine spatial trends in the Tallahassee metro area. Horner generates zone-to-zone travel distances (how not explained), and these are used to estimate average commuting distances. Horner's focus is the relative distributions of workers and jobs and whether these have changed over the same time period. He calculates the minimum "required commute" based on Giuliano and Small (1993), the "maximum commute" (what if we maximized distances between all workers and all jobs), and the estimated actual commute. Results are given in Table 5 below, and show that while the "required commute" hardly changed, the "maximum commute" increased by about 1.2 miles, indicating that the relative distributions of workers and jobs became more different over the time period, e.g. proximity declined. The actual commute increased by about 0.3 miles, suggesting that the greater dispersion of workers and jobs did not result in increases as large as the change in distribution might have allowed.

Horner also calculated the zone level ratio of jobs to workers, and conducted a correlation analysis on the ratio 1990 vs 2000; the correlation is 0.6. He interprets this as indication that land developers and land regulators have taken actions to maintain stable jobs-housing balance, but provides no evidence of such actions. He also conducted correlations for in-commutes (commutes associated with jobs in zone i) and out-commutes (commutes associated with workers in zone i); out-commutes were more highly correlated than in-commutes (0.8 vs 0.3) suggesting that redistribution of workers to jobs was more prevalent. That is, job changes are more frequent

TABLE 5 Commute Estimates (miles), 1990 and 2000

	1990	**2000**
Min average required commute	2.60	2.64
Estimated actual average commute	4.81	5.09*
Max average possible commute	6.66	7.81*

* Indicates that the difference between groups is significant at $p < .001$
Source: Horner (2007), p. 325

than residential changes, and hence adjustments to changing spatial patterns are made via job location changes.

Yang (2008) conducted a similar study of Boston and Atlanta using CTPP data for 1980, 1990 and 2000. Boston and Atlanta are selected for their similar populations and different urban structures. Rather than calculating the "maximum commute," Yang estimates a "proportional matched commute" (PMC) which assigns workers to jobs based on the proportional distribution of workers within the metro area. This measure is intended to represent the distance between the average resident and average job. Table 6 gives selected results. The first two rows give average travel time and distance as computed from the CTPP data. Travel time and distance are shorter for Boston than for Atlanta, but also increase more over the period. For both metro areas the increase in distance was far greater 1980 – 1990 than 1990 – 2000. The minimum average required commute is much shorter for Boston, reflecting a higher degree of proximity of jobs and workers. There is very little change in the required commute, suggesting that proximity of workers and jobs changed little. The PMC values are comparable for both metro areas and increased over the two decades. As metro areas expand outward, the average distance between all jobs and all workers must increase, so increasing PMC implies spatial expansion. As in the Tallahassee study, it appears that workers adjust to changing spatial patterns by changing job locations.

Finally, Lee (2007) examines overall patterns of population and employment distributions of six Consolidated Metropolitan Statistical Areas: New York, Los Angeles, Boston and Portland from 1990 to 2000, and San Francisco and Philadelphia for 1980 to 2000. He uses a series of centralization and concentration indices. Selected results are given in Table 7. The

TABLE 6 Commute Estimates (km) for Boston and Atlanta, 1980, 1990, 2000

	Boston			Atlanta		
	1980	1990	2000	1980	1990	2000
Estimated actual ave commute (min)	23.1	23.8	27.6	27.0	26.4	30.5
Estimated actual ave commute (km)	11.4	14.7	16.3	18.5	21.7	22.1
Change (%)	--	28.9	10.9	--	17.3	1.8
Min ave required commute (km)	5.9	6.2	6.8	10.7	10.8	10.4
Change (%)		5.1	6.5		1.0	-3.7
Proportional matched commute (km)	27.2	36.5	37.5	26.2	34.9	41.7
Change (%)		34.2	2.7		33.2	19.5

Source: Adapted from Yang, 2008, p. 396.

TABLE 7 Changes in Centralization and Concentration, Six Metro Areas

	Centralization Area-based centralization index			Concentration Gini Coefficient		
	1980	1990	2000	1980	1990	2000
New York						
Employment		0.69	0.65		0.86	0.82
Population		0.61	0.61		0.78	0.77
Los Angeles						
Employment		0.64	0.60		0.88	0.85
Population		0.58	0.55		0.81	0.80
San Francisco						
Employment	0.49	0.42	0.39	0.90	0.87	0.85
Population	0.38	0.34	0.32	0.83	0.81	0.80
Boston						
Employment		0.53	0.50		0.73	0.71
Population		0.43	0.42		0.62	0.60
Philadelphia						
Employment	0.59	0.55	0.49	0.85	0.81	0.72
Population	0.53	0.49	0.46	0.75	0.69	0.66
Portland						
Employment		0.76	0.72		0.95	0.90
Population		0.66	0.66		0.84	0.83

Source: Adapted from Lee, 2007, pp. 492-493

area-based centralization index measures the cumulative proportion of employment or population with distance from the center. It ranges from -1 (perfect decentralization) to +1 (perfect centralization). The Gini Coefficient ranges from 0 to 1, with 0 meaning an equal distribution across all zones and 1 meaning a perfectly concentrated distribution (all population or employment in one zone).

Table 7 shows that all six areas decentralized in employment, but from quite different starting points. Portland is the most centralized (it is the smallest metro area in the group), followed by New York and Los Angeles. Measures for San Francisco may be affected by the San Francisco Bay. Changes for population tend to be smaller, with no change for New York or Portland. All metro areas have undergone varying amounts of deconcentration, again from different starting points and with employment changing more than population. These data suggest that within the broad trends of decentralization and deconcentration, metro areas differ in degree and rate of change.

3.3 Employment Centers

A key issue in urban spatial structure is whether employment is predominantly dispersed, or whether concentrations of employment – employment centers – are a significant feature of contemporary metropolitan areas. There is an extensive literature on employment decentralization and subsequent development of urban form. Contemporary metropolitan areas are characterized by decentralized employment of two forms: some dispersed in concert with the

population, and some clustered in "activity centers." Researchers have given several names to such activity centers or locations of substantial employment concentration, including for example *subcenter* (Giuliano and Small, 1991), *subcity employment center* (Cervero, 1989), *edge city* (Garreau, 1992), *job concentration* (Forestall and Greene, 1997), *employment pole* (Coffey and Shearmur, 2002), and *employment center* (Giuliano et al 2007, and Redfearn 2007). For the purpose of this report, we use the term 'employment center' to denote a site of significant geographic concentration of economic activity, including the CBD.

In economic terms, an employment center is a cluster of activity of sufficient magnitude to influence land prices and hence spatial form. In the case of a single center, identifying the center is trivial (the zone with highest land value per unit, or highest density). In theory, identifying centers in a polycentric area is also straightforward: any cluster that *independently* influences land values constitutes a center. The reality of metropolitan areas is far more complicated. Metropolitan areas have many clusters of employment, from isolated suburban office parks to the downtown. These clusters follow a variety of topographies – including natural and economic geography; neither of which is readily parameterized into circles or ellipses. In some cases major freeways define linear concentrations, in others a cluster might be broken up by a river or canyon. It is therefore not surprising that in empirical research employment centers have been defined in many different ways.

In one of the earliest works on employment centers, Cervero (1989) described "subcities" as "like downtowns in their densities and land-use mixtures," "secondary office and retail centers within their respective metropolitan markets" (page 80). Cervero's subcities included locations like Post Oak Galleria in Texas and South Coast Plaza in California. Garreau (1991) names the emerging new centers that are far from the CBD 'edge cities.' To qualify as an edge city, a settlement must satisfy five conditions: 1) at least 5 million square feet of rental office/commercial space; 2) at least 600,000 square feet of rental retail space; 3) more jobs than bedrooms; 4) perceived by people as one place (has a distinct single identity); and 5) was nothing like a city 30 years ago. Garraeu describes Tysons Corner, Virginia as an archetypal edge city.

Lang and Lefurgy (2003) introduce the notion of *edgeless city,* which is characterized by mostly isolated buildings spread across a vast area, and without a discernable boundary. The term 'edgeless city' describes a sub-regional structure rather than a city per se. According to their study, most metropolitan rental office space is either in the CBD or edgeless cities, with more space in edgeless cities than in the CBD. They estimate that edgeless cities have nearly twice the rental office space than the edge cities. They also observe that most edgeless cities are not edge cities waiting to grow up. The emerging spatial structure is interspersed employment and population without formation of any discernable 'center.' While suggestive, one shortcoming of this research is the focus on office space. Office space is just one of many types of production facilities within metropolitan areas – and houses an associated portion of employees and occupations.

Others have taken an urban economics approach and developed various methods based on employment density and related factors. Giuliano and Small (1991), identify an employment center as a set of contiguous analysis zones[3] such that each have a certain minimum employment density ***D*** and together have a certain minimum total employment ***E***. In the same study they used values of 10 jobs per acre and 10,000 jobs for ***D*** and ***E*** in a case study of Los Angeles. McMillen and McDonald (1997) adopt a nonparametric procedure, using locally weighted regression (LWR) estimates of employment density. McMillen (2001) proposes a two-stage

[3] Analysis zones are spatial units approximately the size of census tracts.

non-parametric procedure. McMillen and Smith (2003) combine the McMillen (2001) and Giuliano and Small (1991) methods described above. The McMillen (2001) method provides a list of potential employment center sites, which includes all tracts with significantly positive residuals. An employment center is then defined as a group of sites from this list that are contiguous and for which total employment exceeds 10,000. Using TAZ level employment data from the 1990 CTPP, they produce an exhaustive list of employment centers for 62 metropolitan areas. Lee (2007) used a modified McMillen and Smith method, as well as the Giuliano and Small method to identify centers in 1980, 1990, and 2000 for selected metropolitan areas, also using CTPP data.

Finally, Redfearn (2007) utilizes spatial econometric techniques to generate a smooth employment density surface, identify local maxima on the density surface (which are potential center candidates), and then utilizes an iterative procedure to cluster Census tracts, maximizing the mean average density differences between the clusters and the tracts that surround them. He then uses several statistical tests to confirm that the centers are significantly more dense (with regard to employment) from their surroundings.

Results from these studies are summarized in Table 8 below. Presence of employment centers, however defined, is demonstrated across varying metropolitan area size, age, location, and growth rates. We conclude that employment centers are a significant aspect of metropolitan spatial structure. Table 8 also shows that different methods and data sources lead to different results.

Just two of the employment center studies examine trends over time. We discuss the Lee (2007) study in this section, and the Giuliano et al (2007) as part of the Los Angeles case study that follows. Lee identifies employment centers using a combination of non-parametric/parametric method, and by the Giuliano and Small method. His results are summarized in Tables 9 and 10 below. Tables 9 and 10 give results for centers identified via locally weighted regression (LWR) and centers identified via minimum density respectively. Each table gives shares of total employment in the CBD, in other centers, and the total share of employment in centers. It can be seen that the two methods give quite different results for CBD shares; the LWR method tends to capture only the highest density zones, resulting in a small share of total employment. Comparing results in the two tables, Los Angeles and San Francisco stand out for their small share of CBD employment, while New York, Boston and Philadelphia have relatively larger CBD shares. Results for Portland are mixed.

The two tables also suggest that New York, Boston, Portland and Philadelphia are more monocentric: the main center has a large proportion of all center employment. Los Angeles and San Francisco are more polycentric, with the CBD having a smaller share of all center employment, the difference dependent on how centers are identified. Monocentricity is associated with more deconcentration; these more monocentric metro areas have a smaller total share of jobs in centers. Interestingly, employment centering seems to be a function of both age and size: New York, Boston, Philadelphia may be more monocentric because the core areas were built up before the 20th century, while Portland's monocentricity is explained by its relatively small size. The share of all jobs in centers varies both across metro area and between the two definitions of centers.

Comparing 1990 and 2000, CBDs however defined lost employment share, but only in the case of Portland is there a large change. Other centers also lost share in every case except Los Angeles using the LWR centers. Lee's analysis is therefore consistent with a trend of deconcentration: employment growth is faster outside of center, and hence an increasing share

TABLE 8 Select Empirical Studies of Urban Form

Author	Study Period	Data Source	Method Used	Study Area	# of Centers
Giuliano and Small (1991)	1980	Southern California Association of Governments	Parametric Employment Density ≥ 10 jobs/acre and Total Employment ≥10,000	Los Angeles CMSA	35
Forestall and Greene (1997)	1990	Census Transportation Planning Package (CTPP)	Parametric Jobs/Workers ≥ 1; and At least one tract with Jobs/Workers ≥ 1.25	Los Angeles CMSA	120
McMillen and McDonald (1997)	1980	CTPP	Non-parametric Locally weighted regression (LWR)	Suburban Chicago MSA (excludes city of Chicago)	15
Anderson and Bogart (2001)	1990	NA	Parametric Employment Density ≥ 5,000 jobs/ square mile & Total Employment ≥ 10,000	Cleveland	9
				Indianapolis	11
				Portland	11
				St. Louis	10
McMillen and Smith (2003)	1990	CTPP	Combination of Non-parametric and Parametric LWR to identify potential centers, then apply a minimum total employment criterion of 10,000 jobs to select final centers.	Chicago, IL	12
				Dallas, TX	12
				Detroit, MI	8
				Los Angeles, CA	46
				New York, NY	38
				Portland, OR	3
				San Diego, CA	6
				San Francisco, CA	12
				Seattle, WA	14
				Washington, DC	10
Giuliano et al (2007)	1980	SCAG	Parametric Employment Density ≥ 10 jobs/acre and Total Employment ≥ 10,000	Los Angeles CMSA	36
	1990				46
	2000				48
	1980	SCAG	Employment Density ≥ 20 jobs/acre and Total Employment ≥ 20,000	Los Angeles CMSA	10
	1990				13
	2000				15
Redfearn (2007)	2000	SCAG	Non Parametric LWR and statistical algorithms	Los Angeles CMSA	41
Lee (2007)	1990	CTPP, CMSA	Revised McMillan and Smith	New York	34
				Los Angeles	44
				Boston	10
				San Francisco	22
				Portland	3
				Philadelphia	14
	2000	CTPP, CMSA	Revised McMillan and Smith	New York	35
				Los Angeles	42
				Boston	8
				San Francisco	18
				Portland	3
				Philadelphia	11

TABLE 9 Share of Jobs in Centers, CBD, Other Centers by Metro Area, Lee's GWR Centers

	New York	Los Angeles	Boston	Portland	San Francisco	Philadelphia
Share in CBD						
1990	14.0	3.3	12.2	12.9	6.7	10.8
2000	12.6	2.9	10.3	7.9	6.2	9.4
Share in other centers						
1990	8.8	23.4	7.1	6.2	19.8	6.7
2000	8.3	26.2	5.1	3.8	13.0	5.4
Total share in centers						
1990	22.8	26.6	19.4	19.2	26.5	17.4
2000	21.0	29.1	15.4	11.7	19.2	14.8
Total employment (millions)						
1990	9.0	6.8	2.2	0.7	3.1	2.3
2000	9.4	6.7	2.3	1.1	3.4	2.4

Source: Lee (2007), pp. 501-507

TABLE 10 Share of Jobs in Centers, CBD and Other Centers by Metro Area, Lee's Min Density Centers

	NY	LA	Boston	Portland	SF	Philadelphia
Share in CBD						
1990	21.8	15.3	22.0	26.8	14.7	20.9
2000	21.2	13.0	21.8	19.2	14.2	15.9
Share in other centers						
1990	8.5	22.3	5.1	7.8	15.7	10.7
2000	7.5	19.3	2.0	9.3	19.7	6.7
Total share in centers						
1990	30.3	37.6	27.0	34.6	30.4	31.6
2000	28.7	32.3	23.8	28.6	33.8	22.7
Total employment (millions)						
1990	9.0	6.8	2.2	0.7	3.1	2.3
2000	9.4	6.7	2.3	1.1	3.4	2.4

Source: Lee (2007), pp. 501-507

of employment is located outside centers. Finally, Lee's analysis shows a general trend of fewer centers, except in the case of Portland (see Table 7 above). A decline in the total number of centers would be consistent with a trend of deconcentration as centers lose employment to other non-center locations.

4. EMPLOYMENT CENTERS IN LOS ANGELES

We now present a case study of Los Angeles metropolitan region. The Los Angeles Region is among the most widely studied for metropolitan spatial trends. Several researchers have found Los Angeles region to be polycentric (Giuliano and Small 1991, Forestall and Greene 1997, McMillen and Smith 2003, Giuliano et al 2007, and Redfearn 2007) while others have argued

that the region is now "beyond polycentricity" and the employment patterns are becoming decentralized and less concentrated (Gordon and Richardson 1996, Lee 2007). Our current research on Los Angeles spatial structure began in 2004. This case study summarizes Giuliano et al 2007, and also presents findings from more recent work.

4.1 Data

Our analysis area is the 2000 urbanized area portion of the five county Los Angeles CMSA, which includes the counties of Los Angeles, Orange, Riverside, San Bernardino and Ventura (see Figure 5). We use the urbanized area as defined by the US Census and exclude the vast tracts of mountains and deserts with little or no employment or population. Our data includes census tract level employment by place of work for 1980, 1990 and 2000. The data were obtained from the Southern California Association of Governments (SCAG), and are based on employment records from the California State Economic Development Department. The data are verified via other data sources (e.g. Dunn and Bradstreet firm data). Population data is available from the US census. All data are geocoded and converted to 1990 census tracts geography. There are 2,474 tracts covering a total area of about 5 million acres (just under 8,000 square miles).

4.2 Results

Table 11 gives employment and population by county to provide some context. Over the entire period, employment increased from about 5.4 million to about 7.3 million (35% growth), and population increased from 11.2 to 15.8 million (41% growth). Growth was uneven both across the decades and across counties. In relative terms growth was slowest in Los Angeles County, but in terms of absolute numbers, Los Angeles County added the greatest number of jobs and people. Los Angeles County stands out also as the only county that lost employment,

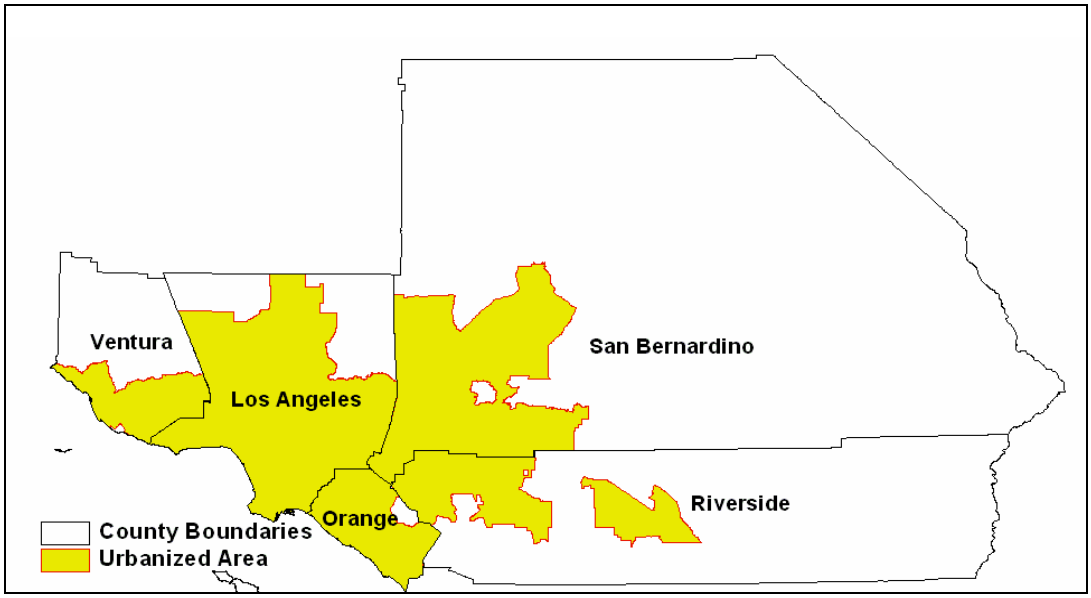


FIGURE 5 Urbanized portion of Los Angeles CMSA.

TABLE 11 Employment and Population by County, Urbanized Area

	1980		1990				2000			
County	Emp	Pop	Emp	Change (%)	Pop	Change (%)	Emp	Change (%)	Pop	Change (%)
LA	3.93	7.46	4.60	17.0	8.82	18.2	4.44	-3.5	9.54	8.2
Orange	0.92	1.93	1.30	41.3	2.41	24.9	1.51	16.2	2.87	19.1
Riverside	0.13	0.54	0.29	123.1	0.91	68.5	0.43	48.3	1.13	24.2
SB	0.24	0.79	0.43	79.2	1.28	62.0	0.55	27.9	1.56	21.9
Ventura	0.17	0.47	0.25	47.1	0.6	27.7	0.31	24.0	0.68	13.3
Total	5.39	11.19	6.87	27.5	14.02	25.3	7.24	5.4	15.78	12.6

1990 – 2000. The fastest growth in both jobs and population took place in Riverside County, with a more than doubling of jobs between 1980 and 1990. Jobs increased more than population 1980 – 1990 in Orange County, but the trend reversed 1990 – 2000. In San Bernardino and Riverside counties, jobs increased faster than population, an indication of transformation from bedroom suburb to urbanized area. It is also worth noting that over this period the regional economy has undergone significant restructuring: the share of manufacturing employment declined from 20% in 1980 to 12% in 2000, while share of service employment increased from 26% to 36%. In addition, congestion on the region's highways and airports has increased with population and economic growth.

4.2.1 Employment Distribution

The region's employment is highly concentrated, but the degree of concentration has declined. A simple way of measuring concentration is to rank order all spatial unit by density and determine the share of jobs located in the most dense land area. The share of jobs contained in the densest 10 percent of land area declined from 83.5% in 1980 to 71.1% in 2000. The greatest declines took place in the suburban counties (Riverside, San Bernardino, Ventura), while the share in Los Angeles remained stable. The share of jobs in tracts with low job density (less than 10 jobs per acre) increased, while the share of jobs in the highest density tracts has remained stable, and those in medium density tracts declined slightly. Employment has also decentralized: the average distance of jobs from the Los Angeles CBD increased from 18 miles in 1980 to 24 miles in 2000. Employment concentrations also decentralized: the average (weighted) distance of all tracts with more than 20 jobs per acre increased from 8.3 to 11 miles. These changes suggest a mix of decentralization and dispersion, but with significant remaining concentration.

4.2.2 Employment Centers

Using the Giuliano and Small criteria listed in Table 8, 36 employment centers were identified in the 1980 data, while 46 and 48 were identified in the 1990 and 2000 employment data, respectively. The centers' characteristics are quite varied, with a few very large centers and many smaller centers. Table 12 gives selected characteristics of centers. Average size, employment density, and population density are quite stable, though the largest center in 1980

TABLE 12 Selected Characteristics of Employment Centers, Los Angeles CMSA

	1980	1990	2000
Largest center (emp. in 1,000's)	1,074	1,022	558
Average number of jobs/center	60,380	58,423	56,616
Average size (acres)	2,882	2,882	2,793
Average jobs/acre	20.95	20.95	20.27
Average population/acre	10.45	10.45	10.88
Average emp/pop ratio	2.01	2.01	1.86

and 1990 splits into two distinct centers by 2000 – indicated by the drop in the maximum size of the centers. Note that the employment to population ratio is quite low, suggesting a high degree of intermixing.

The share of employment in centers remained steady in LA County, increased in Orange County, and decreased from an already small base in the other counties (Table 13). We calculated average distance of centers from the LA CBD, and found that distances increased; there was a decentralization of centers over the time period.

Centers are an important feature of Los Angeles spatial structure, and display remarkable stability, considering the amount of change that took place over the period. Figure 6 shows an overlay of 1980, 1990, and 2000 centers. It can be seen that more center growth took place to the northwest and southeast of the downtown; these are formerly suburban areas that became

TABLE 13 Percent Share of Total County Employment Inside Centers

County	1980	1990	2000
Los Angeles	46.0	46.4	46.1
Orange	36.7	39.1	43.1
Others	5.5	4.5	1.1

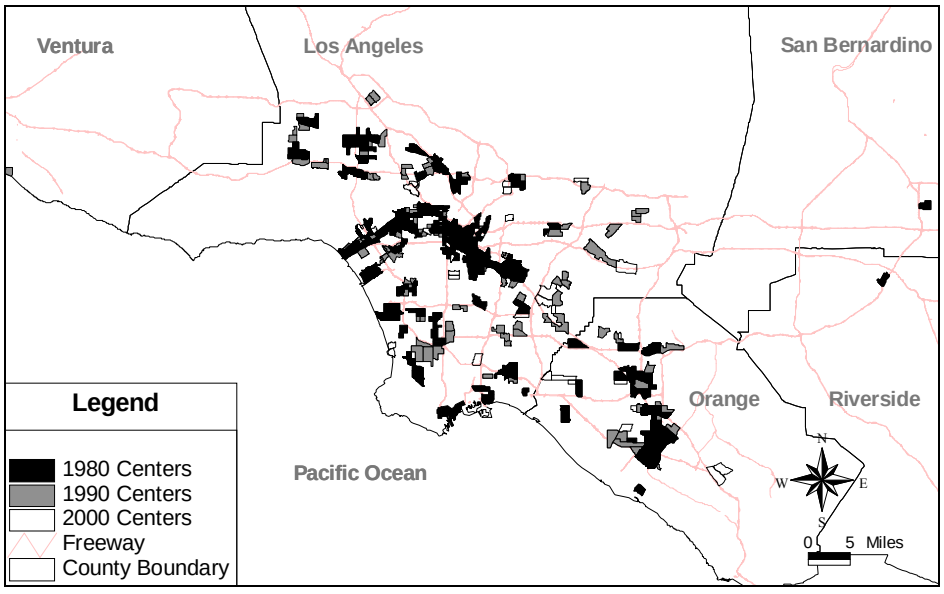


FIGURE 6 Changes of employment centers, 1980–2000.

more urban. The outer suburbs are in a different stage of development, with rapidly growing dispersed employment. We speculate that new centers will emerge in these areas in the coming decades (and indeed have been identified via the more flexible Redfearn method).

4.2.3 Structure and Characteristics of Centers

In an effort to shed light on the internal structure of employment centers, we describe some characteristics of centers. This is part of our ongoing work on the function of employment centers. We hypothesize that centers in Los Angeles are analogous to cities in regions: they constitute a hierarchy, and have different economic functions and specializations. Different function implies different internal spatial organization.

As noted in the previous section, employment centers vary in size, from the smallest making the density and employment cutoffs, to the largest. Center size follows a rank size distribution in each of the years. Table 14 gives the distribution of centers by size. As might be expected, the largest centers have the highest average and peak density. However, the extent of population and job mixing is not a function of size.

Employment mix differs inside and outside of centers, and these differences are more pronounced for the largest centers. Table 15 gives employment shares by industry sector, inside and outside centers, for the year 2000 centers (patterns for 1990 and 2000 are quite similar, and comparable 1980 data are not available). The lower panel gives the same information for only

TABLE 14 Selected Characteristics of 2000 Centers

	N	Acres	Average Jobs/acre	Peak tract jobs/acre	Jobs/pop
Centers with 10 – 20K jobs	20	17,400	15.22	17.02	1.66
Centers with >20 – 50K jobs	18	34,180	16.49	22.24	1.62
Centers with >50 – 100K jobs	5	20,162	16.09	20.55	2.46
Centers with >100 – 500K jobs	4	44,409	22.67	32.90	1.97
Centers with >500K jobs	1	17,949	31.09	303.24	1.80

TABLE 15 Employment Share by Industry Sector, Inside and Outside Centers, 2000

	Manuf	Sp manuf	Transp	Whlsl	Retail	FIRE	Bus svc	Health	Ent	Services	PA	Other	Total
10-10													
Inside	13.3	5.2	6.3	7.8	11.3	7.3	8.3	6.6	4.5	17.7	7.6	4.0	100
Outside	9.2	2.8	4.9	5.8	20.2	5.2	6.0	6.6	3.3	21.1	7.8	7.1	100
Total	10.8	3.7	5.4	6.5	16.9	6.0	6.8	6.6	3.8	19.8	7.7	6.0	100
20-20													
Inside	8.1	2.8	6.3	5.6	11.4	9.4	8.6	7.7	5.6	22.3	9.0	3.1	100
Outside	11.3	3.9	5.2	6.7	17.9	5.3	6.5	6.4	3.4	19.3	7.5	6.5	100
Total	10.8	3.7	5.4	6.5	16.9	6.0	6.8	6.6	3.8	19.8	7.7	6.0	100

the largest centers. It can be seen that there is relatively more concentration of manufacturing and specialized manufacturing, FIRE and business services in the "10-10" centers, and relatively less concentration of retail and general services. For the largest centers, there is relatively more concentration for FIRE, business services, health and entertainment. Manufacturing is now more concentrated outside centers. These patterns make sense. There are agglomeration economies in manufacturing, but manufacturing processes are land intensive, hence employment density is limited.

Population mixing, as measured by the jobs/population ratio, is shown in Table 16. For the entire region, the ratio is stable and implies about 0.45 jobs/person. As expected, ratios are greater than 1 inside centers and substantially less than 1 outside centers. The ratio inside centers is notably higher in Orange County than LA County; we surmise this is due to centers in Orange County being newer and hence subject to zoning that discourages job and population mixing. A closer comparison between 1990 and 2000 reveals that the ratio outside centers is decreasing in Los Angeles and Orange counties while it is increasing for all the other counties. This indicates higher levels of job segregation (which in turn alludes to concentration) in the former and greater dispersion in the latter.

Finally we use five centers to illustrate differences among centers and possible implications for commuting. Table 17 gives basic characteristics of the five centers. LA downtown is the historic CBD of the region. It is a mixed center and includes retail, services, specialized services, and manufacturing. It has the highest average employment density, and by far the highest peak density. Santa Ana/Irvine is located around Orange County's airport. It is nearly as large as the LA downtown, but has much lower employment density, and less population. Pasadena is a specialized service center, with higher proportions of business and FIRE, and very little manufacturing. It is much smaller than the first two centers, has higher density than Santa Ana/Irvine, and more population mixing. LAX and Rosemead are manufacturing centers and include heavy and specialized manufacturing, transportation, and wholesale. The airport tends to crowd out residential uses, as reflected in the very high jobs to population ratio.

TABLE 16 Jobs–Population Ratio by County

		Jobs-Pop Ratio 1990	**Jobs-Pop Ratio 2000**
LA County	Inside Centers	1.53	1.63
	Outside Centers	0.33	0.29
	All County	*0.52*	*0.47*
Orange County	Inside Centers	3.35	3.33
	Outside Centers	0.35	0.32
	All County	*0.54*	*0.53*
Other Counties	Inside Centers	2.62	2.83
	Outside Centers	0.33	0.38
Total Region	Inside Centers	1.72	1.86
	Outside Centers	0.33	0.32
	Total	0.45	0.46

TABLE 17 Characteristics of Five Centers, 2000

ID	Name	Type	Pop	Emp	Acres	Emp Density	Peak Density	J/P Ratio
1	LA downtown	Mixed	310128	557951	17949	31.1	303.2	1.80
3	Santa Ana/Irvine	Mixed	66914	306950	16648	18.4	23.9	4.59
9	Pasadena	Spec Service	38855	60332	2823	21.4	40.8	1.55
10	LAX	Manuf	7266	54252	2993	18.1	18.1	7.47
18	Rosemead	Manuf	27323	32695	1936	16.9	29.3	1.20

Table 18 gives commuting information for the same centers. The commuting data are calculated from the 2000 CTPP, but weighted to be consistent with our employment and population data. The table also gives totals for all centers and for the entire region for comparison purposes. As expected, LA downtown has the longest median commute in both time and distance, as well as the lowest drive alone share and highest transit share. Median distance and time are much shorter for Santa Ana/Irvine, despite its lack of population mixing. Modal shares are more auto-oriented than the regional averages. Pasadena has the shortest median travel distance and time and the second lowest transit share. LAX and Rosemead have similar distance and travel time, but Rosemead has the highest carpool share. We suspect that Rosemead has more low wage workers, and hence, in the absence of extensive transit service availability, more reliance on carpools.

Table 18 leads to the following observations. First, only the LA downtown has a substantial transit share, consistent with the focus of the regional transit system on the downtown. Second, Santa Ana/Irvine stands out for its high drive alone share, reflecting its emergence around several major freeways and its auto-oriented design. Mode shares for the other centers are close to the regional average for all commutes. Third, there is no apparent relationship between size of the center and commute distance. Finally, among the smaller centers, there may be evidence that manufacturing centers are associated with longer commutes, likely because of the externalities connected with manufacturing activity. These examples illustrate the variation across centers that in turn have implications for the travel patterns they generate.

TABLE 18 Commuting Characteristics for Five Centers

ID	Name	Med distance	75th % distance	Med time	Drive alone	Carpool	Transit
1	LA downtown	9.1	15.0	30	63.6	15.7	16.7
3	Santa Ana/Irvine	6.7	11.5	24	80.1	14.4	2.4
9	Pasadena	5.8	14.6	19	75.2	14.4	3.5
10	LAX	7.0	13.0	25	75.8	15.1	5.0
18	Rosemead	8.2	15.5	23	68.8	19.0	4.2
Total all centers		7.0	13.0	25	73.5	14.5	7.3
Total region		5.8	12.3	22	73.2	14.9	4.9

Our Los Angeles case study leads to the following conclusions. First, agglomeration economies at the intra-metropolitan scale continue to be a significant organizational factor in the space economy. In the context of substantial employment and population growth, structural change in the regional economy, and rising congestion, the share of employment in centers remains remarkably stable. If localized benefits of agglomeration were in decline, we would expect to see the share of jobs in centers decline significantly. One explanation for stability is historical path dependence. The structure of regions is established by structures and infrastructure with long lifetimes.

Second, differences in spatial patterns across the core, mature suburbs and newer suburbs, provides a complex picture of urban evolution. Employment has decentralized, but forces of both concentration and dispersion are evident. For Los Angeles, neither the simple concept of concentration or of dispersion is a good fit for what we observe. Empirical studies of other metropolitan areas suggest a more consistent story of decentralization and deconcentration. Los Angeles may indeed not be a prototype for the future, but rather may reflect its own history as an early 20th century polycentric region. The truth is that we don't know. The case of Los Angeles is highly suggestive that internal metropolitan dynamics are perhaps far more nuanced than is generally allowed in the existing literature. But given the evidence on the pervasiveness of polycentricity, we suspect that internal dynamics may be at work that are central to our understanding of metropolitan regions and all the variables we've been asked to consider in this report. We suggest that more case studies are in order to better understand urban evolution in the US and its implications for travel.

5. CONCLUSIONS

We summarize our observations from the literature review, and then close with some speculative discussion on future trends.

5.1 Conclusions from the Literature Review

The literature on metropolitan spatial patterns leads to the following conclusions. First, urbanization continues, with 80% of the US population residing in urbanized areas as of 2000. Second, based on county level BEA data, the distribution of population and jobs across metropolitan size categories has been relatively constant for several decades. Even using the new metropolitan definitions, we find no evidence of population shifts to small metro areas or to exurban areas. These trends suggest that large metropolitan areas will continue to hold the majority of both population and jobs and will remain the dominant feature of the US space economy. To the extent that rural households travel more and longer distances by private vehicle than urban households, this trend suggests reduced VMT.

Second, long term trends of population and employment decentralization and deconcentration within metropolitan areas are evident through 2000. Population and employment growth rates are higher in the suburbs than in central cities, so the central city shares of both declined. However, there is some evidence that the trend has slowed down in recent decades. Decentralization and deconcentration suggest more household travel, all else equal, and these trends are in part explained by reduced transport costs.

Beyond these general trends between central cities and suburbs is the question of sub-

metropolitan spatial distribution: is decentralization accompanied by deconcentration, or is there spatial clustering? Our third conclusion is that the empirical literature on employment centers provides extensive support for sub-metropolitan level agglomeration economies. Across a variety of identification methods and metropolitan areas, employment centers are found in both large and medium size metro areas. There are more centers in the largest metro areas, as would be expected. The role of the CBD differs across metro areas; New York and Boston stand out for their relatively large share of total employment; Los Angeles stands out for its small share. Lee's (2007) study suggests that where the CBD accounts for a larger share of total employment, it also accounts for most of the employment in centers: the share of employment in centers varies much less across metro areas than the CBD employment share.

Despite the presence of employment centers, most metropolitan employment is located outside of centers. The share of employment outside centers is in the range of two-thirds to three-fourths. Importantly, this does not mean however that today's metro areas are better described as dispersed. Some proportion of employment is population serving (e.g. retail, many services) and has been consistently located approximately with population. Unfortunately we have no historical data that would allow us to determine what proportion of employment was dispersed in earlier decades (the central city vs suburb comparisons are not sufficient).

The Los Angeles case study provides the most comprehensive longitudinal analysis of employment centers. It shows that 1) the share of employment in centers is stable over 20 years, 2) center employment has decentralized as formerly suburban areas gained employment and became more urbanized, 3) patterns of change are different for the core, inner suburbs, and outer suburbs, with the core relatively stable, inner suburbs undergoing concentration, and outer suburbs undergoing dispersion; 4) employment centers differ in size, density, industry mix, and population mix, suggesting different functions in the regional space economy, and 5) commuting patterns to jobs in centers is not very different from commuting to jobs outside centers, with the notable exception of the CBD.

Finally we note that data availability and spatial analytical techniques have limited our understanding of urban spatial structure. "Standard" practices that use high levels of aggregation and impose monocentricity produce results that suggest decentralization. But this is very aggregate in nature and cannot speak to how the decentralization is occurring. The employment centers-based research reveals a far more nuanced view of the factors that influence change in urban form – differences in industrial agglomeration and co-location, differences in functions, etc. Newer, more flexible methods allow the data to reveal significant local dynamics internal to metropolitan areas that add much to the discussion as to how cities are evolving.

How these complex intrametropolitan patterns affect travel is uncertain. As transport cost declines, it becomes a more attractive substitute. Hence individuals are willing to travel farther for a better job, bigger shopping center, or more authentic Chinese cuisine. The Horner (2007) and Yang (2008) studies suggest that commute distances have increased more than simple changes in spatial structure would require; this is consistent with declining transport costs. Yang also estimated travel cost parameters for each metro area, and found that they declined consistently over the two decade period. These studies (along with several earlier excess commuting studies not discussed in this paper) suggest that if transport costs increased, commute distances would decrease, holding constant urban structure. The Los Angeles case study shows that the median commute to jobs inside or outside centers is not very different, while commutes to specific employment centers vary according to their location within the region, the types of jobs they attract, and possibly the spatial configuration of the center itself.

5.2 Future Trends

The Committee has requested that we consider future trends in light of congestion, higher energy prices, land constraints, growth policies, and other factors. The theoretical portion of the literature review discussed the role of congestion in the formation of employment centers. Employment centers represent a willingness to pay for the external benefits of co-location. These benefits must outweigh the costs of higher rent, higher wages, and congestion. We would expect more specialization in the most dense, congested centers, as fewer types of economic activities realize sufficient net agglomeration benefits. Congestion affects travel demand as well. Since congestion is not evenly distributed within metro areas, it will deter travel to some destinations more than others. As metropolitan congestion increases, we should expect shifts of some activity to less congested places, and possibly emergence of new centers. Los Angeles and the San Francisco Bay Area may be examples of how congestion affects metro areas.

Higher energy prices have broad impacts, affecting heating and cooling, all forms of production, as well as transport costs. The impact of higher energy prices on urban form depends on the extent to which higher prices are offset by efficiency gains. In general we would expect more concentration – higher density and more co-location of workers and jobs. If history is a guide, however, higher energy prices are likely to be offset by further efficiency gains and hence have no significant impact on urban spatial trends – higher fuel prices are more likely to result in a shift to more fuel efficient vehicles than in travel behavior changes.. More generally, the resistance to dramatic changes in urban form due to energy prices is a function of two features of modern economies. First, incomes generally rise – and have risen dramatically since the last spike in energy prices – implying that energy becomes a smaller and smaller fraction of household budgets and a less significant influence on behavior. Second, the vast majority of what makes up urban form is prohibitively expensive to move. So while rents/prices may adjust, the locations of structures and infrastructure is relatively fixed, imposing an economic geography that may persist for some time.

What about public policy? Public policy has played an important role in reducing transport costs through highway building and low taxes, and in facilitating suburban expansion through housing finance, tax, and zoning policy. Public policy is offered as a key explanatory factor when comparing US urban spatial structure and travel patterns with those of other developed countries (Nivola, 1999; Pucher and LeFevre, 1996). However, decentralization and deconcentration is observed in major metropolitan areas throughout the developed world, suggesting that public policy is mediated by larger market forces (Giuliano, 1999, Bruegmann, 2005)

What about local planning and policy efforts? We noted in our introduction the extensive public policy efforts aimed at reversing current spatial trends. These include various types of development incentives and disincentives, decisions on infrastructure investment, growth boundaries, etc. Although zoning and growth control impacts have been extensively studied, our understanding of the effects of other local policies remains limited (Fischel 1989, 2004; Landis 2006). There is some evidence that growth controls, especially growth boundaries, tend to displace growth thereby augmenting dispersion (Nelson and Moore 1993; Jun 2004). We have anecdotal evidence of successful policy intervention, for example the revitalization of downtown areas in Boston, Chicago, and New York, but we also have examples of unsuccessful efforts, for example Detroit or Baltimore (Frieden and Sagalyn, 1991; Peiser and Schmitz 2007). Case studies of redevelopment efforts offer complex explanations of outcomes that include not only

market conditions, financial investments or zoning variances, but local leadership, governance structure and a host of other factors (Garvin, 1995). Portland's comprehensive growth management policies are considered by some to be exemplary, yet Portland's growth patterns do not yet appear to be substantially different from cities without such controls. It is possible that the impact of these policies will eventually become evident as the urban landscape continues to change. Agarwal is conducting research on the effect of local government policies on growth of employment centers in Los Angeles, and finds no significant relationship between various measures of growth promotion or growth controls and employment center growth. He has conducted the same analysis for all city employment growth and gets the same result.[4]

While there is little evidence to suggest that local land use or infrastructure policies influence employment growth, these policies may affect the local characteristics of that growth. We noted in our Los Angeles case study that employment centers differ with respect to density, population mix, and commuting patterns. We associate these differences with building and design practices: high capacity arterials, off-street parking, office parks, etc. vs small blocks and narrow streets. Garreau's (1991) description of edge cities emphasizes their structural differences from the conventional downtown.

We conclude with some suggestions for research that should improve our understanding of the evolution of US metropolitan areas. First, we suggest more detailed and fine grain study of metropolitan areas. The standard approach of comparing central city and suburb is not adequate for capturing the variation and complexity of contemporary metropolitan areas. Second, in light of this observation, systematic longitudinal studies are needed to better understand patterns of change within metropolitan areas. It is only through such studies that the foundations for location choice can be illuminated. Ultimately, it is the aggregation of the choices of households and firms that manifest themselves as the urban form we're trying to understand. Finally, we need a better understanding of the role of public policy, particularly at the local and regional level, to influence land use patterns.

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Appendix A

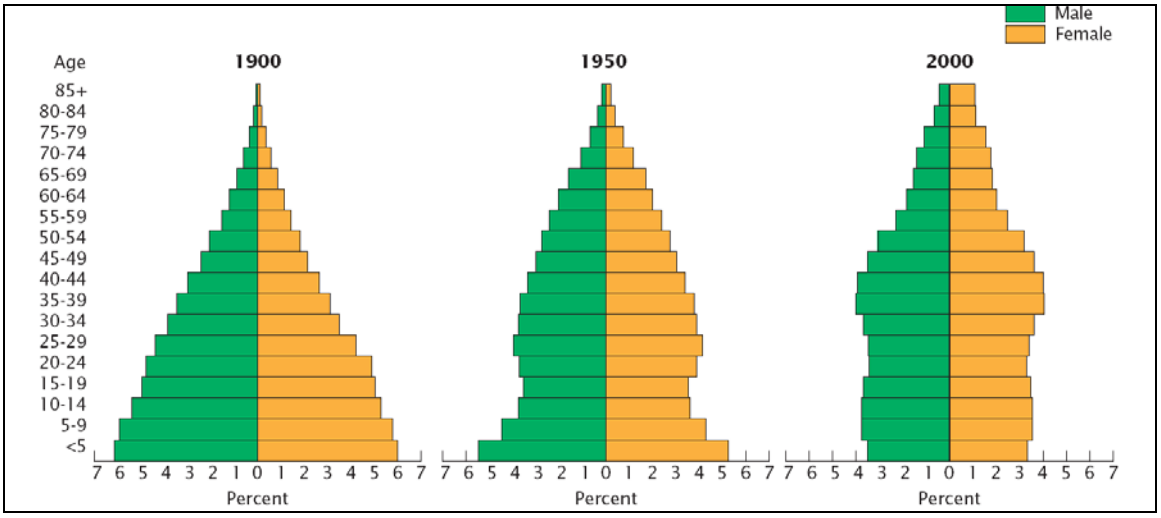
Summary of U.S. Population Trends

There are three major trends in U.S. population demographics: aging of the population, increase in single person households, and increasing foreign immigration. These trends are briefly summarized.

A.1. AGING OF THE U.S. POPULATION

Over the past century, the age distribution of the U.S. population changed from relatively young to relatively old. The U.S. has experienced rapid population "aging" during the later half of the past century (Shreshtha, 2006).[5] The median age of the U.S. population increased from 28 years in 1970 to a record high of 35 years in 2000 (U.S. Census Bureau, 2002).

Changes in the U.S. age structure over the past century may be illustrated by population pyramids where each bar represents the percentage of the population in each age-sex group (Figure A-1). Figure A-1 shows the overall shift in the population pyramid from a classical pyramid shape at the beginning of the century to a more rectangular shape based on the 2000 census, which is indicative of aging of the population. The ages 35-54 year bulge in the 2000 distribution depicts the baby-boom generation. The larger proportions of the population in the older age groups result in part from sustained low fertility rates and declines in mortality at older ages during the latter part of the century (U.S. Census Bureau, 2002).



Source: U.S. Census Bureau, 2002.

FIGURE A-1 Age and sex distribution of the total population.

[5] Aging of population is a process in which the proportions of adults and elderly increase, while the proportions of younger persons decrease, resulting in a rise in the median age of the population.

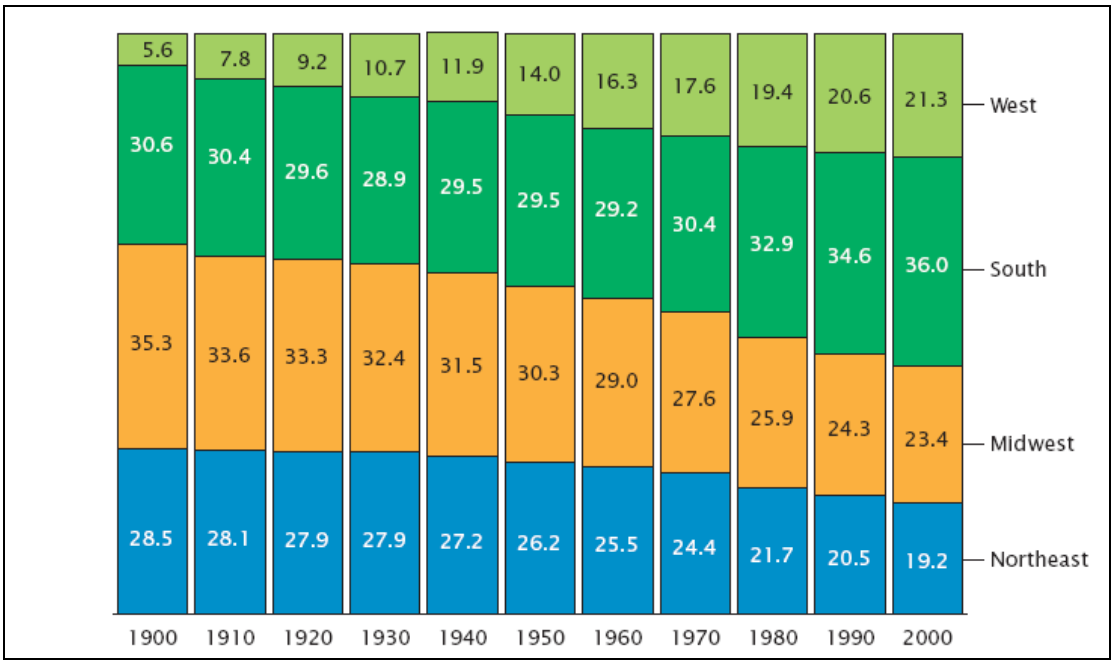
Between 1980 and 2000, the population aged 65 years or older increased from 25.5 million (11.3 % of the total population) to almost 35 million, 12.4% of the total population (U.S. Census Bureau, 2002). A more rapid growth of population aged 65 years and older will begin in 2011 when the first of the baby-boom generation will reach the age of 65 years, a trend that will continue for many years. The older adult population is not equally distributed across the U.S. The most popular destinations for retirees have been Florida, California, Arizona, Texas, and North Carolina (Longino and Bradley 2003).

A.2 DECREASING HOUSEHOLD SIZE AND CHANGING STRUCTURE

The number, size, types, age, sex, and racial composition of households in the U.S changed significantly during the later decades of the past century. Reasons include women having fewer children, increased mobility of the population, affordability of homes, and the overall increase in the racial and ethnic diversity of the U.S. population.

During the past century, average household size declined from 4.6 to 2.6, a 44 percent decrease (U.S. Census Bureau, 2002). Between 1950 and 2000, the proportional share of one-person households increased significantly: from 9.5 to 26 percent of all households. In 2000, more than half of the U.S. population lived in households comprised of one, two, or three persons. The steepest decline in average household size occurred in the 1970s, a period coinciding with the end of baby-boom and relatively low levels of immigration. The smallest decline in average household size occurred in the 1990s due mainly to higher immigration levels and the tendency for immigrants to live in larger households.

The growth of households differed by region, altering each region's proportional share of the total number of U.S. households. The number of households in the West has grown rapidly increasing their share of all households during the past century (see Figure A-2). The share of



Source: U.S. Census Bureau, 2002.

FIGURE A-2 Distribution of households by region: 1900 to 2000 (percent).

U.S. households in the Northeast and Midwest generally declined while the South's share of households declined during the first part of the century, remained stabile during the mid-century, and then increased in the later periods.

Female-maintained households represented an increasing proportion of all U.S. households from 1970 to 2000 (U.S. Census Bureau, 2002). In 1970, women represented about 21 percent of all householders in the United States. By 2000, their share had grown to more than 36 percent.

A.3 GROWTH OF IMMIGRANT POPULATION

Immigration is a robust source of population growth in the U.S. The number of immigrants living in the U.S. has been increasing steadily since 1970 as measured by the size of the foreign-born population in decennial censuses. Fueled primarily by immigration from Latin America and Asia, the foreign-born population grew from 9.6 million in 1970 to 19.8 million in 1990 (Passel and Suro 2005). In the last decade of the 20th century the numbers jumped dramatically by 57% to 31.1 million in Census 2000. In 2000, there were 12.1 million foreign-born households in the U.S. (Myers and Liu 2004). Immigrants accounted for more than third of the population increase that occurred in the 1990s (Homeownership Alliance 2004). As many immigrants who arrive in the U.S. are young adults, they actually offset the possible population loss in this age bracket caused by the baby-bust generation (Myers and Liu 2005).

Foreign-born households constitute increasingly large shares of total households in the U.S.: 11% in 2000 (Myers and Liu, 2005). In the 1990s, immigrants accounted for 32% of all household growth and 67% of all rental growth nationwide. In California and New York, immigrants accounted for 100% of all rental growth and over half of all growth in owner-occupied housing during the same period.

The considerable growth of foreign-born population and households is not evenly distributed across the U.S. Different regions and areas host different numbers of immigrants (Myers and Liu 2005). In 2000, more than one-half of the foreign-born population lived in just three states – California, New York, and Texas – or in 10 metropolitan areas (U.S. Census Bureau 2003).

Appendix B

Glossary of Terms[6]

Metropolitan Area. The general concept of a metropolitan area (MA) is one of a large population nucleus, together with adjacent communities that have a high degree of economic and social integration with that nucleus (as measured by commuting to work). Some MAs are defined around two or more nuclei. Each MA must contain either a place with a minimum population of 50,000 or a U.S. Census Bureau-defined urbanized area and a total MA population of at least 100,000 (75,000 in New England). An MA contains one or more central counties. An MA also may include one or more outlying counties that have close economic and social relationships with the central county. In New England, MAs consist of groupings of cities and county subdivisions (mostly towns) rather than whole counties.

Central City. In each metropolitan statistical area and consolidated metropolitan statistical area, the largest place and, in some cases, one or more additional places are designated as ‘‘central cities’’ under the official standards. A few primary metropolitan statistical areas do not have central cities. An MA central city does not include any part of that place that extends outside the MA boundary.

Consolidated and Primary Metropolitan Statistical Area (CMSA and PMSA). If an area that qualifies as a metropolitan area (MA) has 1 million people or more, two or more primary metropolitan statistical areas (PMSAs) may be defined within it. Each PMSA consists of a large urbanized county or cluster of counties (cities and towns in New England) that demonstrate very strong internal economic and social links, in addition to close ties to other portions of the larger area. When PMSAs are established, the larger MA of which they are component parts is designated a consolidated metropolitan statistical area (CMSA). CMSAs and PMSAs are established only where local governments favor such designations for a large MA.

Metropolitan Statistical Area (MSA). Metropolitan statistical areas (MSAs) are metropolitan areas (MAs) that are not closely associated with other MAs. These areas typically are surrounded by nonmetropolitan counties (county subdivisions in New England).

Urbanized Area (UA). An urbanized area (UA) consists of densely settled territory that contains 50,000 or more people. At least 35,000 people in a UA must live in an area that is not part of a military reservation.

Suburban. The U.S. Census bureau does not identify a place as “suburban,” rather it divides a metropolitan area into “inside central city” and “outside central city.” While many researchers treat the area “outside central city” as suburban, others tend to be more subjective.

[6] Census definitions (source: www.census.gov).