

Giuliano, Genevieve; Redfearn, Christian

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Not all sprawl - Evolution of employment centers in Los Angeles, 1980-2000

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NOT ALL SPRAWL:

EVOLUTION OF EMPLOYMENT CONCENTRATIONS IN LOS ANGELES, 1980 - 2000

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Genevieve Giuliano

Christian Redfearn

with

Ajay Agarwal, Chen Li, and Duan Zhuang

School of Policy, Planning and Development

University of Southern California

Los Angeles, CA 90089-0626

giuliano@usc.edu

ABSTRACT: Are contemporary metropolitan regions becoming more dispersed? There are theoretical arguments for both concentration and dispersal. The purpose of our research is to establish an empirical base that can help us understand the evolution of metropolitan spatial structure. Using data for the Los Angeles region from 1980, 1990 and 2000, we identify employment centers and describe spatial trends in the pattern of employment inside and outside these centers. Our findings point to three trends: 1) a remarkable degree of stability in the system of centers; 2) a marked spread in the average distance of jobs from the traditional core; 3) emergence and growth of suburban employment centers. Thus decentralization is not simply dispersion, but rather both deconcentration and concentration. These trends appear to defy simple models of urban evolution and call for a more nuanced portrayal of the dynamics underlying these trends.

Key Words: Employment center, urban structure, urban development

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I. Introduction

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.

Our contribution to the discussion is empirical. We establish a set of results on the spatial distribution of employment within the greater Los Angeles urban area over a twenty year period of pronounced change in terms of both total number of jobs and the many variables that influence firm location choice: transportation and communication costs, land prices, etc. Polycentricity of the region in 1980 is well documented (Giuliano and Small, 1991; Heikkila et al, 1989; McMillen, 2001; Forstall and Greene, 1997, among others). We examine employment trends from 1980 to 2000 in order to determine whether the region has undergone significant spatial transformation. We identify employment centers in 1980, 1990 and 2000, and so are able to describe their emergence, growth, and, occasionally, their decline. We find evidence of both concentration and deconcentration; the region remains polycentric, but centers outside the traditional core are growing faster than the core itself; employment growth in the older suburbs is concentrating, while employment growth in the newer suburbs continues to disperse.

The remainder of this paper is organized as follows: In Section II, we briefly review the literature on employment concentration and the formation of employment centers. We then discuss methods for identifying employment centers, and the empirical evidence of intra-metropolitan evolution. In Section III, we describe our methodology and data. We then present our results in Section IV. The paper concludes with a discussion of the implications of our findings.

II. Trends in Urban Form

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 subcenter formations within metropolitan areas. The overlap between the two areas is substantial, and understanding both is important for placing our results in context.

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. Of course, no discussion of employment density would be complete without addressing transportation costs.

Concentration & 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.

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, the complexity of many aspects of knowledge-based activity creates the need for face-to-face communication, and

expert managers to control and direct information flows from central locations. Creativity and innovation 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. Large cities also have the densest transport and communications networks and generally best access to global networks. (Graham and Marvin, 1996).

Third, industry restructuring favors agglomeration. In a world of flexible production, subcontractors must be in continuous contact with existing and prospective customers to compete for and secure business (Scott, 1988). 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). Finally, it is argued that major cities have the advantage of being cultural and educational centers as well as destinations for consumption activities.

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.

It is further argued that people’s preferences for 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 (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; Granger and Bloomquist, 1999, Halstead and Deller, 1997).

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, 1996; Lang and Lefurgy, 2003).

Concentrations of Employment within a Metropolitan Area

Contemporary metropolitan areas are characterized by decentralized employment of two forms; some dispersed in concert with the population, and some clustered in "centers." In this paper, we use 'employment center' to denote a site of significant geographic concentration of economic activity, including the CBD. In the context of standard urban economic theory, employment centers are formed for the same reasons that were initially responsible for formation of the CBD i.e. agglomeration economies, internal and external scale economies of production, and diseconomies of transportation (congestion). As a metropolitan area grows, the existence of employment centers is more likely. Over time, the size of the CBD grows to a point where the negative externalities (congestion costs, land prices) outweigh the positive externalities of locating in the CBD. Not only might new firms then choose to locate outside the CBD, but existing firms may choose to relocate as well. Firms that realize agglomeration benefits will tend to cluster in another location outside the CBD, eventually forming a new employment center. However, some firms value agglomeration or clustering less than others and may tend to locate outside centers. To the extent that industry sectors that value agglomeration grow less than other sectors, more dispersion would result.

Helseley and Sullivan (1991) argue that development of an employment center outside the CBD begins when transportation diseconomies reduce the social value of labor in the CBD to the point at which the social value of labor in the employment center exceeds the social value of labor in the CBD by the fixed cost of employment center infrastructure.

What are the reasons that make certain locations attractive for firms to cluster, creating employment centers? One view is that employment centers emerge as a result of the decision making of local governments, including tax and land-use policies (Fujita, 1989; Sullivan, 1986; Zhang and Sasaki, 1997, 2000). Another is that private developers facilitate migration of firms, and hence play an important role in the creation of employment centers (Henderson and Mitra, 1996; Anas et al, 1998). Anas et al (1998) argue that both developers and local governments play a critical role in the formation of new employment centers. The underlying assumption here is that there are several rival developers, each competing for some strategic location. Government intervention then could become the key factor in deciding the new location. Intervention could come in the form of land use regulation, providing infrastructure at certain specific locations, or providing subsidies to developers and/or to firms for relocation at specific locations, etc.

Chen (1996) demonstrates that an exogenous change in transportation technology could result in employment center formation, as lower transportation costs and a decrease in agglomeration economies will loosen ties to the central city. Anas et al, (1998) argue that spatial heterogeneities, such as climate and access, can also be a factor in the formation of multiple employment centers of varying size and characteristics. Additionally, location of a firm may depend on idiosyncratic preferences of entrepreneurs, knowledge-workers, chief executive officers, or others involved in decision making.

As noted in the previous section, there are conflicting notions regarding the value of agglomeration economies in the contemporary economy. Gordon and Richardson (1996) argue that metropolitan areas have moved “beyond polycentricity” and the emerging urban form is generalized dispersion. 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. Most edgeless cities are not edge cities “waiting to grow up”, but rather a new form of spatial dispersion. The emerging spatial structure is interspersed employment and population without formation of any discernable ‘center,’ a consequence of the factors cited above.

Empirical Support

The primary challenge facing researchers who would test these theories is the lack of appropriate data on intra-metropolitan employment concentrations. There is extensive evidence that larger U.S. cities have already become polycentric, including empirical studies of Los Angeles (Giuliano and Small, 1991), Cleveland (Bogart and Ferry, 1999), Chicago (McMillen and MacDonald, 2001) and San Francisco (Cervero and Wu, 1997) that use various versions of center definitions based on total jobs and job density. Polycentricity has also been empirically demonstrated via polycentric density gradient estimation for Los Angeles (Gordon et al, 1986; Small and Song, 1994, Heikkila et al, 1989) and for Chicago (McDonald and Prather, 1994).

There have been numerous longitudinal studies testing the monocentric model on population density, and the historical trend of decentralization is well documented.ⁱ However, longitudinal studies of polycentricity are limited. Small and Song (1994) use Los Angeles region data for 1970 and 1980, and find the polycentric model a better fit relative to the monocentric model in 1980. Coffey and Shearmur (2002) compare the Toronto, Montreal, Vancouver, and Ottawa-Hull metropolitan areas using 1981 and 1996 census tract level place of work data. They find that the central business district has declined in relative, but not, absolute importance and conclude that agglomeration economies continue to play a significant role in intra-metropolitan location.

Urban geographers have written extensively on the nature and evolution of modern suburbs (e.g. Baerwald, 1978; Erickson, 1983; Berry, 1981). This work is qualitative in nature, and typically uses detailed historical case studies to test an evolutionary model of urban development. In sum, while polycentricity of some of the largest North American cities has been demonstrated, there has been little empirical work on changes in polycentricity over time, or on trends of deconcentration or dispersion.

III. Research Approach, Methodology, & Data

The purpose of our research is to establish empirical evidence of trends in the spatial distribution of employment from 1980 to 2000. If, for example, advancements in communication technology and lower transportation costs are indeed reducing the need for clustering, then we should see an overall reduction in employment concentration i.e. fewer or less dense employment centers. But, what if the opposite is true and there is an increase in the number of employment centers? Does this imply that certain sectors still value clustering and that these sectors are growing enough to be able to create centers? Do more but less dense centers imply that

agglomeration is indeed active, but better communication facilities and cheaper transportation have broadened the spatial scope of agglomeration economies? And can we explain differences in growth among centers, or emergence of new centers?

The Los Angeles Region

We answer these questions using data from the Los Angeles consolidated metropolitan statistical area (CMSA). Specifically, we measure the regional employment distribution across the CMSA in 1980, 1990 and 2000 – identifying concentrations of employment for each cross-section – and examine the evolution of these employment centers over the three sample periods. We conduct a series of comparisons and tests to determine whether employment patterns in the region are becoming more or less concentrated.

The Los Angeles Region is ideal for studying metropolitan spatial trends. Giuliano and Small (1991) identified 32 employment centers in the Los Angeles region in 1980. Much has happened since then: communication technology has advanced significantly, computing power is now much greater than before, services and information processing increasingly dominate the U.S. urban economy, U.S. firms now have a much broader international orientation, and so on. The Los Angeles region has grown substantially in terms of population and employment. Since 1980 the region has added 1.86 million jobs and 4.58 million persons. Suburbs extend from Ventura County in the west to the deserts of San Bernardino County. The region's highways and airports have become ever more congested. Given changes of this magnitude, it is appropriate to ask whether the employment centers of 1980 still exist, whether dispersion is the dominant trend, or whether the region remains polycentric.

Having grown rapidly in the post-WWII era, several waves of suburban development have occurred. The central core of the region is Los Angeles County south of the Santa Monica Mountains; it developed prior to 1950. Rapid post-war growth and construction of the freeway system in the 1950s and 1960s generated rapid growth of bedroom suburbs in the San Fernando Valley and Orange County. Residential growth continued to move outward in the 1970s and 1980s to San Bernardino and Riverside Counties, and, more recently, to the eastern portions of Ventura County (see Figure 1).

Identifying Employment Centers

In theory, identifying centers in a polycentric area is straightforward: any employment cluster that independently influences land values (and hence employment and population

distributions) 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. In practice, they are neither convenient circles nor ellipses; nor are they independent – two or more centers may influence land prices in any one location. In some cases major freeways define linear concentrations. It is therefore not surprising that in empirical research employment centers have been defined in many different ways, with a distinct trend toward more complex specifications as data availability and computing power have improved.

Employment centers can be defined in both absolute and relative terms. Giuliano and Small (1991) use an absolute definition: an employment center is a relatively compact geographic area containing a “sizeable” employment base. McMillen (2001) defines employment center as a “site (1) with significantly larger employment density than nearby locations that has (2) a significant effect on the overall density function.” (p.448)

Giuliano and Small (1991) use an absolute measure based on total employment and employment density. They argue that a relative measure would exclude some larger centers in the core area. A major criticism of the Giuliano and Small approach is its arbitrariness: the more stringent the cutoff, the fewer centers will be identified. Absent some formal estimation of density or land value gradients, there is no way to determine whether the center fulfills the theoretical requirement of influence on the employment or land value distribution. That said, their approach has held up well, becoming the benchmark for other approaches (Redfearn, 2004). McMillen (2003) surmises “their procedure has so far proved the most popular” ...and... “non-parametric estimation procedure allows the cut-off points for employment density to vary both within and across cities, whereas researchers using the Giuliano and Small procedure typically let local knowledge and *a priori* expectations determine the choice of cut-off points” (pp 57, 58).

Several more recent efforts have been aimed at developing more flexible parametric forms to capture suburban concentrations. These include use of locally-weighted regression to smooth the density surface (McMillen and McDonald, 1997); two-step methods to identify center peaks from a set of candidate peaks (McMillen and McDonald, 1998; McMillen 2001); and contiguity matrices (McMillen, 2003). Other approaches include variants on gradient estimation to identify potential centers (Heikkila et al, 1989; Small and Song, 1994), and estimations of spline functions (Baumont, Ertur, and Le Gallo, 1999; Craig and Ng, 2001; Muniz, Galindo, and Garcia, 2003).

These varied approaches have both advantages and disadvantages, and none escape some degree of judgment on the part of the researcher. The simple parametric forms arose when both data and computing power were limited. More functional forms are now possible to estimate (the negative exponential can be derived as the “correct” functional form given some assumptions about utility), but it has not been common to compare these forms against more complex urban models. Moreover, gradient estimations typically begin with a set of candidate centers which are identified arbitrarily. Spline functions test for peaks along directional rays, but at what point a peak is sufficiently large to be considered a “center” is again subject to judgment, and are the results dependent on the choice of rays? The parametric approaches offer ease of computation and coefficients that can be readily compared, but these models fair poorly in a complex metropolitan area like Los Angeles. For example, models are subject to specification error when the locations of multiple candidate centers are spatially correlated. The fully flexible, nonparametric, approaches may best map a polycentric employment density surface, but once estimated how are trends gleaned from them? The mixed approaches strike a balance, but here too arbitrary are decisions made; for example, one must choose the window size and kernel when estimating a local weighted regression. There is no general consensus on a “right” way as yet, reflecting both the challenge of measuring the complexity of urban areas and the evolving set of options available to researchers.

After considering various methods of identifying employment centers, we use the simple but robust Giuliano and Small (1991) method.ⁱⁱ This allows us to compare our results directly with the earlier work. Giuliano and Small define a center as a cluster of contiguous zone having a minimum employment density of D , and together containing total employment of at least E . D and E cutoffs are expressed as ‘D-E’ from here on; for example ‘10-10’ corresponds to $D = 10$ jobs/acre and $E = 10,000$ jobs. We conducted sensitivity analyses by using different combinations of cutoffs including 10-10, 12-12, 15-15, and 20-20. Interestingly, changing cutoff values from 10-10 to 12-12 did not change our results substantially. Higher cutoff values produced more or less similar results until raised to 20-20. We therefore concluded that 10-10 and 20-20 are reasonable lower and upper limits for cutoffs, and present results for both.

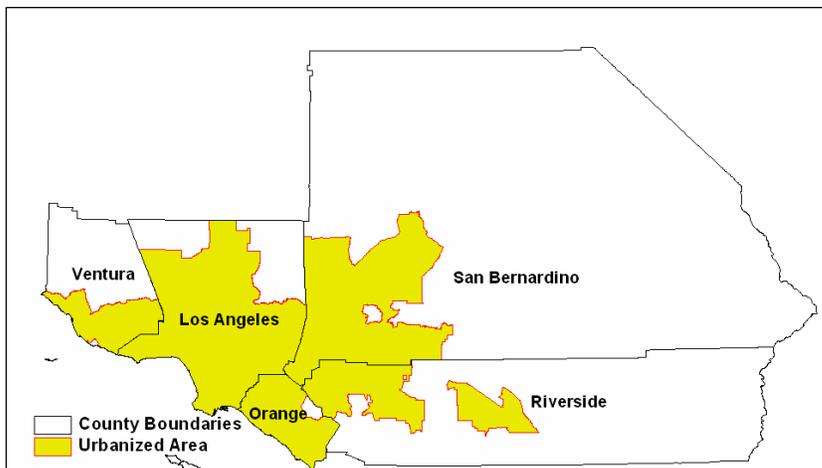
Contiguity of geographic units also must be addressed. Giuliano and Small (1991) defined contiguity as having at least 0.25 miles of common boundary between two census tracts. However, the definition is arbitrary, and even more so in the case of historical data. For our

study, we convert 1980, 1990 and 2000 data into the same geography. It is difficult to justify a definition based on the particular characteristics of the selected geographic units. We ultimately decided to define two zones as contiguous if they share any common boundary.

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 1). 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.ⁱⁱⁱ These large but almost empty tracts contain a small fraction of the region's population and employment, and could not reasonably be expected to include employment centers.

Fig 1 Los Angeles Region Urbanized Area



Maintaining a consistent geography across the three analysis years - 1980, 1990, and 2000 - is essential for valid comparison. We chose 1990 census tracts as our unit of analysis, and converted all the data to 1990 census tract geography.^{iv} There are 2,474 tracts covering a total area of about 5 million acres (just under 8,000 square miles).

A brief summary of regional employment and population trends will help to place our results in context. Table 1 gives employment and population, by county, for the Urbanized Area. Over the entire period, employment increased from about 5.4 million to about 7.3 million (35%), and population increased from 11.2 to 15.8 million (41%). Growth was uneven both across the decades and across counties. Population and employment growth was more rapid 1980 – 1990 than 1990 – 2000, and while employment increased more than population 1980 – 1990, the

reverse was true 1990 – 2000. 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, 1990 – 2000. 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.

Table 1 Employment and Population by County, Urbanized Area

County	1980		1990				2000			
	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	0.60	27.7	0.31	24.0	0.68	13.3
Total	5.39	11.19	6.87	27.5	14.01	25.2	7.24	5.4	15.78	12.6

IV. Results

We present our results in two parts. First, we discuss general regional trends in employment density. Then we discuss employment centers identified under the 10-10 and 20-20 criteria.

Trends in Employment Density

The simplest measure of concentration is the distribution of regional employment. Because we are using constant boundaries, average employment density must increase as employment increases. However, the distribution of that employment can take many forms. Table 2 shows the share of employment contained in the 10 percent of land area that contains the highest employment density for the region and for each county (census tracts were rank ordered on employment density). Employment is highly concentrated in the region; that is, the densest tracts contain the vast majority of all jobs. However, share of jobs contained is decreasing over time. Los Angeles County is the exception, with the share of jobs rather stable from 1990 to 2000. Table 2 does not tell us about spatial distribution, but rather about density distribution.

Table 2 Share of Jobs Contained In The Densest 10 Percent Of Land Area

	1980	1990	2000
LA County	69.6	64.0	65.5
Orange	59.7	53.7	51.6
Riverside	85.4	62.4	59.3
San Bernardino	94.5	79.5	78.9
Ventura	66.6	66.9	63.1
All	83.5	74.5	71.1

Table 3 shows the share of total urbanized area employment inside tracts with employment density less than 10, between 10 and 20, and 20 or more jobs/acre. The share of jobs located in tracts with less than 10 jobs/acre increases slightly over the period. There is little change in the other two categories despite the significant increase in total employment over this 20-year period. The results presented in the table are consistent with deconcentration, but the changes are small in magnitude.

Table 3 Share of Total Metropolitan Jobs (Percent)

Tracts	1980	1990	2000
Less than 10 jobs per acre	54.3	56.4	57.7
Between 10 and 20 jobs per acre	24.2	24.5	22.3
20 or more jobs per acre	21.5	19.1	20.0

Polycentricity complicates simple measures of dispersion and concentration. One basic measure of the spatial distribution of employment is the average distance of all jobs to the region's historic center, defined as the peak zone of the Los Angeles downtown area. The evolution of this metric is reported in the first row of Table 4. The average distance of all jobs increases substantially, suggesting decentralization.

We also calculate the average distance of high density zones from the historic center. Distances are calculated from tract centroids. We use two measures, simple linear distance, and distance weighted by employment. In all cases, the average distance increases. That is, employment concentrations are decentralizing. The trend is most pronounced for the weighted distance of tracts with more than 20 jobs per acre. Note that in 1980 the average weighted distance is a little more than 8 miles, indicating a remarkable degree of concentration around the

historic core, given the size of the region. The average distance increases about 70% by 2000. The spatial distribution of employment concentrations has shifted outward from the center, in concert with the overall decentralization of employment.

Table 4 Average Distances of Jobs and Tracts to Los Angeles Downtown Center

	1980	1990	2000
All Jobs	18.64	23.30	25.78
All tracts with > 10 jobs/acre			
Unweighted	11.79	14.91	16.28
Weighted	12.73	14.90	16.61
All tracts with > 20 jobs/acre			
Unweighted	9.12	13.16	15.36
Weighted	8.33	10.57	14.00

4.2 Employment Centers

This section examines trends in employment centers using the two criteria described above.

The Evolution of the System of “10-10” Centers

Using the 10-10 cutoff criteria, 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 are shown in Figures 2 through 4. The centers are numbered in rank order. As noted earlier, we decided to strictly accept contiguity of tracts, and as a result we have one “mega-center” in 1980 that spans an arc along the Wilshire Corridor from East Los Angeles to Santa Monica (center 1 in Figure 2). We call this the “main center”, and it encompasses the traditional Los Angeles downtown, as well as Hollywood, West Los Angeles, and Santa Monica. In 1990 a small portion of the main center breaks off and becomes an independent center to the east of the CBD (center 32, Figure 3). The main center splits approximately in half in 2000, with Santa Monica-Westside becoming an independent center (center 2, Figure 4). Break-up of the main center is the result of employment losses. The second largest center in 1980 is “Santa Ana/Irvine”, located along SR 55 and I-405 (center 2). In 1990, one piece breaks off to join a new center (center 24 Santa Ana), and the remainder expands to include the South Coast Plaza area (center 33 in 1980). Visual inspection of Figures 2 through 4 reveals emergence and growth of centers to the east and southeast, and to a lesser extent the northwest of the central core.

Figure 2 10/10 Centers 1980

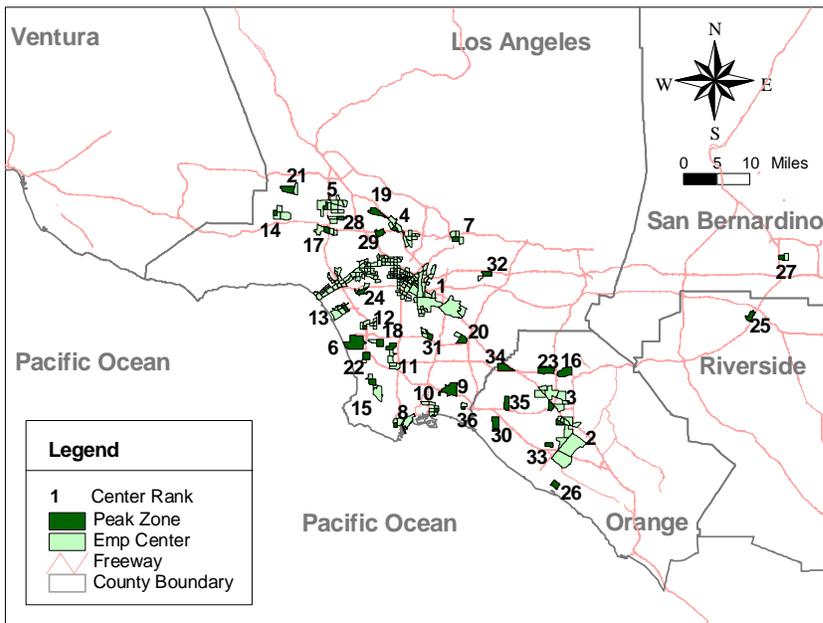


FIG 3 10/10 CENTERS 1990

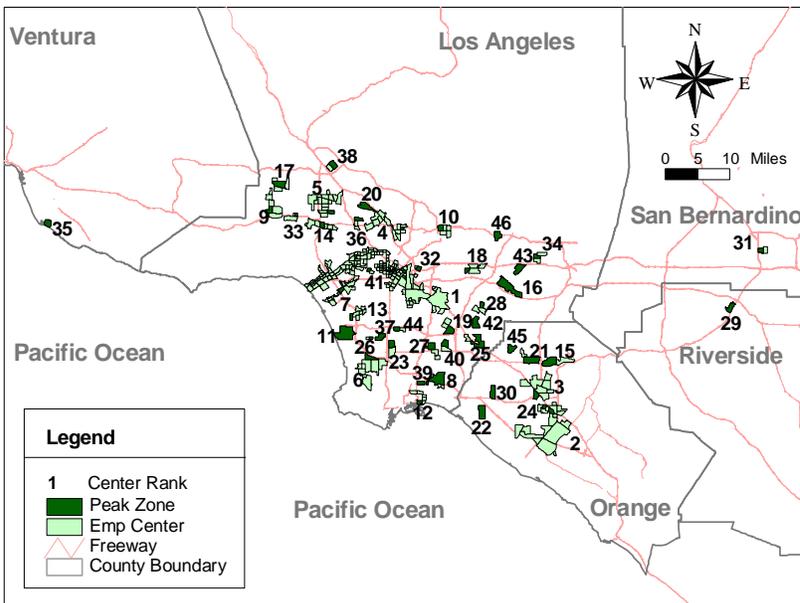


FIG 4 10/10 CENTERS 2000

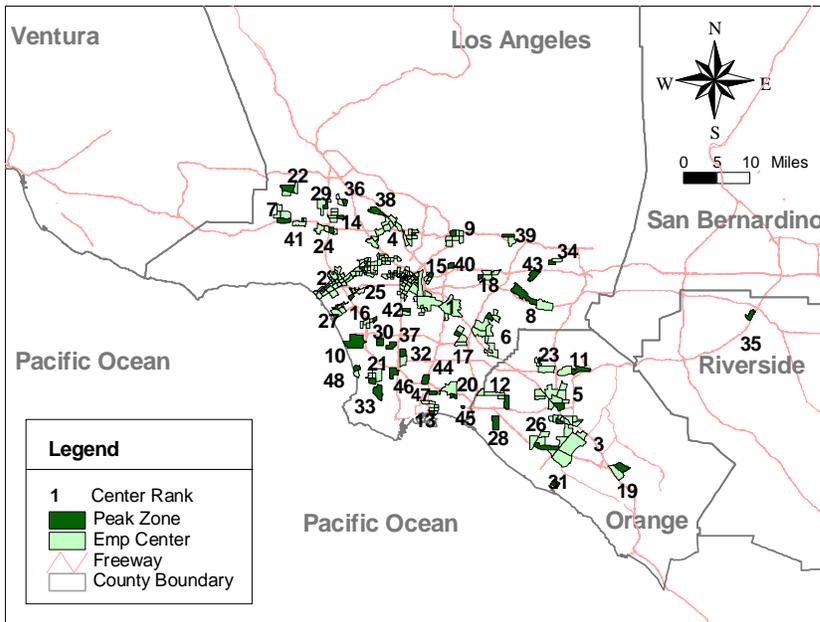


Table 5 Selected Characteristics of 10-10 Centers

	1980	1990	2000
N of centers with 10 – 20K jobs	15	21	20
N of centers with >20 – 50K jobs	15	15	18
N of centers with >50 – 100K jobs	4	6	5
N of centers with >100K jobs	2	4	5
Max jobs (1,000's)	1,074	1,022	558
Range of size (acres)	426 -- 35,188	356 -- 34,406	105 -- 17,949
Range of density (jobs/acre)	10.09 -- 30.51	11.3 -- 57.97	11.27 -- 104.64

The centers' characteristics are quite varied, with a few very large centers and many smaller centers. Table 5 gives selected characteristics of centers. There is a "rank size" effect, in that there are only a few very large centers. The centers with over 100,000 jobs are the LA main center and Santa Ana/Irvine in 1980 (centers 1 and 2 in Figure 2). Anaheim and Burbank/Glendale emerge as large centers in 1990 (centers 3 and 4 in Figure 3); the center formed from the split of the LA main center in 2000 accounts for the fifth large center (centers 1 and 2 in Figure 4). The range of employment density increases, as some rather unique single tract centers reach the minimum employment threshold.

Table 6 gives information on total employment and employment shares, inside and outside centers, by county, under the 10-10 criteria. Recall that we consider the LA main center to include the corridor from LA downtown to Santa Monica. Turning first to the upper half of the table, total employment in centers has increased along with the number of centers. In 1980 the LA main center is remarkably dominant, accounting for nearly half of all employment in centers (and 20% of the region's employment). The LA main center loses both in absolute number and share of jobs in centers over the period, but still accounts for more than a third of jobs in 2000 (combining the two centers that emerged from the break-up).

Of the 10 new centers in 1990, 9 emerge in LA County. In 2000, there is one new center in LA County, and one in Orange county; one center in the other counties disappears. Patterns across the counties are quite different. Total employment in centers in LA county increases 1980 to 1990, then decreases 1990 to 2000. Center employment in Orange County nearly doubles 1980 to 2000, hence gaining regional share. In contrast, center employment in the other counties, which accounts for less than 2 percent of all employment in centers, rises and then falls. Finally, employment in centers as a share of total regional employment declines only slightly over the period.

Turning now to the lower half of the table, the dominance of LA County in terms of employment outside centers in 1980 is evident. In fact, in 1980 LA County center employment accounts for one third of the region's total employment, and LA County's total employment accounts for nearly $\frac{3}{4}$ of the regional total. By 2000, the percentage shares are 28 and 61 respectively. The greatest amount of employment growth outside centers took place in the other counties, while the Orange County share remained steady.

Table 6 presents a mixed picture of centralization and decentralization. If we look at each county, the pattern becomes clearer (see Table 7). The share of employment in centers remained steady in Los Angeles County, increased in Orange County, and decreased from an already small base in the other counties.

Table 6 10-10 Employment Centers Summary Table

Area	1980			1990			2000		
	N	Emp	Share	N	Emp	Share	N	Emp	Share
Within Centers									
LA main	1	1,073,690	49.4	1	1,021,912	38.0	2	985,142	36.3
Rest of LA Co.	25	736,407	33.9	34	1,111,579	41.4	37	1,065,156	39.2
Total LA Co.	26	1,810,097	83.3	35	2,133,491	79.4	38	2,050,298	75.5
Orange Co.	8	335,365	16.0	8	509,926	19.0	9	652,593	24.0
Other counties	2	28,230	1.3	3	44,070	1.6	1	14,674	0.5
Total centers	36	2,173,692		46	2,687,487		48	2,717,565	
Center share of region total			40.3			39.1			37.5
Outside centers									
		Emp	Share		Emp	Share		Emp	Share
LA Co.		2,123,614	66.1		2,463,883	58.8		2,393,120	52.9
Orange Co.		580,021	18.0		793,193	18.9		861,738	19.0
Other counties		510,730	15.9		930,113	22.2		1,269,099	28.1
Total not in centers		3,214,365			4,187,189			4,523,957	
Region total		5,388,057	59.7		6,874,676	60.9		7,241,523	62.5

The Evolution of the System of “20-20” Centers

Using the 20-20 cutoff criteria, 10 employment centers were identified in 1980, 13 in 1990 and 15 in 2000. The centers are shown in Figures 5 through 7. The centers are numbered in rank order. All of the 1980 centers are in Los Angeles County; Orange County has 2 in 1990 (centers 10 and 13) and 3 in 2000 (centers 4, 7, 9). No centers are identified in the other counties. Raising the criteria to 20-20 not only eliminates the smaller centers, but also eliminates some of the larger clusters of employment with lower average density, for example Santa Ana/Irvine in Orange County, which does not appear until 1990. The maps show quite clearly the dominance of the LA main center in 1980. The more restrictive criteria “breaks up” the main center, with 5 centers forming a crescent from LA downtown to Santa Monica (centers 1, 2, 4, 5, 6). While some version of that crescent remains in 1990 and 2000, the new centers emerge to the north and southeast of the main center.

Table 7 Percent Share of Employment In 10-10 Centers

	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

FIG 5 20/20 CENTERS IN 1980

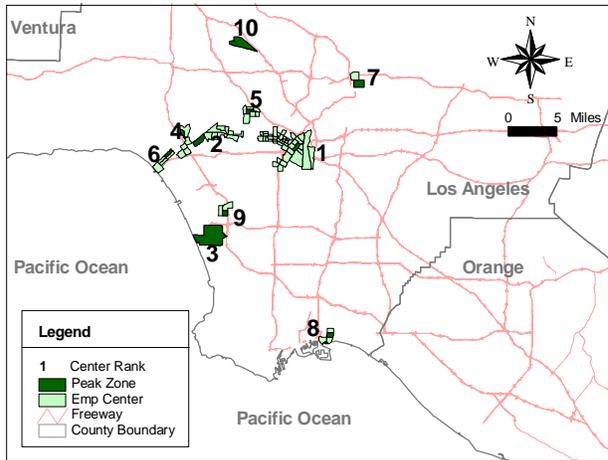


FIG 6 20/20 CENTERS IN 1990

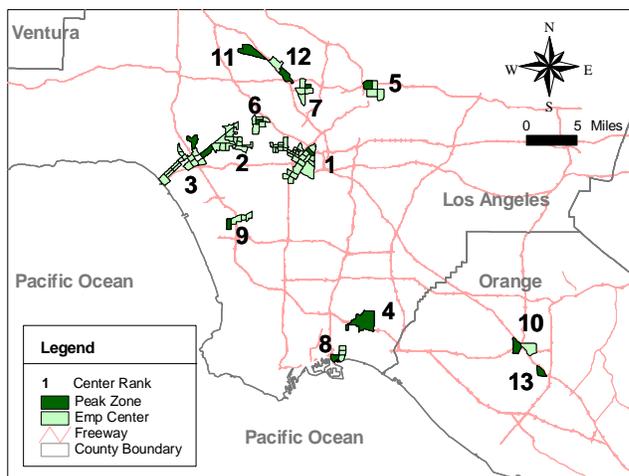
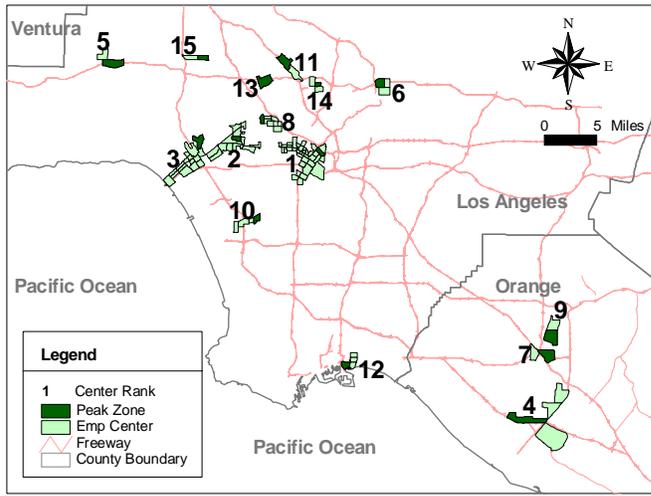


FIG 7 20/20 CENTERS IN 2000



The LA downtown center is the largest in all 3 periods, but declines from over 500,000 jobs in 1980 to under 400,000 jobs in 2000. It also shrinks in size, from 8296 acres in 1980 to 5764 acres in 2000. Centers with over 100,000 jobs include LA downtown and West LA in 1980 (centers 1, 2). Santa Monica (also part of the “crescent”) is added in 1990 (center 3); Santa/Ana-Irvine is added in 2000 (center 4).

Table 8 presents summary information for the 20-20 centers. The upper portion of the table gives employment and employment share for the centers by location. In this case the Los Angeles downtown is a single center. In order to compare better with the 10-10 results, we add a row that includes the other centers in the Westside corridor that approximates the LA main center under the 10-10 criteria. Under the stricter criteria, the LA downtown and its corridor of centers to the west overwhelmingly dominates regional employment in centers in 1980, accounting for about 83% of all center employment. The LA downtown alone accounts for 55 percent. While the LA downtown loses employment during the period, the other centers to the west gain employment, but not enough to offset gains outside this core area. Centers in the remainder of LA County increase in number and total employment. Total number of jobs in centers in LA County is remarkably stable. The fastest center growth occurs in Orange County, where the employment share increases from zero to 17.5%. The share of total regional employment in centers drops in 1990, then increases again in 2000. We observe that while the share of

employment in centers has remained relatively stable, new centers have emerged outside the main core, and most of the center growth has occurred outside the core.

The lower portion of Table 8 is similar to Table 6. The dominance of LA County in 1980 is evident, and its loss of center share employment is similar (from 17% in 1980 to 13.5% in 2000). Finally, if we consider center employment shares within counties, the share in LA County declines slightly from 23.4% in 1980 to 22.1% in 2000. In Orange County, the share increases to 16% in 2000. Hence while we observe stability in LA County, there is a clear trend of concentration in Orange County.

Table 8 20-20 Employment Centers Summary Table

Area	1980			1990			2000		
	N	Emp	Share	N	Emp	Share	N	Emp	Share
Within Centers									
LA downtown	1	505,793	55.0	1	401,054	38.8	1	392,977	33.0
Rest of LA main	4	255,318	27.7	3	318,235	30.8	3	348,982	29.3
Rest of LA Co.	5	159,134	17.3	7	262,878	25.4	8	239,444	20.1
Total LA Co.	10	920,245	100	11	982,167	95.0	12	981,403	82.5
Orange Co.	0	0	0	2	51,397	5.0	3	207,846	17.5
Total centers	10	920,245		13	1,033,564		15	1,189,249	
Center share of region total			17.1			15.0			16.4
Outside centers									
		Emp	Share		Emp	Share		Emp	Share
LA Co.		3,013,466	67.4		3,615,207	61.9		3,462,015	57.2
Orange Co.		915,386	20.5		1,251,722	21.4		1,306,485	21.6
Other counties		538,960	12.1		974,183	16.7		1,283,773	21.2
Total not in centers		4,467,812	82.9		5,841,112	85.0		6,052,273	83.6
Region total		5,388,057			6,874,676			7,241,523	

Finally we consider the average distance of centers from the LA downtown, under both 10-10 and 20-20 (see Table 9). The LA downtown center is omitted from the calculations, and average distances are from the peak tract centroid of each center to the peak tract centroid of the

LA downtown center. There is a pattern of declining average distance in the case of unweighted distance for 10-10 centers, but increasing average distance in all other cases. The dominance of the LA core is evident in the 20-20 weighted distance calculations; with an average distance of under 5 miles, it is difficult to understate the extent to which the largest concentrations of employment are centralized around the historic downtown in 1980. Although average distance almost doubles by 2000, a high degree of concentration remains.

Table 9 Average Distances of Centers To Los Angeles Downtown Center

	1980	1990	2000
10-10 centers			
Unweighted	19.27	18.36	17.57
Weighted	9.82	11.89	13.31
20-20 centers			
Unweighted	11.40	14.05	14.09
Weighted	4.92	7.70	9.54

Our analysis of employment centers yields results consistent with the density patterns described in the previous section. Using either liberal or conservative cutoffs for defining employment centers, we find 1) the LA downtown remains the single largest and most dense employment concentration in the region, but it loses both employment share and absolute amount of employment; 2) the LA “core”, a corridor extending from downtown to Santa Monica, remains the largest and densest cluster and the concentration shifts westward over time; 3) employment centers are decentralizing, with the fastest growing centers located many miles from the core; 4) particularly notable concentration is observed in Orange County, a prototypical “sprawled suburb” by reputation; 5) employment growth is most rapid in the outer suburban counties, where employment is increasingly dispersed; and finally 6) there is stability in the share of employment inside and outside of centers, despite rapid employment growth over the period.

5. CONCLUSIONS

Our examination of spatial trends in the Los Angeles region suggests that 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 (and rising congestion), the share of employment in centers remains stable. If localized benefits of

agglomeration were in decline, we would expect to see the share of jobs in centers decline significantly. Observed spatial trends are complex. In the core of the region, stability is the dominant feature. Although the downtown center loses employment over the period, other core centers remain relatively stable. More importantly, trends inside and outside centers are consistent; employment in centers fared no worse than employment outside centers.

In Orange County, the dominant trend is concentration. Within Orange County, jobs in centers increase faster than jobs outside centers, so the share of jobs in centers increases. Concentration is also evident in centers to the west and north of Los Angeles downtown, as reflected in the increased average distance of center employment from downtown. These observations are consistent with the theory of employment center development. In the outer suburban counties, the dominant trend is dispersion. The share of jobs in centers declined markedly, while job growth overall was the most rapid in the region.

Taken together, these trends are consistent with the evolutionary models of Hartshorne and Miller (1989) and others. Formerly suburban Orange County is now a mature urban center, while the outer suburban counties are still in the process of building a job base sufficient for agglomeration benefits to take hold. The trends are not consistent with the notion of the dispersed metropolis, or with decline of the urban core. The notion of historical path dependence is helpful in understanding our results. Longevity of the built capital stock and physical infrastructure generates long-term advantages for the core, despite traffic congestion, housing shortages and very high land values. The benefits of access that the Los Angeles core provides, at least for some segments of the economy, apparently continue to influence location decisions.

This paper represents only a first step in understanding the spatial evolution of contemporary metropolitan areas; much remains to be done. First, our use of the Giuliano and Small approach in defining centers was based largely on the sense that none of the parametric approaches could capture the complexity of the region. One next step is to repeat this exercise and compare these result with those based on centers identified using parametric approaches. Our preliminary results using monocentric and polycentric models confirm the Small and Song (1994) findings of polycentricity. However, upon closer examination we find that all the statistical fitting occurs within a short distance of the center(s), yielding few insights regarding the influence of centers in a regional context.^v Ideally we would like a systematic and robust method that takes into account both absolute and relative size of concentrations and that is

flexible enough to accommodate the geographic irregularities of the real world. Third, we have not explored the economic function of centers, their influence on the population distribution, or the extent to which these have changed over the period of study. Finally, and most importantly, our work leads to the obvious question of how and why centers emerge, grow, or decline. Given the number of centers in Los Angeles, there is the opportunity to formally test theories of center formation, such as those of Sullivan (1986) or Henderson and Mitra (1996) or Zhang and Sasaki (1997).

We conclude that our descriptive analysis provides a complex picture of urban evolution. Forces of concentration and deconcentration are evident. Agglomeration economies continue to exist at the intra-metropolitan level. To the extent that the Los Angeles region is a prototype, the simple concept of the sprawled metropolis is not a good fit with contemporary urban regions.

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ENDNOTES

ⁱ For a review, see Anas, Arnott and Small, 1998; also see Jordan, Ross and Usowski, 1998; Bunting, Filion and Priston, 2002.

ⁱⁱ In other work we are researching methods for identifying employment centers using LWR smoothing techniques and locating boundaries based on gradient tests. For this comparative work we felt it more important to maintain comparability with the earlier Giuliano and Small study. Moreover, the focus of this work is on spatial trends, rather than methodology. Some preliminary comparisons of centers identified using old and new methods show good consistency.

ⁱⁱⁱ <http://www.census.gov/population/censusdata/urdef.txt>

^{iv} Correspondence tables based on employment were available for the 2000 to 1990 conversion, but not for the 1980 – 1990 conversion; we used the only available alternative, a population-based conversion table.

^v Results available from the authors upon request.