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SUBURBAN POPULATION AND EMPLOYMENT CHANGE, 1980-1990

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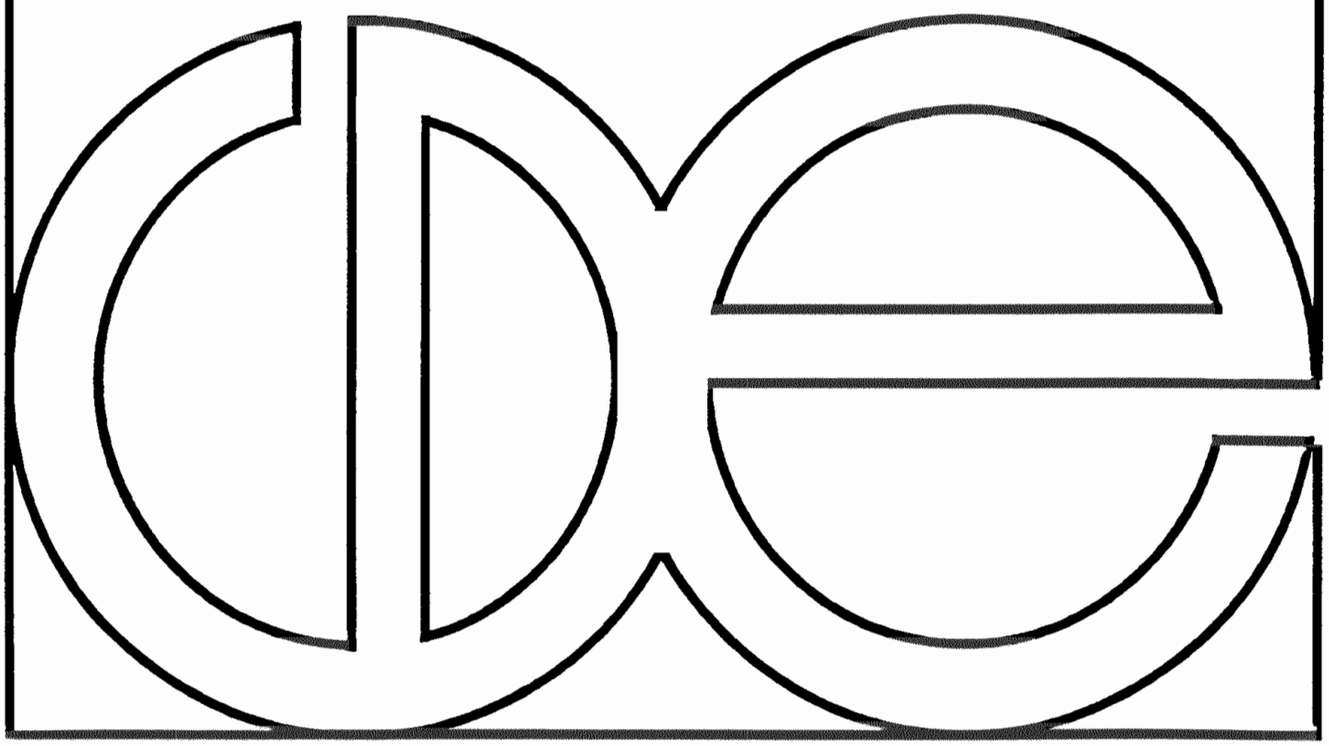

Suburban Population and Employment Change, 1980-1990*

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Abstract

Over the last fifty years considerable attention has been paid to the tremendous growth of suburbia. Initially, suburbs were perceived as homogenous bedroom communities that functioned only to supply labor to the center city economy. In recent years, however, this simplistic view has been revised. Suburbs are important centers of economic activity --both production and consumption -- and the rapid suburbanization of the metropolis represents significant restructuring of the urban system.

Research on economic and demographic changes in the suburbs indicates that "flight" from the center city is no longer the primary source of growth. Instead, population growth is determined primarily by in-migration from nonmetropolitan areas and from other metropolitan areas. Employment growth is the result of new job creation in the suburbs -- from the expansion of existing firms and the establishment of new businesses -- and of firm relocation from outside the metropolitan area. The center city is bypassed by both population and industry; no longer is it the point of first entry to a metropolitan system. This restructuring has led several researchers to propose alternative forms of spatial organization.

One such alternative focuses on the increasingly complex system of cities operating in the suburban ring. Population and economic activity are not dispersed evenly among suburbs. Dense clusters of activity, resembling the center city of old, are evident. A dominance hierarchy is developing among the suburbs of a metropolitan area.

This research examines the effects of dominance, or network position, on demographic and economic changes in suburban cities between 1980 and 1990. The question addressed here is: Do more dominant suburban cities attract people and jobs at a greater rate than subdominant places, and thereby strengthen their network position, or do dominant cities suffer the negative characteristics of large center cities and experience slower growth than lower-order places?

Suburban Population and Employment Change, 1980-1990

In previous research I have identified a complex system of cities within the suburban ring (Hughes 1991,1993). And while many studies have demonstrated suburban differentiation by race, income and industrial structure (i.e. Guest 1978; Logan 1976; Logan and Schneider 1984; O'Hare and Frey 1992; Schnore 1957; Stahura 1986), I argue that hierarchical differentiation also operates. That is, suburbs are not equally *sub*urban. Some suburbs are more dominant while others are suburban to these more dominant suburbs, not to the center city.

Several researchers contend that the increased scope and complexity of the metropolitan community has moved it beyond applications of extant theory. It is argued that the monocentered foundation -- a basic tenet of urban theory -- is seriously compromised by the current distribution of population and employment through the suburban ring (Birch 1975; Fava 1975; Gordon, Richardson and Wong 1986; Gottdiener and Kephart 1991; Hartshorn and Muller 1989; Muller 1981; Richardson 1988; Sly and Tayman 1980; Wheaton 1979). I argue that recognition, and further analysis, of the hierarchical differentiation among suburbs may address theoretical shortcomings and lead to reformulations that incorporate a suburban system of cities.

Briefly, I have shown that several suburban cities occupy central positions and manifest characteristics typically attributed only to the center city. They are consumer centers providing regularly consumed goods and services to their resident and a dependent periphery population, their economies are specialized in services (reflecting coordinative and administrative functions), and they act as labor magnets, orienting the metropolitan labor force (Giuliano and Small 1991; Greene 1980; Hughes 1991). In short, these dominant suburbs are more similar to center cities than they are to popular conceptions of suburbia (Baldassare 1992; Garreau 1991; Muller 1989; White 1976). Suburban central places dominate a geographic or industrial sector of the metropolitan area and create subsystems within the larger metropolitan community.

It is not yet clear whether the suburban hierarchy is the result of national industrial restructuring, whether is it a natural outcome of system expansion, or whether advances in transportation and communication technologies have reduced the need for a central location (or some combination of these and several factors). There is, however, mounting evidence that deviations from the monocentered form arise in the suburbs (Marshall and Stahura 1986; Sly and Tayman 1980; Stahura 1982). Suburbs do not merely reflect and respond to changes occurring in the center city. They attract population and employment from nonmetropolitan areas and from other metropolitan communities, often competing with the center city for expanding demographic and economic resources (Stanback 1991; Stanback and Knight 1976). In this way the suburbs affect metropolitan restructuring, rather than simply reflecting system dynamics.

Given the significant differentiation among suburbs, it is reasonable that they experience different rates of growth. The characteristics of an individual suburb influence its population and employment change (Logan 1978; Molotch 1976). This paper extends research of hierarchical differentiation by examining the effects of dominance, or network position, on demographic and economic changes in suburban cities between 1980 and 1990. The question addressed here is: Do more dominant suburban cities attract people and jobs at a greater rate than subdominant places, and thereby strengthen their network position, or do dominant cities suffer the negative characteristics of large center cities and experience slower growth than lower-order places?

DATA AND MEASUREMENT

Data

This paper examines recent population and employment change of 384 suburban cities in 41 metropolitan areas. These 41 metropolitan areas, listed in Appendix 1, were chosen because in 1980 they displayed a clear multinodal structure[1], and there is evidence that a hierarchal system of cities

operates in these complex networks (Hughes 1991,1993). More simply put, some suburbs are "suburban" not to the center city but to more dominant suburban cities. It is a guiding principle of this research that differential network position affects the growth rates of suburban cities. While this hierarchy may well extend through all communities in a metropolitan area, only the 384 largest suburban cities in these multinodal SMSAs are examined here; data availability and disclosure rules restrict this analysis to incorporated suburban cities of at least 25,000 population (in 1980).

While these 41 metropolitan communities constitute only 13 percent of 1980 SMSAs they contained 40 percent of the total U.S. population and 54 percent of the metropolitan population. They accounted for 39 percent of total employment in the U.S. and 55 percent of metropolitan employment.[2] And, 87 percent of suburban cities over 25,000 population were located in these metropolitan areas. There is, however, considerable diversity among these metropolitan areas. They vary by region, area and age. They range in population rank from first to 73rd and contain between two and 46 large suburban cities. One similarity is their proximity to other metropolitan areas. Twenty-one are included in larger SCSAs and another 18 are adjacent to other SMSAs; only two, Oklahoma City and St. Louis, are more isolated systems. Although many of these metropolitan areas may be considered part of a larger complex, I focus on the SMSA because the theoretical basis of the SMSA is well established and because its commuting network remains identifiable.

By and large data for this analysis are from 1980 and 1990 Census of Population and Housing, and 1982 and 1987 Economic Census data files. Additional data from the *County and City Data Book* and the *State and Metropolitan Area Data Book* are derived from the 1980 Census of Population and Housing. These 384 cities are classified as suburban by 1980 definitions of metropolitan area, and this is held constant across the time frame of the analysis. Although several of these suburbs were reclassified to center cities of PMSAs when the current MSA/PMSA/CMSA categorization was instituted, I maintain 1980 SMSA boundaries and suburb definitions here. I argue

that the reclassification, itself, does not affect population and employment growth and that this recategorization of suburban cities is a recognition of their dominance. Additionally, because this analysis evaluates differential growth among cities of a system it is critical to preserve the units across time.

Description and Measurement of Variables

Table 1 defines the variables used to predict population and employment growth in these suburban cities. While different theoretical perspectives posit different correlates of growth this analysis focuses on ecological factors. Additionally, these models are similar to a model predicting the network position of a suburban city (Hughes 1993); Appendix 2 provides results of this analysis. A primary purpose of this paper is to evaluate the effect of network position on growth, therefore, it is useful to control for those factors contributing to network position.

[Table 1 about here]

Two separate dependent variables are examined here. First is suburban city population change between 1980 and 1990 (U.S. Bureau of the Census 1983,1991a) Again, cities were classified as suburban in 1980 and that definition is retained through the time frame of this analysis. The political boundaries of the city, however, are not constant across time; cities have annexed land between 1980 and 1990. With data currently available, it is not possible to reconstruct 1980 units, therefore, a variable controlling for annexation is included in these models. This is discussed below. The second dependent variable is change in total employment between 1982 and 1987 (U.S. Bureau of the Census 1984abc,1985a,1991b). Total employment is calculated as the sum of employment in manufacturing, wholesale, retailing and services, as reported in the Economic Censuses. Several industries -- such as transportation, construction, and finance, insurance and real estate (FIRE) -- are not included in "Total Employment"; employment by place for these industries is not reported in the

Economic Censuses. Employment by place of work data from the 1990 Census of the Population, which includes all industries, are not yet available. Population and employment change are also included as predictors in the appropriate model (population change in the employment change model and employment change in the population change model). There are reciprocal effects between these two variables (Irwin and Kasarda 1991) and future research of suburban growth will include this complex relationship.

The models consist of three blocks of independent variables: characteristics of the suburban city; characteristics of the center city; characteristics of the metropolitan area. Characteristics of the individual suburban city are listed first. The variables listed here are generally considered indicators or characteristics of a dominant (center) city. Most of these are self-explanatory and the hypothesized relationships parallel those posited for center cities. Several variables, however, warrant additional explanation.

First, a suburban city's position in the metropolitan system is measured by its centrality in the 1980 labor exchange network. Commuting patterns have defined metropolitan areas and central places since 1949 (Bogue 1949); however, they were recognized as a principle indicator of economic and social integration in early theories of intrametropolitan relationships (Burgess 1924; McKenzie 1933). Because they tap actual interaction, commuting flows clarify the differential position and function of metropolitan cities (Cervero 1989; Filina 1987; Frey and Speare 1992; Giuliano and Small 1991; Guest 1975; Pisarski 1987; Sly and Tayman 1980; Yu 1972).

Individual metropolitan commuting networks for these 41 SMSAs were constructed from 1980 Journey-to-work data (U.S. Bureau of the Census 1985b).[3] To assess a city's position in the commuting network, I utilize a measure of point centrality developed by Bonacich (1987). This is a graph theoretic measure of centrality[4] that was initially constructed to measure position in individual

interaction networks. However, it is equally apropos macro-level interaction matrices (Hughes 1993; Irwin and Hughes 1992; Irwin and Kasarda 1991). The calculation of point centrality for city *i* is:

$$c_i(\alpha,\beta)=\sum_j (\alpha+\beta c_j)R_{ij} \quad (1)$$

where:

c_i = the centrality score of city *i*.
α = network specific constant that standardizes centrality scores.[5]
β = specifies the range of interactions considered.
c_j = the centrality score of city *j*.
R_{ij} = magnitude of commuting flow from city *i* to city *j*.

In this analysis network position is defined as a city's dominance of the commuting network, such that places attracting a disproportionate share of the metropolitan labor force occupy a more central position. However, in all metropolitan areas considered here the center city attracts more labor than any given suburban city. This is hardly surprising since, even in these multinodal metropolitan areas, the center city is the largest single employment node. Rather than simply noting the largest employment center I am interested in evaluating growth in suburban cities that act as labor magnets; cities that may compete for dominance of the system.

The Bonacich measure, however, is sensitive to the magnitude of exchanges among places and to total employment. If absolute commuting flows are used the centrality scores produced by this equation are a function of total employment (Irwin and Hughes 1992). To address this the commuting matrices have been transformed to reflect relative labor force attraction. Labor force attraction is measured as the proportion of each city's resident labor force commuting to a given city of destination.[6] Cell entries, or flow magnitudes, based on labor force attraction range from zero to one. For example, in the Akron, Ohio SMSA 26.4 percent of Barberton's employed residents commute to Akron; therefore, R_{ij} of the Barberton (origin) to Akron (destination) cell is .264. Under this interpretation of dominance a city is central if it acts as a labor magnet and attracts a

disproportionate share of others' labor. One city dominates another to the extent that the (other's) resident labor force is oriented toward its economy. I expect more dominant suburban cities to attract or stimulate employment, while population is attracted to less dominant, more residential, suburbs.

Next, sales sufficiency of the suburban city (in 1982) evaluates local economic activity in terms of the ability to provide sufficient variety and quantity of regularly consumed goods and services to the local population. Cities having sufficient economic activity are relatively independent of other economies (Clark 1945); residents do not have to travel to other cities to procure basic goods and services. Cities having excess economic activity support a resident and a dependent hinterland population. Thus to some extent they dominate a sector of the metropolitan economy. Conversely, cities that do not have sufficient economic activity are more dependent on an external economy. Cities having diverse and vital economies in 1982 may be more attractive to economic growth. Population, however, may prefer to locate outside the political (and tax) jurisdiction of such cities, yet within easy access of consumer oriented economic activity.

Here, sales sufficiency is a composite index, based on Feldt's measure (1965), of the dollar value of sales in wholesale, retail and service industries (U.S. Bureau of the Census 1984abc). The Sufficiency Index (S_j) is calculated in a two-step equation; first:

$$I_{ij} = \frac{ea_{ij}/p_j}{EA_i/P} \tag{2}$$

where:

ea_{ij} = economic activity (sales) in industry i in city j.
p_j = population of city j.
EA_i = economic activity (sales) in industry i in nation.
P = national population.

The above equation produces industry-specific quotients for a given city. Second, a standardized summary measure of all economic activity is calculated as:

(3)

$$S_j = \frac{\sum_{i=1}^{n} \frac{(w_i I_{ij})}{\sigma_i}}{\sum_{i=1}^{n} \frac{w_i}{\sigma_i}}$$

where:

w_i = proportion of total national employment in industry i.
I_{ij} = sufficiency quotient for industry i in city j.
σ_{ij} = standard deviation of I_{ij} over all units.

In this summary measure a score of 1.00 indicates self-sufficiency. Scores greater than 1.00 indicate greater economic activity, while scores less than 1.00 indicate that there is not sufficient economic activity to support the resident population.

Finally, industrial specialization in services (again in 1982) is an indicator of the predominance of administrative and coordinative industries. Ecological theory posits that such industries locate centrally so as to most efficiently orient the metropolitan area (Dunn 1983; Hawley 1986; Kasarda 1972; Meyer 1984). Thus dominant, or central, cities specialize in these industries. As with sales sufficiency, agglomeration economies may operate in cities specialized in services, attracting or stimulating economic growth; yet, population growth may occur outside such cities.

Specialization in service industries (in terms of employment) is measured by a location quotient (U.S. Bureau of the Census 1984c) as:

(4)

$$L_{ij} = \frac{\frac{n_{ij}}{\sum_{i=1}^{n} n_{ij}}}{\frac{N_i}{\sum_{i=1}^{n} N_i}}$$

where:

n_{ij} = employment in industry *i* in city *j*.
Σn_{ij} = total employment in city *j*.
N_i = metropolitan employment in industry *i*.
ΣN_i = total metropolitan employment.

This location quotient is based on the individual metropolitan economy, rather than the nation; it identifies service specialization given the metropolitan area's industrial structure. Scores greater than 1.00 indicate more employment in services than would be expected in this metropolitan economy. Scores less than 1.00 indicate that the city's industrial structure is under-represented in these coordinative industries. Note that these are industry-specific scores; there is no standardized summary measure of industrial specialization as there is with sales sufficiency.

The sufficiency index and the location quotient measuring specialization in service industries (and other measures based, mathematically or theoretically, on these) have been used throughout the literature on dominance as indicators of central place function and they reflect theoretical concepts of position in the urban hierarchy (see Berry and Kasarda 1977; Gottmann 1976; Hawley 1950; Marshall and Stahura 1986; Muller 1981,1989; Perloff et al. 1960; Sassen 1990; Wilson 1978 among others). The Bonacich measure of centrality is less widely used (Hughes 1993; Irwin and Hughes 1992) although the foundations of point centrality measures are established urban geography (Nystuen and Dacey 1961; Taaffe and Gauthier 1973). Each of these measures tap a related concept of dominance well-founded in urban and spatial theory.

The remaining characteristics of the suburban city are definitionally more straightforward, although the hypothesized relationships are not. For instance, distance[7] between the suburban city and the center city is often hypothesized to be an important correlate of suburban growth potential, however, the direction of the relationship is less clear. On the one hand, due to frictional constraints suburban cities located farther from the center may be less influenced by expansion, or contraction, in the center city economy (Blotevogel and Schickhoff 1986; White, Osterman and Binkley 1990).

Further, the more distant suburban cities may orient the adjacent nonmetropolitan areas and, therefore, act as a central place for the fringe population (Nelson 1992; Sly and Tayman 1980). These cities may attract population and industry accruing at the edge of the metropolitan system. On the other hand, suburban cities located closer to the center may capture economic spillover from the center city, and distance may be negatively associated with growth (Erickson 1983; Giuliano and Small 1991; Yu 1972). Related to this, population potential (Zipf 1946) is generally considered to be positively associated with growth, however, recent research indicates that potential growth is reduced through competition with proximate cities (Palmer et al. 1990). Population potential is calculated as:

$$P_{ccj} = \frac{p_{cc} * p_j}{d^2} \tag{5}$$

where:

p_{ccj} = population of (closest) center city.
p_j = population of suburban city *j*.
d^2 = distance, in miles, between suburban city *j* and (closest) center city.

As with their effects on center cities, age and density (U.S. Bureau of the Census 1988) of the suburban city may also affect suburban population and employment growth. On the one hand, older suburban cities may have developed diversified economies and become consumer or employment centers. Thus they may be better able to attract or stimulate economic activity. Older suburbs, however, may be less attractive to population moving into, or throughout, the metropolitan community. On the other hand, newer suburban cities may be better able to attract corporate headquarters and high growth industries dissuaded from locating in older, denser cities. Younger suburbs may also be attractive to workers and their families wishing to live near their places of work. Similarly, to a point higher density facilitates social interaction; however, beyond a given level there are negative returns to density as congestion decreases accessibility. And while research has shown that center city density is negatively related to growth (Kasarda and Irwin 1991; Suttles 1978), it may

be that suburban cities have yet to achieve levels of density that discourage population and employment growth.

Annexation controls for the expansion of political boundaries. Its inclusion clarifies the confounding effect of simply incorporating adjacent, occupied land on population and employment change. Additionally, a comparison of the relative effects of annexation on population and on employment growth indicates whether it is the strategy of suburbs to incorporate population or clusters of economic activity.

The second and third blocks of variables listed in Table 1 are contextual factors that may influence suburban population and employment change. Bear in mind that suburban cities are part of a system and their growth may be correlated with system-wide characteristics. Aspects of the center city and of the metropolitan area may modify the effects of individual suburb characteristics.

Three center city variables are included in these models. These indicate the role of the center city in the metropolitan system. First is the age of the center city. In older center cities space for expansion may be limited; such cities may be more built-up and available land and office space relatively expensive. Further older center cities, located in mature metropolitan areas, may be less able to annex additional land. Therefore, cities suburban to older center cities may attract expanding metropolitan population and employment (Oland 1978). Conversely, younger center cities may not have completely integrated suburban cities and, therefore, the suburb may be more independent and may compete with the center city for expanding industries and population.

Second, center city sales sufficiency, like the suburban indicator, is based on Feldt's index (1965) and has a similar interpretation. In this case, however, sales sufficiency is constructed to measure the center city's provision of locally consumed goods and services to the *metropolitan* (rather than its resident) population. In the traditional ecological formulation, the center city provides

consumer goods and services to the metropolitan population; to the extent that it is not the retail hub of the community, suburbs may assume this role and attract population and economic activity.

Finally, center city industrial specialization in manufacturing (U.S. Bureau of the Census 1985a) may affect suburban expansion. Like the related suburban city indicator, manufacturing specialization is measured with the industry-specific location quotient. On the one hand, center city specialization in manufacturing is an indicator the center city's orientation. Manufacturing is an export industry and a center city specialized in manufacturing may be more oriented toward an external market than toward the local economy. In this case suburban cities may attract industries involved in providing local consumer goods and services. These industries have been a significant contributor to suburban employment growth in recent years (Schneider 1986,1992; Schneider and Fernandez 1989). On the other hand, center cities specialized in manufacturing may be located in metropolitan areas developed around a manufacturing base. Suburban cities in these metropolitan areas may suffer the disadvantage of being located in a system dominated by a declining industry.

The third block of variables are characteristics of the metropolitan area. Again, these are factors exerting system-wide influence. Included here are characteristics of metropolitan structure, metropolitan orientation, the scope of metropolitan interaction and recent metropolitan growth.

Two measures of metropolitan structure are included. First, is a measure of network centralization. This is a based on Freeman's (1979) measure and has been modified to take the standardized centrality scores produced by the Bonacich measure into account (Irwin and Hughes 1992). Network centralization (C) for commuting network x is calculated as:

$$C_x = \frac{\sum_{i=1}^{n} [c_i^*(\alpha,\beta) - c_i(\alpha,\beta)]}{\sqrt{n(n-1)}} \qquad (6)$$

where:

$c_i^*(\alpha,\beta)$ = largest value of $c_i(\alpha,\beta)$ in the network.
$c_i(\alpha,\beta)$ = Bonacich centrality score for city *i*.
n = number of cities in network.

This measure indicates the degree to which network exchanges are dominated by few cities. The measure ranges from zero to 1.00, with zero indicating an even distribution throughout the network and 1.00 denoting the complete domination of network transactions by one point. As higher network centralization is indicative of a more dominant center city, and is negatively related to a suburban city's network position (see Appendix 2), it also may be negatively related to suburban city growth. In more centralized networks suburban cities may be less successful in competing with the center city for expanding population and economic activity. The second measure of system structure is the number of suburban cities in the metropolitan area. This is an indicator of potential competition and should be negatively related to a suburban city's growth.

The orientation of the metropolitan economy is based on a typology developed by Noyelle and Stanback (1984). The authors identify the type and number of central place functions in the metropolitan area and categorize the economy as oriented toward the local, regional or national system. In these models the scheme developed by Noyelle and Stanback is dichotomized; diversified service centers constitute one category while specialized service centers, production centers and consumer-oriented centers comprise the second category. Diversified service centers may attract diverse and, therefore, more employment. Population may be attracted by the local orientation of metropolitan areas in the second category.

The scope of metropolitan interaction is measured by the (land) area of the metropolitan community (U.S. Bureau of the Census 1984d). Over greater distances access to center city businesses may decrease and the need for suburban clusters of industry providing consumer goods increase. Therefore, suburban employment may expand to meet consumer demand. Greater scope

also may influence population change by attracting population from the nonmetropolitan hinterland, or from adjacent metropolitan systems, to the suburbs.

The region in which the metropolitan area, and its constituent suburban cities, is located also may influence population and employment change. Throughout the 1980s metropolitan areas in the South and West grew at a faster rate than metropolitan areas in the Northeast and North Central regions (Abbot 1987; Frey 1990,1992; Frey and Speare 1988). This growth may be transmitted to all suburban cities in the regions. And because a given city's growth potential may be influenced by growth throughout the system, measures of metropolitan population and employment change are included in these models. These variables also control for spatial autocorrelation (Cliff and Ord 1970; Kasarda and Irwin 1991). They exclude population and employment growth in each suburban city and indicate how much the metropolitan area would have grown without the change experienced by a given suburb.

Unfortunately, several of these variables are collinear with another, although the variables affected differ in each model. As such, the model of population change is not identical to the model of employment change. Some variables that are important predictors of one dependent variable can not be included as predictors of the other. Therefore, direct comparisons are not possible across the models, although general inferences about the relative effects of each variable can be made.

These variables are used to predict population and employment change between 1980 and 1990 in 384 suburban cities. Again, a primary focus of this discussion is the effect of a suburban city's position in the metropolitan system (in 1980) on change throughout the decade. I turn first to an examination of population change.

ANALYSIS OF POPULATION CHANGE, 1980-1990

Description of Population Change

Table 2 provides the absolute and percent change in population by type of place. The same information is graphically represented in Figure 1. Listed first are values for the nation, for the multinodal metropolitan areas examined here, and for the center cities and suburbs of these 41 SMSAs.

[Table 2 and Figure 1 about here]

As shown in Table 2, the U.S. population grew by 22 million between 1980 and 1990. The multinodal metropolitan areas gained more than 11 million people. Again, these 41 metropolitan areas represent only 13 percent of all metropolitan areas (in 1980) yet they account for 51 percent of national growth. By far, the majority of population increase in these SMSAs occurred in the suburbs. Center cities grew by just 4 percent while the suburban ring grew by 17.3 percent. Further, the suburbs account for nearly 90 percent of the population increase in these metropolitan areas.

Population growth, however, is not evenly distributed across the suburban ring. The second section of Table 2 presents absolute and percent *suburban* population change for components of the suburban ring. Here, the 384 suburban cities are categorized by network position (in 1980); each category represents one standard deviation ($\bar{x}=.345$, $s=.231$). Evidence of differential growth rates across these levels of dominance is more dramatic in Figure 1. The most dominant and least dominant suburban cities grew more slowly than the middle-range cities. In fact, the growth rates of these cities are more similar to the center city than they are to any other segment of the suburban ring. Suburban cities in the range .35-.56 grew the fastest, experiencing a 20 percent increase throughout the decade. The balance (of the suburban ring) also recorded substantial population increase between 1980 and 1990, growing by nearly 7 million residents (or 18.6 percent). The balance of the suburban ring includes population in cities less than 25,000 (in 1980) and population in

unincorporated areas. It is not clear whether this population resides predominately in smaller cities and towns or whether it is spread evenly across interstitial, rural space. It is clear, however, that these smaller communities attract the majority of suburban population growth. It may be that these areas are suburban to the more dominant suburban cities and that people prefer to live outside the political (and tax) jurisdiction, yet within the consumer and labor shed, of these larger cities. Further analysis of the distribution of population through the balance of the suburban ring is warranted.

Although suburbs clearly experience different levels of growth this does not affect the distribution of population through the metropolitan community, at least in the short term. Table 3 provides the distribution of the metropolitan population, by type of place, for 1980 and 1990. Given the divergent rates of increase, the stability of population distribution, especially within the suburbs, across time is significant. This finding, however, corroborates results reported by Farley (1964) and Massey and Denton (1988).

[Table 3 about here]

Overall, population growth is strongest in moderately dominant places and in the smaller communities of the balance. The most dominant and least dominant places are less successful in attracting, or retaining, population. Further analysis is needed to determine whether that same factors operates in these two very different types of suburban cities. In terms of function the most dominant suburban cities resemble center cities and the same factors disadvantaging (relatively) center cities may affect suburban central places. These factors may not similarly affect the least dominant suburbs.

Correlates of Population Change

The preceding discussion has shown that population growth differs by a suburban city's position in the metropolitan hierarchy. I now turn to an examination of the factors influencing

differential growth. I am particularly interested in the effect, if any, of network potion in 1980 on a city's ability to attract population through the 1980-1990 decade. Standardized OLS coefficients for this model are presented Table 4. Additionally, a sheaf coefficient (Heise 1981) is calculated for each block of variables. The sheaf coefficient is interpreted as a standardized partial regression coefficient and provides a single robust measure of the effect of a group of variables, holding constant the effects of other blocks.

[Table 4 about here]

The sheaf coefficient is included to test the relative effects of suburban characteristics, versus the contextual effects of center city and metropolitan areas characteristics, on population change. Because suburban growth is typically measured as the residual of metropolitan growth, after change in the center city population is taken into account, it is generally considered to respond to, and reflect, center city and metropolitan area dynamics. Sheafing together the effects of suburban city characteristics, and comparing these with the effects of system characteristics, provides an indication a suburb's ability to independently affect its population change. Examining the "Sheaf" column of Table 4, it is clear that, while all three clusters of variables significantly affect population change, the characteristics of suburban cities are more important predictors of growth than the characteristics of other spatial units. Thus there is additional evidence that the factors affecting suburban city growth operate independently of system-wide characteristics (Marshall and Stahura 1986; White et al. 1990).

Within the group of suburban city characteristics several variables have a significant effect on population change. Most interesting, to my mind, are the strong negative effects of the three indicators of central place function: network position, sales sufficiency and specialization in service industries. Network position has a significant negative relationship with population growth. Albeit, this is a somewhat weaker predictor than other suburban city characteristics. The negative

relationship between network position and population change suggests that more dominant suburbs attract less population than subdominant places.

This interpretation is carried to the two other indicators of central place function. First, higher levels of sales sufficiency, indicating that a place is an important consumer center, are negatively associated with higher levels population growth. In order to have a high sufficiency index a city must have a diverse economy, with significant employment in all industries providing locally consumed goods and services. Table 4 indicates that suburban cities with such diverse economies are not as attractive to population as cities less involved in consumer economic activity. Similarly, suburban cities specialized in service industries also experience lower levels of population increase. Again, specialization in service industries is an indicator that a suburban city occupies a position similar to that theorized to belong to a center city. This analysis suggests that, like center cities, such suburban cities are less able to attract, or retain, population than other suburbs.

Population in 1980, however, is positively associated with population change. Controlling for network position and industrial structure, suburban cities that were population nodes in 1980 experienced greater population growth than other suburban cities. Similarly, suburban cities located farther from the center city, and, therefore, the more spatially independent suburban cities, have higher levels of population increase. And cities that annexed land also experienced higher levels of growth.

Net of other characteristics, recent employment change also is positively associated with population change. That is, suburban cities with expanding employment bases also experienced higher levels of population increase. Controlling for the strong negative effects of the three indicators of dominance, this suggests that growing job opportunities attract population moving into the metropolitan area, or population relocating from other cities -- perhaps the center city -- within the metropolitan community.

Taken together this analysis indicates that suburban population nodes, cities with rapidly expanding economies, suburbs located nearer the metropolitan fringe, and to some extent the less dense and younger suburbs experienced higher levels of population growth through the decade. More dominant suburbs -- suburban cities that more closely resemble center cities than they do stereotyped bedroom suburbs -- are less competitive in attracting population. However, because the strongest predictor of population change is annexation it may be that observed growth is an artifact of political decisions and the unique opportunities to annex; that little actual population increase occurred within the original boundaries of these large suburban cities.

Only two of the center city characteristics significantly affect population change in a suburban city. The age of the center city is negatively related to population change, as is the center city's specialization in manufacturing. Cities suburban to older center cities and center cities that are traditional manufacturing centers attracted less population than the suburbs of younger center cities and of center cities specialized in retail or services. The economies of younger center cities, and the suburbs of these metropolitan areas, may reflect technological and organizational changes arising in the service oriented, postindustrial economy and, therefore, these areas may be better able to attract population from nonmetropolitan areas and from metropolitan areas dominated by older, more traditional center cities (Sassen 1990).

Finally, net of the characteristics of the suburban city and the characteristics of the center city, three characteristics of the metropolitan community have a significant effect suburban city population change. First, the negative coefficient for the number of suburban cities suggests that increased competition between suburbs significantly decreases any given suburb's ability to attract population. Second, recent metropolitan population growth (excluding the population change of each suburb, individually) is positively correlated with population change in a suburban city. General metropolitan growth and expansion appears to be transmitted to all suburbs in the system. Finally,

the scope (land area) of the metropolitan area is also positively related to population change in a given suburban city. The suburbs of spatially large metropolitan areas gained more population than the suburbs of more compact metropolitan communities.

Although characteristics of the larger system significantly affect population change in constituent suburbs, individual suburban cities modify, or enhance, these system-wide influences. For example, the suburbs of faster growing metropolitan areas, as indicated both by recent metropolitan population change and by the age and orientation of the center city, generally attracted more population; these suburbs did not attract population equally, however. Political decisions (such as annexation) and ecological characteristics (such as network position) of each suburban city significantly affect its population change between 1980 and 1990.

I now turn to an analysis of employment change between 1982 and 1987 in these 384 suburban cities. While a specific aim of this analysis is to evaluate the effect, if any, of network position on employment change, the more general discussion will focus on differences among the factors affecting population change and those influencing employment change. In other words, do suburban cities that attract population also attract employment, or do different factors influence economic growth?

ANALYSIS OF EMPLOYMENT CHANGE, 1982-1987

Description of Employment Change

Absolute and percent change in employment by type of place are provided by Table 5. Figure 2 graphically represents the same information. As with Table 3, values for the nation, for the multinodal metropolitan areas examined here, and for the center cities and suburbs of these 41 SMSAs are listed first.

[Table 5 and Figure 2 about here]

Table 5 shows that the U.S. gained nearly 9 million jobs between 1982 and 1987. The multinodal metropolitan areas grew by 4.3 million; thus these 41 metropolitan areas (which constitute 13 percent of 1980 metropolitan areas) account for 49 percent of national growth. The majority of employment increase in these SMSAs occurred in the suburbs. Center cities grew by just 9 percent while the suburban ring grew by nearly 26 percent. Further, the suburbs account for 78 percent of the employment increase in these metropolitan areas.

Employment growth, however, is not evenly distributed across the suburban ring. The second section of Table 5 presents absolute and percent *suburban* employment change for components of the suburban ring. As in Table 3 the 384 suburban cities are categorized by network position (in 1980). The lower section of Figure 2 graphically depicts this information. Unlike population growth, suburban employment change is more evenly distributed across the categories of network position. Recall that the most dominant and least dominant suburbs gained population more slowly other suburbs. In terms of employment, however, the least dominant suburban cities (with centrality scores less than .12) grew the fastest, experiencing nearly a 40 percent increase over this five year period. These thirty cities, however, gained only 40 thousand jobs; this is the smallest absolute change recorded by any category. The balance of the suburban ring also evidenced substantial employment increase between 1982 and 1987, growing by 2 million jobs (or 25.7 percent). Again, the balance of the suburban ring includes employment in cities less than 25,000 population in 1980 and in unincorporated areas. On the one hand, it may be that a significant portion of employment growth in the balance is located in interstitial employment nodes such as office or industrial parks, or regional retail malls and service complexes (regional health care facilities, for example). Given the rapid employment growth in the least dominant suburban cities, on the other hand, job generation may be within the boundaries of small suburban cities and towns. These have infrastructure in place that may

be attractive to business expansion. Because these data do not address the distribution of employment through the balance of the suburban ring, further analysis of this is indicated.

Although suburban cities experience different levels of growth this does not significantly affect the distribution of employment through the metropolitan community, at least within this five year period. Table 6 provides the distribution of the metropolitan employment, by type of place, for 1982 and 1987. The stability here parallels the findings reported in Table 4 and provides additional support for the results reported by Marshall and Stahura (1986) and Schneider (1986,1992).

[Table 6 about here]

Overall, employment growth is strong throughout the suburban ring. Unlike their attraction for population, however, the least dominant places gained employment at a faster rate than any other type of place. This may be a result of the relatively rapid growth in small businesses through this time period and may reflect the proliferation and expansion of consumer oriented businesses in residential suburbs (White et al. 1990). Further, the most dominant places grew somewhat more slowly than other suburbs. As more data become available through the 1990s researchers will need to monitor employment change in the most dominant suburban cities to determine whether growth is slowing, perhaps falling to the relatively anemic rates evidenced by center cities.

Correlates of Employment Change

Given this indication that a suburban city's employment growth between 1982 and 1987 varies by its position in the metropolitan hierarchy, I now turn to a broader examination of those factors influencing differential growth. Standardized OLS coefficients for this model are presented Table 7. Note that this model is not identical to the model presented in Table 4. Several of the variables included in the analysis of population change are highly collinear in a model of employment change; therefore, the model has been modified. Although direct comparisons across the models are not

valid, general inferences about differences in the factors affecting population and employment change can be made. As with the analysis of population change, a sheaf coefficient (Heise 1981) is calculated for each block of variables and is included to test the effects of suburban characteristics, net of the contextual effects of system-wide characteristics, on employment change.

[Table 7 about here]

Perhaps the most striking finding reported in Table 7 is the very strong effect of suburban city characteristics (.726) on growth. Although the effects of all three clusters of variables are statistically significantly, center city (.141) and metropolitan area (.165) characteristics are substantially weaker predictors of employment change than suburban city characteristics. Suburbs do not merely mirror system-wide dynamics. And, suburban differentiation (in terms of employment change), both within and among metropolitan areas, results from the competitive advantages of individual suburban cities.

Within the group of suburban city characteristics several variables have a significant effect on employment change. Because my primary aim is to evaluate the effects of dominance on a city's ability to attract, or retain, employment the strong effects of two central place indicators -- network position and sales sufficiency -- are particularly interesting. Position in the 1980 commuting network is positively associated with employment change between 1982 and 1987, such that places with higher centrality scores gained more jobs than less central places. Recall that network position is based on a city's ability to attract a disproportionate share of the metropolitan labor force. Table 7 indicates that, net of other characteristics, cities dominating the commuting network in 1980 also dominated employment growth. Similarly, suburban city sales sufficiency is positively related to employment growth, indicating that important consumer centers provide a positive environment for job creation and expansion. Although the effect of specialization in service industries, the third indicator of dominance, is not statistically significant it is also positively related to employment change. Taken

together, these indicate that dominance and growth are positively related, and that indicators of dominance are important in predicting employment change.

More important than statistical significance is that these indicators of dominance exhibit strong *positive* effects on employment growth while they have *negative* effects on population change (see Table 4). That is, suburban central places are attractive for employment growth but less so for population growth. Dominance affects the two processes differently and this may lead to even greater hierarchical differentiation among suburban cities in the future.

Population potential (in 1980) is also positively associated with employment change. Note, however, that distance (net of other variables, including population potential) is not a significant predictor of employment change. Population potential can be viewed as a measure of the magnitude and ease of [potential] population exchange between two places; or, perhaps more importantly, as a measure of the fluidity of [potential] exchange of consumer dollars. This is not a measure of actual exchange but rather of the potential for exchange. Here, population potential indicates the access of the center city consumers to the suburban city's economy, and visa versa. Suburban cities with greater access to the center city economy, and to its consumer purchasing power, also experienced higher levels of employment increase.

Along these same lines, a suburban city's recent population change is also positively associated with employment growth. Suburban cities with expanding population bases also experience higher levels of employment increase; slower growing economies had slower growing populations. It may be that employment growth is stimulated by the increased consumer demands of an expanding population. A wide variety of retail goods and services (as well as the wholesalers supplying these goods) are required to support any population; rapid population growth may stimulate the expansion, or creation, of firms providing these. The positive effects of population potential and recent

population growth indicate that access to a large number of consumers is an important determinant of employment growth.

Age of the suburban city is the only individual characteristic to negatively (with statistical significance) affect employment change. The coefficient indicates that younger suburbs gained more jobs than older suburbs. Older cities, suburban or not, are not as attractive to expanding employment opportunities. Younger suburban cities may offer incentives, fiscal or in terms of infrastructure and amenities, that stimulate job growth.

Notice that annexation between 1980 and 1990 is not a significant predictor of employment change. It is, however, an important determinant of population change. This provides additional evidence that suburbs tend to annex residential areas, rather than areas occupied by economic activity.

One center city characteristic significantly affects employment change in a suburban city, and this effect is modest. The age of the center city is positively associated with employment change in the suburbs, such that cities suburban to older center cities gained more jobs than suburbs of younger center cities. This may be because older center cities attract fewer jobs and, therefore, a greater share of metropolitan growth accrues in the suburbs (Marshall and Stahura 1986). Younger center cities, which are typically less dense and have newer infrastructures, may be better able to compete with their suburbs for jobs.

Finally, net of the characteristics of the suburban city and the characteristics of the center city, only recent metropolitan employment change affects employment change in a given suburb. Like the corresponding variable measuring population change, recent metropolitan employment growth is measured as metropolitan growth excluding the employment change of each suburb, individually. And, like metropolitan population change (see Table 4) it is positively correlated with suburban change. General metropolitan growth and expansion appears to be transmitted to all suburbs in the system.

Overall, this analysis indicates that more dominant suburbs are more competitive in attracting employment. Although characteristics of the larger system affect employment change in its suburbs, individual suburban cities modify system-wide influences. The suburbs of faster growing metropolitan areas, for example, gain more jobs. The hierarchical position of each suburban city, however, further affects its employment change between 1982 and 1987.

CONCLUSIONS

This paper extends previous research on the suburban system of cities and provides a test of the effects of dominance on growth. Several conclusions about suburban population and employment change can be drawn. Two, however, stand out as particularly important.

First is that network position significantly affects suburban population and employment change. Network position, as with the two other indicators of dominance, affects the two processes quite differently. On the one hand, dominance is negatively related to population growth, indicating that more dominant cities attract fewer people than less dominant cities. On the other hand, dominance positively affects employment change. More dominant suburban cities are better able to capture or stimulate economic growth than less dominant suburbs.

These findings might suggest that hierarchical differentiation among suburban cities is increasing; some enhance their positions as employment centers and suburban central places while other continue to specialize in residential functions. This may indicate, as Greene (1980) has suggested, that deconcentration from the center city does not result in an even distribution of population and economic activity across the suburbs. Instead suburban centripetal forces create eddies of dominance and subdominance through the suburban ring. Dominant suburban cities take on more of the characteristics of a center city and subdominant places serve as the residential suburbs of these suburban central places.

Conversely, the strong positive effect of employment change on population change might support arguments offered by Giuliano and Small (1991). They contend that more dominant suburban cities, unlike the CBDs they resemble, attract a mix of population and employment. This is suggestive of a reduction in the functional differentiation among suburbs. Residential suburbs attract employment and take on economic functions. In this case the hierarchical differentiation among suburban cities also may decrease.

These divergent interpretations of suburban dynamics clearly indicate that an analysis of the reciprocal relationship between population change and employment change is warranted. A more complex model is needed to tease out the real affects of dominance on growth. This also may provide a better indication of future developments in metropolitan form and the suburban hierarchy.

A second conclusion to be drawn from this research is that characteristics of the individual suburban city are more important predictors of growth than characteristics of the center city and metropolitan community, and although not directly tested here I would suspect they are more important than characteristics of the region as well. Individual suburbs do not equally reflect system dynamics. This raises the question of unmeasured characteristics of suburban cities and their effects on population and employment change. Suburbs adopt various strategies to encourage, or discourage, population and employment growth. In addition to the ecological characteristics included here zoning regulations, tax structures and infrastructure improvements also may affect the growth of a suburban city.

One indication that political strategies might influence a suburban city's future position in the metropolitan hierarchy are the divergent effects of annexation on population and employment change. The positive coefficient of annexation in the population change model and the negative effect evidenced in the employment change model suggest that suburban cities tend to annex areas occupied by population rather than economic activity. Increased population (and the increased land area

incorporated during annexation) places higher demands on public services such as sewage and garbage disposal, and police and fire protection. The increase tax revenue generated by the annexed population, however, may not offset the increased costs of providing them with public services. In the future these cities may be unable, or unwilling, to offer incentives and an atmosphere attractive to business. This may solidify their position as residential suburbs and increase the hierarchical differentiation among suburban cities.

An issue that this research does not address, although one the analysis suggests might be important, is that of the relationship between metropolitan structure and metropolitan growth. These 41 multinodal metropolitan areas represent only 13 percent of 1980 SMSAs, yet they garnered half of national population and employment growth through this time period. This raises the question: Does the multicentered form, with its hierarchical system of cities, foster employment and population growth, or is the more complex form the outcome of past system expansion?

Though questions remain to be addressed, it is clear that hierarchical differentiation among suburbs exists. Network position significantly affects a suburban city's ability to attract, or retain, population and jobs. Because the effects of dominance, and other ecological characteristics, vary across the two processes, this analysis suggests that cities occupying different positions in the metropolitan system may be impacted quite differently by national demographic and economic dynamics.

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FOOTNOTES

[1]Metropolitan areas were selected, and defined as multinodal, if they contained more large suburban cities (of at least 25,000 population in 1980) than they had center cities. In most cases a metropolitan area needed two large suburbs to be classified as multinodal, however, if the metropolitan area had more than one center city (i.e. Minneapolis/St. Paul) it required three or more suburban cities to be included in the analysis. See Hughes (1991) for a more detailed discussion of the selection of metropolitan areas and suburban cities.

[2]These are calculated from employment by place of work data from the 1980 Census of Population and Housing. They will not match percentages calculated from Table 5 because "Total Employment" from the 1982 Economic Censuses excludes several industry lines.

[3]The journey-to-work items are on the Census long form and are asked to approximately 20% of households. Only half of the responses to these items from the 1980 census were coded. This analysis, then, is based on a 10% (approximately) sample of the 1980 census count. Because the commuting flows analyzed here are large, this does not significantly bias the results.

[4]Excellent discussions of the mathematical foundations of graph theory (e.g. Buckley and Harary 1990; Busacker and Saaty 1965; Harary, Norman and Cartwright 1965) and of sociological applications of this theory (e.g. Bonacich 1972,1987; Freeman 1979; Friedkin 1991; Marsden 1981) are available. It is important to note here, however, that there are a variety of graph theoretic measures, each relying on different assumptions about the causes and effects of relative network position. These are categorized as degree, betweenness, closeness and competitive distance measures (Bolland 1988; Bonacich 1987; Freeman 1979).

[5]According to Bonacich, ". . . α is selected so that

$$\sum_i c_i(\alpha,\beta)^2,$$

the squared length of $c(\alpha,\beta)$, equals the number of units in the network" (1987:1173). I use an iterative routine, written in SAS/IML (version 6), to select α and calculate $c_i(\alpha,\beta)$.

[6]The transformation performed here is a simple proportioning of the matrix and is consistent with graph-theoretic principles (Harary, Norman and Cartwright 1965:369-70).

[7]Distance is calculated from longitude and latitude coordinates (U.S. Bureau of the Census 1983).

Table 1. Definition of Variables in Models of Suburban Population and Employment Change

Variable	Definition	Source
Population Change	Absolute change in Population, 1980-1990	U.S. Bureau of the Census (1980, 1990)
Employment Change	Absolute change in Employment[1], 1982-1987	U.S. Economic Censuses (1982, 1987)
Characteristics of the suburban city:		
Network Position	Suburban city's Bonacich centrality score of position the commuting network, 1980	U.S. Bureau of the Census (1980)
SC Sales Sufficiency	Suburban city's sales sufficiency index, 1982 (in wholesale, retail and services)	U.S. Economic Censuses (1982)
Service Specialization	Suburban city's service specialization index, 1982	Census of Service Industries (1982)
Population	Population of the suburban city, 1980	U.S. Bureau of the Census (1980)
Distance to Center City	Straight-line distance from suburb to center city, in miles[2]	U.S. Bureau of the Census (1980)
Population Potential	Zipf (1946) score of population potential between suburb and center city, 1980	U.S. Bureau of the Census (1980)
Age of Suburban City	Number of years since suburban city first reached 25,000 population	U.S. Bureau of the Census
Density of Suburban City	Persons per square mile in suburban city, 1980	County & City Data Book (1988)
Annexation	Difference in land area, 1980-1990	U.S. Bureau of the Census (1980, 1990)
Characteristics of the center city:		
Age of Center City	Number of years since center city first reached 50,000 population[3]	U.S. Bureau of the Census
CC Sales Sufficiency	Center city's sales sufficiency index, 1982 (in wholesale, retail and services)	U.S. Economic Censuses (1982)
Manufacturing Specialization	Center city's manufacturing specialization index, 1982	Census of Manufactures (1982)

(Table 1 continued)

Characteristics of the metropolitan area:

Network Centralization	Modified Freeman (1979) measure of network centralization (Irwin and Hughes 1992), 1980	U.S. Bureau of the Census (1980)
Orientation	Orientation of metropolitan economy as classified by Noyelle and Stanback; recoded[4]: 0=Diversified node 1=Specialized node	Noyelle and Stanback (1984)
Region	Census region in which SMSA is located; recoded: 0=Northeast and North Central 1=South and West	U.S. Bureau of the Census (1980)
Number of Suburban Cities	Number of suburban cities over 25,000 in SMSA, 1980	U.S. Bureau of the Census (1980)
SA Population Change, 1980-1990	SMSA population change between 1980 & 1990. Excludes individual suburban city change	U.S. Bureau of the Census (1980, 1990)
SA Employment Change, 1982-1987	SMSA employment change between 1982 & 1987. Excludes individual suburban city change[1]	U.S. Economic Censuses (1982, 1987)
Area of SMSA	Area of metropolitan area, 1980	State & Metropolitan Area Data Book 1982

[1]Total employment is the sum of employment in manufacturing, wholesale, retailing and services industries, as reported in the 1982 and 1987 Economic Censuses.

[2]Distance is calculated from longitude and latitude coordinates. In SMSAs with multiple center cities distance is to the nearest center city.

[3]In SMSAs with multiple center cities age is calculated on the first center city to reach 50,000 population or to be officially designated a center city of the SMSA.

[4]Noyelle and Stanback's "Diversified Service Centers" are coded 0; "Specialized Service Centers", "Production Centers", and "Consumer Oriented Centers" are coded 1.

Table 2. Population Change By Type of Place and Level of Dominance[1], 1980-1990

Type of Place	N	Population		Change	
		1980	1990	Absolute	Percent
Nation		226,545,805	248,710,000	22,164,195	9.8
Multinodal SMSAs[2]	41	91,754,790	102,993,804	11,239,014	12.2
Center Cities	55	34,895,499	36,280,149	1,384,650	4.0
Suburban Ring	41	56,859,291	66,713,655	9,854,364	17.3
Centrality > .79	20	1,748,021	1,870,314	122,293	7.0
Centrality .57-.79	28	2,031,481	2,317,892	286,411	14.1
Centrality .35-.56	92	4,964,768	6,005,609	1,040,841	20.0
Centrality .12-.34	214	10,047,124	11,500,955	1,453,831	14.5
Centrality < .12	30	949,447	1,004,656	55,209	5.8
Balance[3]	41	37,118,450	44,014,229	6,895,779	18.6

[1]level of dominance is based on centrality in the 1980 commuting network

[2]boundaries held constant at 1980 definitions

[3]places less than 25,000 population and population in unincorporated communities, 1980

Table 3. Distribution of Metropolitan and Suburban Population, 1980 and 1990

Type of Place	Percent of 1980 Population	Percent of 1990 Population
A. Distribution of Metropolitan Population[1]		
Center Cities	38.0	35.2
Suburban Ring	62.0	64.8
Centrality > .79[2]	1.9	1.8
Centrality .57-.79	2.2	2.3
Centrality .35-.56	5.4	5.8
Centrality .12-.34	10.9	11.2
Centrality < .12	1.0	1.0
Balance[3]	40.5	42.7
B. Distribution of Suburban Population		
Centrality > .79[2]	3.1	2.8
Centrality .57-.79	3.6	3.5
Centrality .35-.56	8.7	9.0
Centrality .12-.34	17.7	17.2
Centrality < .12	1.7	1.5
Balance[3]	65.3	66.0

[1]boundaries held constant at 1980 definitions

[2]suburban cities, based on centrality in the 1980 commuting network

[3]places less than 25,000 population and population in unincorporated communities

Table 4. Standardized Regression (OLS) and Sheaf Coefficients of Population Change

Independent variables	Population Change	Sheaf Coefficient
Characteristics of the suburban city:		.606 ***
Network Position, 1980	-.090 [a]	
SC Sales Sufficiency, 1980	-.071 [a]	
Service Specialization, 1980	-.106 **	
Population, 1980	.189 ***	
Distance to Center City	.121 **	
Population Potential, 1980	-.019	
Age of Suburban City	-.056	
Density of Suburban City, 1980	-.030	
Employment Change, 1982-1987	.297 ***	
Annexation, 1980-1990	.317 ***	
Characteristics of the center city:		.251 ***
Age of Center City	-.220 ***	
CC Sales Sufficiency, 1980	-.011	
Manufacturing Specialization, 1980	-.084 *	
Characteristics of the SMSA:		.289 ***
Network Centralization, 1980	.039	
Orientation (Specialized node=1)	-.096	
Number of Suburban Cities, 1980	-.218 ***	
SA Population Change 1980-1990[1]	.189 ***	
Area of SMSA, 1980	.121 **	
Number of cases	384	
R^2	.609	
Prob > F	.0001	

[a] $p < 1.0$ * $p < .05$ ** $p < .01$ *** $p < .001$

[1] Absolute metropolitan population change (held constant at 1980 boundaries) minus the absolute population change of the suburban city.

Table 5. Employment Change By Type of Place and Level of Dominance[1], 1982-1987

Type of Place	N	Total Employment[2] 1982	1987	Change Absolute	Percent
Nation		49,652,937	58,393,900	8,740,963	17.6
Multinodal SMSAs[3]	41	23,053,947	27,322,080	4,268,133	18.5
Center Cities	55	9,884,457	10,776,272	891,815	9.0
Suburban Ring	41	13,169,490	16,545,808	3,376,318	25.6
Centrality > .79	20	840,210	990,359	150,149	17.9
Centrality .57-.79	28	690,353	856,568	166,215	24.1
Centrality .35-.56	92	1,437,942	1,833,565	395,623	27.5
Centrality .12-.34	214	2,267,272	2,883,297	616,025	27.2
Centrality < .12	30	106,003	146,083	40,080	37.8
Balance[4]	41	7,827,710	9,835,936	2,008,226	25.7

[1]level of dominance is based on centrality in the 1980 commuting network

[2]total employment is the sum employment in manufacturing, wholesale, retail and services, as reported in the 1982 and 1987 Economic Censuses

[3]boundaries held constant at 1980 definitions

[4]places less than 25,000 population and population in unincorporated communities, 1980

Table 6. Distribution of Metropolitan and Suburban Employment, 1982 and 1987

Type of Place	Percent of 1982 Employment	Percent of 1987 Employment
A. Distribution of Metropolitan Employment[1]		
Center Cities	42.9	39.4
Suburban Ring	57.1	60.6
Centrality > .79[2]	3.6	3.6
Centrality .57-.79	3.0	3.1
Centrality .35-.56	6.2	6.7
Centrality .12-.34	9.8	10.6
Centrality < .12	0.5	0.5
Balance[3]	34.0	36.0
B. Distribution of Suburban Employment		
Centrality > .79[2]	6.4	6.0
Centrality .57-.79	5.2	5.2
Centrality .35-.56	10.9	11.1
Centrality .12-.34	17.2	17.4
Centrality < .12	0.8	0.9
Balance[3]	59.4	59.4

[1]boundaries held constant at 1980 definitions

[2]suburban cities, based on centrality in the 1980 commuting network

[3]places less than 25,000 population and population in unincorporated communities

Table 7. Standardized Regression (OLS) and Sheaf Coefficients of Employment Change

Independent variables	Employment Change	Sheaf Coefficient
Characteristics of the suburban city:		.726 ***
Network Position, 1980	.234 ***	
SC Sales Sufficiency, 1980	.271 ***	
Service Specialization, 1980	.060	
Distance to Center City	-.024	
Population Potential, 1980	.124 **	
Age of Suburban City	-.225 ***	
Density of Suburban City, 1980	-.060	
Population Change, 1980-1990	.479 ***	
Annexation, 1980-1990	-.006	
Characteristics of the center city:		.141 ***
Age of Center City	.122 [a]	
CC Sales Sufficiency, 1980	.007	
Manufacturing Specialization, 1980	.052	
Characteristics of the SMSA:		.165 ***
Network Centralization, 1980	.011	
Orientation (Specialized node=1)	.103	
Region (South and West=1)	-.062	
SA Employment Change 1982-1987[1]	.159 **	
Area of SMSA, 1980	-.039	
Number of cases	384	
R^2	.468	
Prob > F	.0001	

[a] $p < 1.0$ *$p < .05$ **$p < .01$ ***$p < .001$

[1] Absolute metropolitan employment change (held constant at 1980 boundaries) minus the absolute employment change of the suburban city.

Figure 1. Population Change by Type of Place

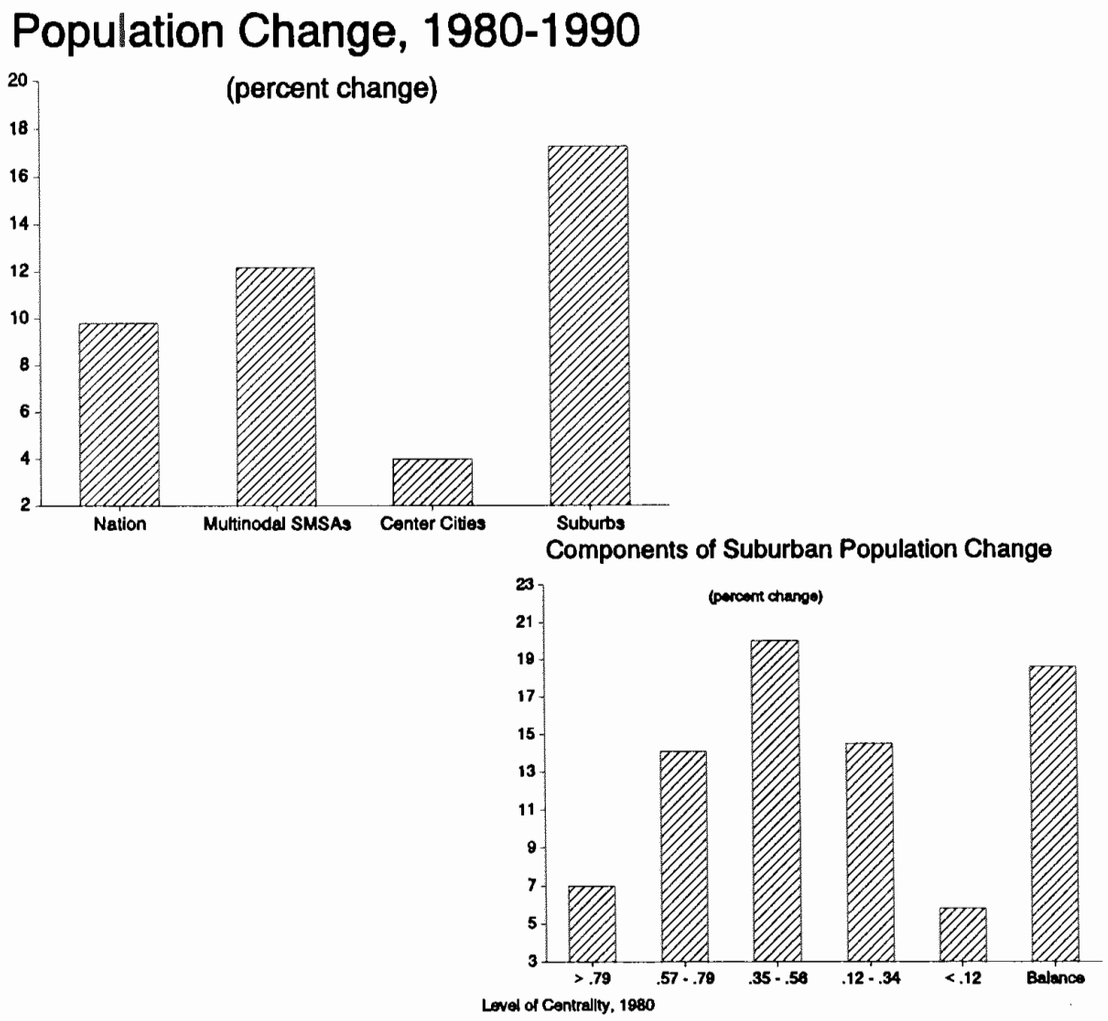
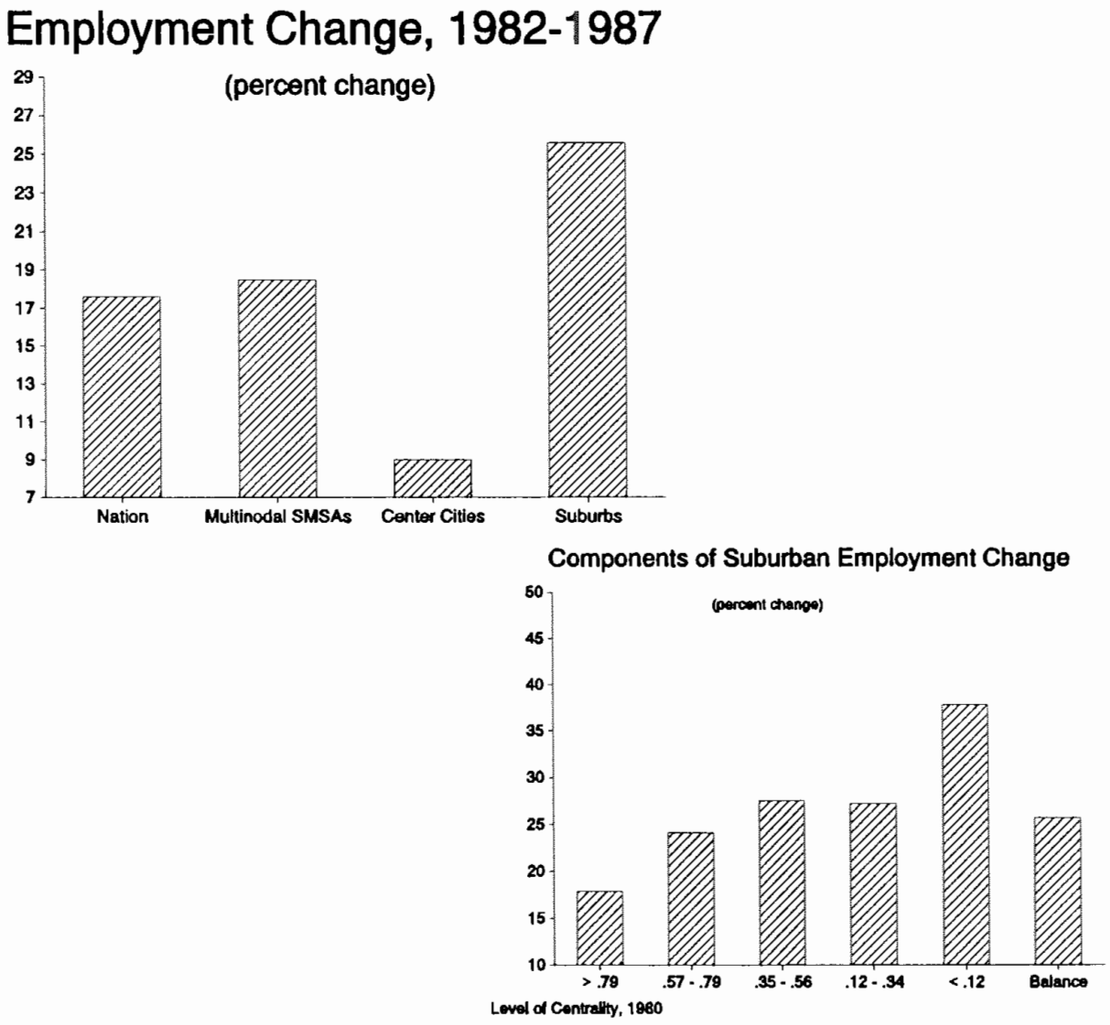


Figure 2. Employment Change by Type of Place



Appendix 1. Metropolitan Areas Included in Analysis

FIPS Code	SMSA Name
80	Akron
360	Anaheim/Santa Ana/Garden Grove
520	Atlanta
1120	Boston
1280	Buffalo
1600	Chicago
1640	Cincinnati
1680	Cleveland
1840	Columbus
1920	Dallas/Fort Worth
2000	Dayton
2080	Denver/Boulder
2160	Detroit
2680	Fort Lauderdale/Hollywood
3000	Grand Rapids
3360	Houston
3640	Jersey City
3760	Kansas City
4480	Los Angeles/Long Beach
5000	Miami
5080	Milwaukee
5120	Minneapolis/St. Paul
5560	New Orleans
5600	New York
5640	Newark
5880	Oklahoma City
6160	Philadelphia
6200	Phoenix
6280	Pittsburgh
6440	Portland, OR
6780	Riverside/San Bernardino/Ontario
6920	Sacramento
7040	St. Louis
7160	Salt Lake City/Ogden
7320	San Diego
7360	San Francisco/Oakland
7400	San Jose
7600	Seattle/Everett
8280	Tampa/St. Petersburg
8840	Washington DC
8960	West Palm Beach/Boca Raton

Appendix 2. Standardized Regression (OLS) and Sheaf Coefficients of Network Position

Independent variables	Network Position	Sheaf Coefficient
Characteristics of the suburban city:		.619 ***
SC Sales Sufficiency	.338 ***	
Service Specialization	-.139 ***	
Population	.374 ***	
Distance to Center City	.150 ***	
Population Potential	.042	
Age of Suburban City	.203 ***	
Density of Suburban City	-.058	
Characteristics of the center city:		.262 ***
Age of Center City	-.189 **	
CC Sales Sufficiency	-.054	
Manufacturing Specialization	-.139 ***	
Characteristics of the SMSA:		.486 ***
Network Centralization	-.281 ***	
Orientation (Specialized node=1)	.090	
Region (South and West=1)	.058	
Number of Suburban Cities	-.244 ***	
Population Change, 1960-1980	-.021	
Area of SMSA	-.006	
Number of cases	385[1]	
R^2	.585	
Prob > F	.0001	

*$p < .05$ **$p < .01$ ***$p < .001$

[1]This analysis includes 385 suburban cities, rather than the 384 in the analyses of population and employment change. The Bureau of the Census changed the place code for one of these cities between 1980 and 1990 (Monroeville PA in the Pittsburgh SMSA: centrality score = 0.37) and it was inadvertently omitted from the 1987 and 1990 datasets. Revisions of this paper will correct this error, although I doubt the results will change.

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