Urban Decentralization: A Redefinition Applied to the Urban Field of Chicago

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Recent studies reflect growing awareness of the complexity of the decentralization process in large urban regions. Nevertheless, most studies treat the decentralization phenomenon via methods unsuited to its complex nature. In this study, decentralization is perceived as a multi-component process consisting of: distance, space, time, pace, direction, and intensity. The interplay among these components helps to define the concept and together they constitute the decentralization pattern for any specific production sector. Decentralization is analyzed by a spatiotemporal polynomial power series model suggested by Krakover (1983). This method is capable of presenting patterns of structural change in urban regions by inspection of five out of the six components (space is excluded). The method is applied using employment data from five production sectors in the urban field of Chicago. The results demonstrate the advantages of the proposed method for the analysis of the process of decentralization.

Decentralization, as a major issue in the study of metropolitan growth, has focused on a variety of phenomena, such as the redistribution of people (e.g., Newling, 1969), employment (Niedercorn and Kain, 1963; Krakover, 1984), and commerce (Kellerman, 1985). It has been established that metropolitan areas have changed from uninodal into multinodal cities (Odland, 1978; Muller, 1981; Erickson, 1986). Nevertheless, despite the wealth of knowledge accumulated around the notion of decentralization, several aspects need further clarification. One such aspect, which is beyond the scope of this paper, is a unified general theory of the process which still awaits its advancement. However, theoretical breakthroughs are rather unlikely before another more fundamental and relatively neglected aspect—the definitional problem—is given its due treatment. The redefinition of the decentralization process as a multi-component trend is at the core of this paper. A conceptual discussion of the components of decentralization and a consequent extended definition are presented in the first section.

In the second section the extended definition is demonstrated via a spatiotemporal polynomial power series model proposed by Krakover (1983). This method enables

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simultaneous identification and measurement of several components embedded in the urban decentralization trend. In the final section, the extended definition and the accompanying methodology are demonstrated using employment data of the urban field of Chicago.

THE DEFINITION OF DECENTRALIZATION AND ITS COMPONENTS

Two recent and representative definitions of decentralization are utilized as departure points for the following discussion. Muller (1981, p.xi) asserted that "decentralization refers to the specific relocation of people and activities from city to suburbs." According to this definition, decentralization is restricted to the actual intraurban movements in a specific direction and, thus, is equated with a certain type of migration flow. Therefore, decentralization, i.e. city-suburb migration, may be identified even in cases where central cities grow faster than their suburban rings.

Another definition was offered by Berry and Kasarda (1977, p.180), who used the term decentralization "to denote the process whereby a suburban ring grows faster, either in relative percentage rates or in absolute numbers, than the central city." This definition suggests that decentralization does not necessarily originate in relocations from the central city to the suburbs, though relocations certainly contribute to the differential growth rates in these two areas. Berry and Kasarda's definition permits, however, growth stemming from other origins, such as different natural growth rates of population, or locational decisions of people coming from outside the region. Thus, they use the term decentralization in a rather conceptual sense to refer to a situation wherein the higher suburban growth is caused by residents or entrepreneurs preferring either to stay in or to move to the suburbs, irrespective of their origin.

Another distinction between the definitions offered by Muller and Berry and Kasarda is the way they treat the time dimension. While, in Muller's view, decentralization is identifiable even in a single time observation, Berry and Kasarda's definition requires the comparative analysis of observations sampled at at least two points in time. Thus, these two definitions, like most others, explicitly or implicitly emphasize the spatial and temporal aspects of decentralization. It is argued, however, that in order to encompass the complex urban decentralization process, attention should be devoted not only to space and time, but also to the following additional components: distance, pace, direction, and intensity (Krakover, 1986).

The contribution of each of these six components to the comprehension of the decentralization process is briefly presented in the following paragraphs. It is also shown that most, if not all, previous studies on urban decentralization failed to identify the multi-faceted nature of the urban expansion process.

THE COMPONENTS OF URBAN DECENTRALIZATION

Space: Generally, decentralization does not spread equally in all directions around the city center. Factors such as physical barriers, urban zoning, urban corridor effects, and social spatial textures may cause decentralization to start or intensify earlier in a selected geographic sector of an urban area. It may take another period of time until urban attributes spread in other directions around the central city, though with different timing, pace, and intensity. The radially differential spread in various directions complicates the definition, and hence the measurement of decentralization.

Decentralization studies do not usually make reference either in their definition or in their analysis to differentially spreading urban space. This shortcoming is reflected in the many studies that attempted analyses of decentralization by comparisons of urban-suburban changes as two distinctly dichotomous and spaceless observation points (Weber, 1899, p.463; Harris, 1943; Schnore, 1957; Tarver, 1957; Niedercorn and Kain, 1963; Cox and Erickson, 1967; Schnore and Klaff, 1972; Berry and Cohen, 1973; Swan, 1973; Muller, 1981; Steiness, 1982). Exceptions can be found among studies dealing with the spatial distribution of urban densities which applied trend surface analysis (Hill, 1973; Schroeder and Sjoquist, 1976). The results obtained by the application of this technique are, however, plagued by several problems, such as boundary effects (Griffith, 1983), the distribution of control points (Unwin and Wrigley, 1987), the displacement of peak points, and the disappearence of the central city observation as an area of lower population density (Barnbrock and Greene, 1977).

Time: The time spans which separate the temporal readings of the decentralization process appear to be an important factor in the determination of other decentralization components. Most decentralization studies explicitly incorporated the time dimension, usually by comparing intercensal data, about ten years apart. In contemporary urban spatial organization processes, a period of ten years seems to be long enough not only to reveal decentralization, but also to conceal directional swings which may have occurred. Obviously, more frequent temporal observations would yield more detailed results. It is argued here that the additional resources invested in the compilation and processing of additional data are more than compensated for by the deeper insight that can be gained through detailed temporal analysis. Without incorporation of detailed temporal information, one is very unlikely to arrive at an estimate of the changes in the pace and directional components of the decentralization process (see also Krakover, 1983).

Distance: Decentralization involves the examination of relocations or differential growth levels in at least two locales separated by distance. How far apart these locales are from each other is an important piece of information relevant to the evaluation of the decentralization process. The measurement of distance is relatively simple when only two observation units are involved. Usually, however, decentralization is studied in areas subdivided into many geographical units. In such cases some criteria have to be developed regarding the measurement of distances pertaining to the decentralization process.

The aforementioned studies, by applying the urban-suburban dichotomy approach, were unable either to specify or to measure the distance component. Other studies attempted an incorporation of the distance component by use of data aggregated for several rings or distance bands (Bogue, 1950; Hawley, 1956; James and Hughes, 1973; Hall and Hay, 1980; Erickson, 1983). Analysis of change in population or employment in distance bands along time allows for identification of intensities of decentralization and their variation through time in a discrete stepped cross-section of the urban region. Although the distance band method considers the components of time, distance, and intensity, it yields only a crude measure of pace, depending on the width of the distance bands and on the time spans separating the temporal readings. These studies were also unable to report directional changes, probably due to the crude measurements of distance and time. Pioneering research suggesting methods of measurement along continuous linearly-arranged observations was presented by Blumenfeld (1954), Boyce (1966), Newling (1969), and Casetti (1972; 1973).

Pace: The pace component refers to the spatial spread of urban growth per unit of time. Measurement of the pace component may provide useful information for analyzing the dynamics of urban growth processes. The pace component may be derived only once the components of distance and time have been accurately measured; therefore it is necessary to trace and register the process of urban spread at as many spatial and temporal readings as possible. Thus, if we accept that pace is a significant component of the definition of decentralization, then, by the same token, we must accept the inclusion of distance and time components. None of the studies reviewed for this paper dealt with the pace component, either conceptually or empirically.

Direction: Another neglected component of decentralization is the direction of the spread of growth. By direction we do not mean the azimuth around the city center (that is covered by the space component), but rather the outward-inward, or spread-backwash, trends. Although by definition decentralization indicates an outward movement of population and economic activities (or their differential growth), recent studies have revealed that the process is not unidirectional. Krakover (1983; 1984) showed that the peak point of differential growth may, at times, move backward; and Erickson (1983) demonstrated that a process of late infilling followed an earlier stage of dispersal. The process of central city gentrification also seems to suggest a certain type of counterbalancing flow (Smith, 1982; Harrison, 1983; Schaffer and Smith, 1986). Certainly, this evidence does not mean that decentralization is reversed, as is sometimes claimed (Plaut, 1983). Rather, it indicates that there might exist some short-term backward fluctuations on top of the long-term decentralization trend. Therefore, a definition which does not provide for the inclusion of such temporary backward trends seems to miss an important facet in the spatial organization of urban areas.

Intensity: The last component, usually only implicitly included in decentralization studies, is intensity. This refers to the level of growth registered at certain critical points, or in specified segments of the urban space. As critical points one may select observations with the highest and lowest growth levels, and the level of growth in the central city and in certain suburban and exurban areas. Once critical points are identified and their growth levels measured, it is possible to calculate differences or ratios between the values measured at these critical points. Most studies of decentralization tabulate the shifting shares or the differential growth rates of population or employment between city and suburbs, or their distribution along distance bands. However, the value of these exercises cannot be fully realized for conceptual analysis, or for applied research, until a method is proposed to disaggregate the spatial information. In other words, while it is useful to sketch out the pattern of decentralization in broad lines, it is also desirable at the same time to relate actual and expected intensity levels to specific locations.

If the scope of urban decentralization is broadened to include all the aforementioned components, then the concept should be redefined as: the pace and intensity by which differential growth spreads along time throughout an urban space from the core to outer areas, allowing for temporary directional shifts.

Despite the advances made in theory and quantitative techniques, the basic empirical method applied for the study of decentralization has not changed. The most common method involves the comparison of shares or percentage growth of population or employment in the city and the suburbs as two distinct spaceless points (e.g. Schnore, 1957; Niedercorn and Kain, 1963; Berry and Cohen, 1973; Muller, 1981). None of these studies, regardless of their objectives, could draw any conclusions concerning distance or the space components of the decentralization process. Since the distance element is missing, there is nothing that can be said about the pace component (in terms of miles per unit of time), nor about the directional changes in the spatial reorganization taking place in the urban region. The findings of these studies are therefore restricted to the timing of changes in the intensity of the differential growth (or shifts in shares) between suburbs and central cities.

The other common method for the analysis of decentralization uses the distance band technique. According to this technique, urban space is divided into distance bands or rings, and averages of all observations in each ring are taken to represent the intensity of decentralization for the whole ring. This method may yield some crude measurements concerning the distance and pace components, but it is still unable to relate the differential intensities to specific locations and to identify directional changes. In the following section, Krakover's (1983) method is proposed as a technique capable of measuring five out of the six components of decentralization outlined above (distance, time, pace, direction and intensity). Even the missing space component is partially addressed by the proposed method in its ability to preserve and display information on any of the individual geographical units included in the analysis.

MEASURING THE DECENTRALIZATION COMPONENTS:

Geographic Units and Variables

Since distances to the city center and time units are the very basic elements of the decentralization process, they should be recorded as finely and as accurately as possible. The territorial extent of the urban region may be subdivided into geographical units such as census tracts, statistical areas, townships, counties or other statistical or political divisions. Once appropriate geographical observation units are selected, the distance of each unit from the city center has to be measured. Distances may be expressed in terms of actual distances in miles or in terms of travelling time and cost from the population gravity center of each geographical unit to the city center of the major metropolis in the area.

The selection of proper time intervals is problematic. The literature review revealed that ten-year intervals are too long to uncover the intricacies of decentralization. Examination of large data sets on employment growth in sub-metropolitan units indicates that growth is composed of two interrelated trends: a long-term trend caused by decentralization and short-term trends representing local business fluctuations. The availability of annual data would allow not only for the identification of the short-term growth component, but also for the application of a moving average method as a remedial treatment, if required. Shorter than annual time intervals do not seem to be required, since they may accentuate the redundant short-term fluctuations.

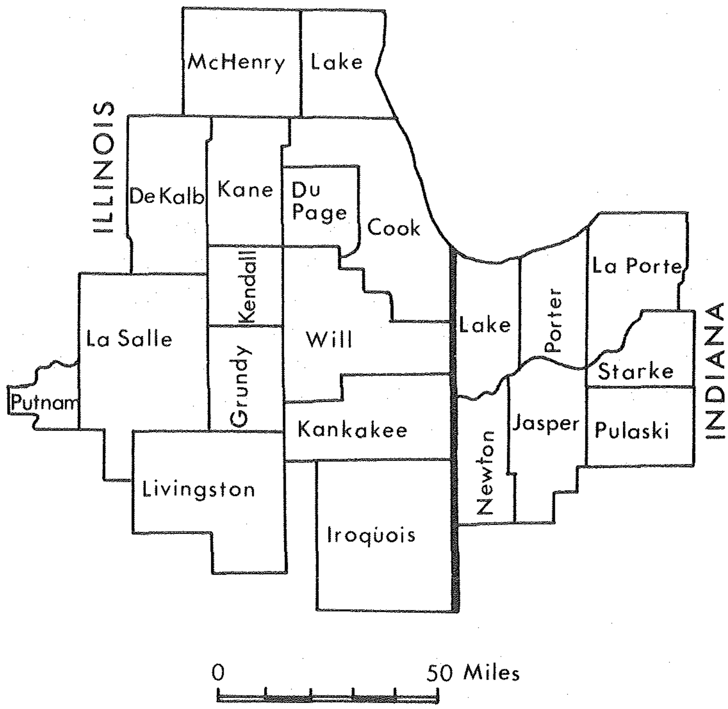
When all geographic observation units (u) within an urban region are arranged linearly according to their distances (d) from the city center, and annual data (t) are available for each geographic observation unit, the data may be organized in a spatiotemporal matrix of (u) by (t) entries. As a means of tracing decentralization, one may utilize population counts, total employment, employment in a particular economic sector, the issuance of building permits, and the like. When the spatio-temporal data matrix is completed, it is possible to analyze the temporal changes in the pattern of the linearly arranged data. The analysis may proceed by using the raw data as total counts or by adopting one of the several common transformations such as growth indices, changes in shares, growth rates, and densities, depending on the objectives of the study. Whichever transformation is used, the complex set of spatiotemporal data may contain some irregularities representing unique conditions. In order to derive the general trends, the matrix should be subjected to a curve-fitting technique by the selection of an algorithm compatible with the conceptual framework on the one hand, and the complexity of the data and the geographic area on the other.

Study Area

In this study the urban field of Chicago (Fig. 1) was selected as an example through which the utility of the proposed definition of decentralization can be demonstrated. The Chicago urban field, rather than its MSA, was used because of abundant evidence accumulated during the 1970s on growth trends taking place beyond the metropolitan boundaries (e.g., Beale, 1977; Berry and Gillard, 1977; Gordon, 1979; Erickson, 1983; Jones *et al.*, 1984). The geographical definition of the urban field of Chicago is adopted from the U.S. Bureau of Economic Analysis (U.S. Department of commerce, 1975;1977). According to this delineation, the urban field of Chicago includes 21 counties divided among the states of Illinois (14) and Indiana (7). In 1980, nine counties out of the twenty-one were defined as metropolitan counties. In that year, the urban field of Chicago housed about 8.4 million people, occupying more than 12,500 square miles, though 62.7 percent of the total population still resided in the central Cook County, which occupied only 7.6 percent of the total area.

Due to the immense territorial extent of the Chicago urban field, counties were used as geographic observation units. Smaller observation units were judged inadequate because they introduced redundant spatial variability. Thus, the 21 counties comprising the urban field of Chicago were arranged according to distances of their population gravity centers (U.S. Department of Commerce, 1974) from the city center of Chicago. The distances were measured in miles along major highways. (It has been impossible to obtain travelling time and cost information for all annual observations included in the study.)

Figure 1: The urban field of Chicago.



The selected period for the study is 1962 to 1980. This period witnessed the development of big suburban shopping malls, the construction of the interstate highway system (including circumferential beltways), the acceleration of the suburbanization process, the decentralization of trade and services, and the migration turnaround observed in exurban areas. Annual data were available through the *County Business Pattern*, 1962, 1964-1980 (U.S. Department of Commerce, 1980), in which information on employment by workplace are compiled annually for each county and for several levels of the Standard Industrial Classification (SIC). In order to demonstrate the variability of the decentralization components, five major SIC sectors were selected: manufacturing industries, retail trade, wholesale trade, services, and

FIRE (finance, insurance and real estate). The data for each of these sectors have been tabulated in a spatiotemporal matrix. In each matrix, the 21 geographic observations (counties) were arranged according to their distances from the Chicago city center along the horizontal axis, while the 19 temporal readings between 1962 and 1980 were arranged, for each observation, along the vertical axis. In order to remove redundant short-term fluctuations, a three-year moving average has been applied, thus truncating the matrices to 21x17, leaving a total of 357 entries in each of the five matrices.

Since the extended definition for decentralization proposed here adopts Berry and Kasarda's (1977) assertion that decentralization is observable by tracing geographic differential growth, the raw data entries were transformed into growth indices, independently for each county and for each economic sector, with the year 1963 serving as the base year. By adopting this method, the counties are compared along their growth performances while the absolute figures have been ignored. Nevertheless, the use of annual data makes it possible to detect secular trends or inconceivable irregularities.

The Applied Model

Consistent with the definitional requirements, the technique sought for processing growth data matrices should be able to preserve the geographic and temporal location of each data entry. Another general requirement is that the adopted technique will not impose a predetermined structure on the data. The technique selected here is a spatiotemporal polynomial power series regression model suggested by Krakover (1983). This polynomial raises the spatial measurement of distance (d) to the 4th degree, and the temporal measurement of time (t) to the 2nd degree, according to the following specification:

$$G(d,t) = \sum_{j=0}^{2} a_j t^j + \sum_{i=1}^{4} \sum_{j=0}^{2} b_{ij} d^i t^j$$

where G(d,t) is the estimated growth level at any distance (d) and time (t), and a_j and b_{ij} are the parameters. As will be shown in the following section, this equation allows for the identification of growth patterns as complex as those described by curves consisting of two maxima and one minima points (or vice versa), side by side with less complex curves such as S-shapes, uninodal parabolas, and even simple distance-decay patterns.

The conceptual reasoning behind the attempt to trace such complex structures of growth distribution in urban fields has been set forth by Krakover (1984). Stated briefly, the expectation for the detection of two maxima points, one in suburbia and the other in exurbia, is related to intra-metropolitan location theory and central place theory. The suburban growth peak is predicted on the basis of theoretical developments concerning the notion of the multinodal city (von Boventer, 1976; White, 1976; Odland, 1978; Ogawa and Fujita, 1980; Erickson, 1986). The other growth peak represents an urban center located in the periphery of the urban field. The location of viable urban centers for the provision of services in the outer areas is predictable on the basis of central place theory. On the other hand, however, core-periphery conceptualization would predict the dominance of the central or suburban peak over the entire periphery of the urban field, thus generating expectations for the emergence of simpler forms. As mentioned above, the polynomial power series adopted for this study has the flexibility of accomodating the complex as well as the simple patterns.

DECENTRALIZATION COMPONENTS IN THE URBAN FIELD OF CHICAGO

The selected polynomial model has been applied to the spatiotemporal data matrices compiled for employment in manufacturing industries, retail trade, wholesale trade, services, and FIRE for the urban field of Chicago. The following analysis of the results is confined mainly to the definitional and measurement aspects, which are the focus of this paper. Thus, only brief comments will later be made on the specific urban decentralization situation in Chicago.

The estimated regression curves are portrayed in Figures 2-6. In these figures, the distance to the city center is presented on the horizontal axis, while estimated growth index and time dimension are read on the vertical axis. It is potentially possible to draw seventeen annual curves connecting the values obtained for all counties for each year. For the purpose of demonstrating the decentralization components, only five such curves were drawn for the years 1963, 1967, 1971, 1975 and 1979. For each curve, the location of the maxima and minima points, in terms of distance to the central city, were identified to the tenth of a mile, using the first derivative function. The results of these measurements are marked on the curves.

A comparison of the transformation of the curves along time permits identification of the decentralization components across a cross-section of the urban field. The measurements of five decentralization components—time, distance, pace, direction, and intensity—along with some parameters of the respective regression results, are presented in Table 1.

These results point out the insight gained by utilizing the extended definition and the accompanying method. The outlined methodology supplies measurements on several aspects of the decentralization phenomenon. For instance, with regard to the peak point of growth, it identifies the *distance* of the peak from the city center, and permits tracing changes in the location of the peak point along *time*. Thus, it is possible to calculate the distance shift of the peak of growth point, to monitor its timing, and hence to figure out the average annual shift, or what we have termed the *pace* component. Furthermore, the results obtained allow for identification of *directional changes* in the decentralization trend, as well as for their timing. These properties are obtained by the capability of the model to preserve the identity of each particular observation in space and time. The ability to keep track of each observation in the output permits measurement of the generalized growth level, or *intensity*, at each spatiotemporal location. This ability seems to compensate, to a certain degree, for the missing two-dimensional spatial component.

Table 1: Measurement of the decentralization components of the central peak of growth in the urban field of Chicago.

	Manufact-uring	Retail Trade	Wholesale Trade	Services	FIRE
No. of observations	357	357	357	357	357
R^2*	.36	.61	.27	.42	.51
Max. distance of peak	34.6	31.7	19.3	55.9	45.6
Year	1967	1971	1967	1967	1967
Min. distance of peak	31.2	30.6	16.8	36.4	31.2
Year	1979	1979	1979	1979	1979
Distance shift of peak in miles	-3.4	-1.1	-2.5	-19.5	-14.4
Time lapse between Min. and Max. in years	12	8	12	12	12
Pace, average annual shift of peak in miles	.283	.138	.208	1.625	1.200
Directional changes	B	S~B	S~B	S~B	B
Intensity of growth at peak point	260.0	293.2	620.7	429.1	381.5

Notes: * All results are significantly different than zero at a .0005 level.
B - Backwash
S~B - Spread followed by backwash

Figure 2: Spatiotemporal structure of differential growth of employment in Manufacturing Industries in the urban field of Chicago.

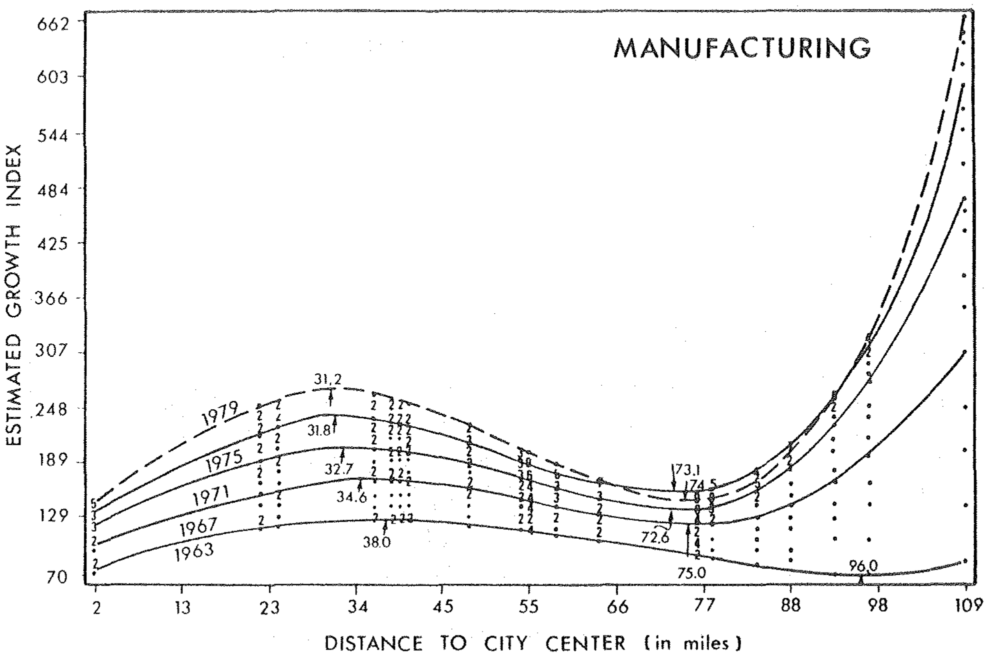


Figure 3: Spatiotemporal structure of differential growth of employment in Retail Trade in the urban field of Chicago.

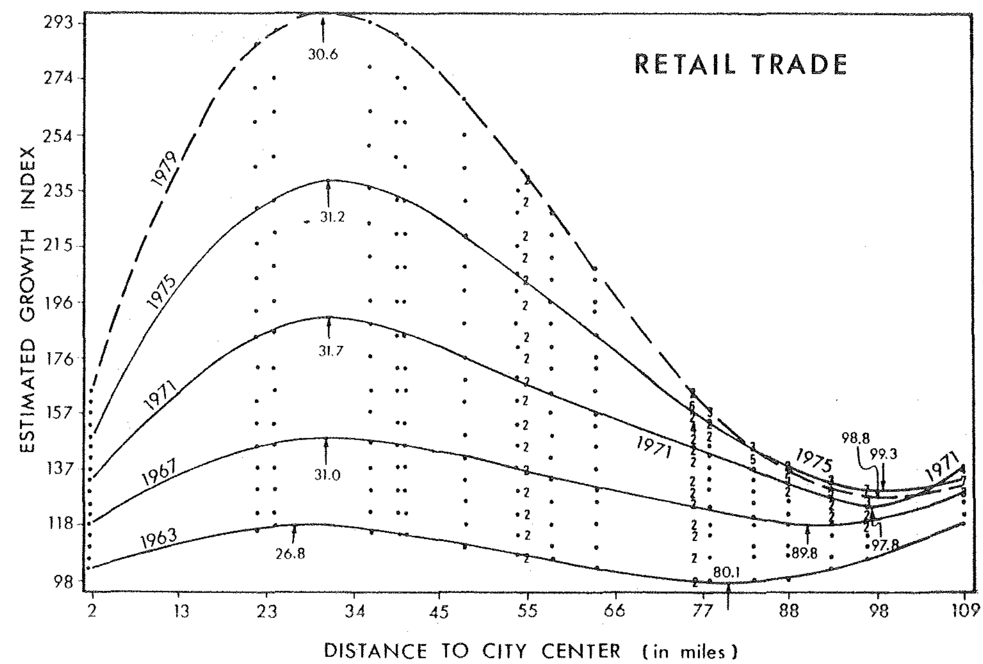


Figure 4: Spatiotemporal structure of differential growth of employment in the Wholesale Trade in the urban field of Chicago.

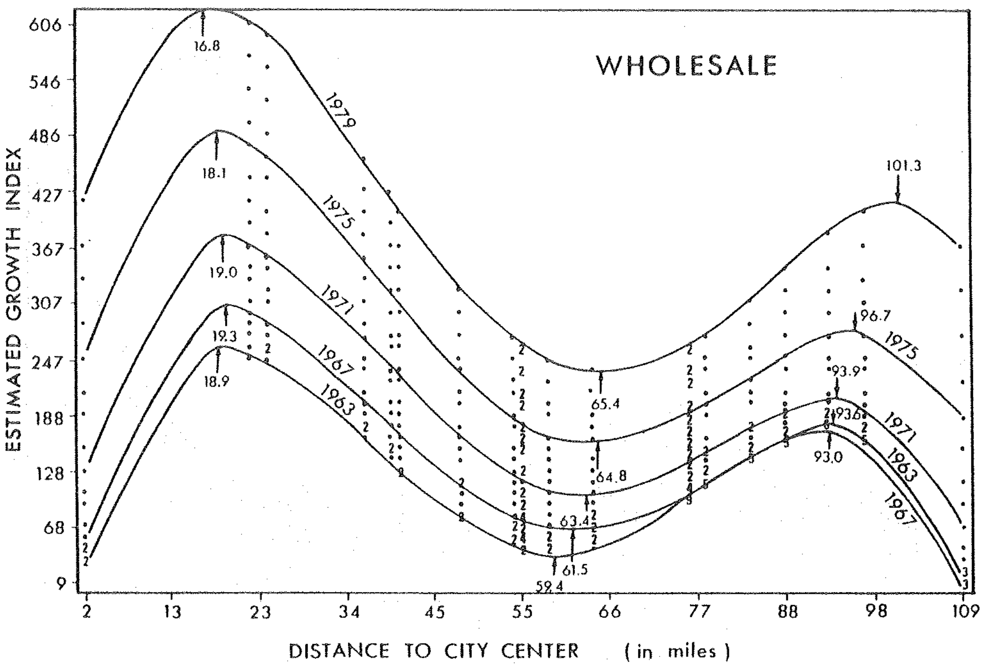
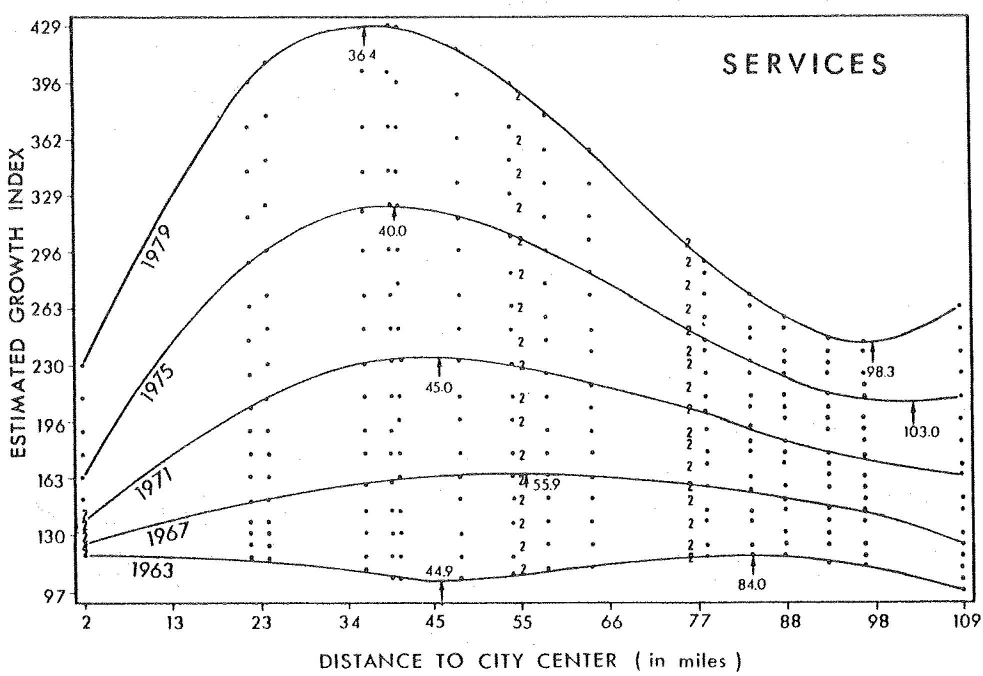
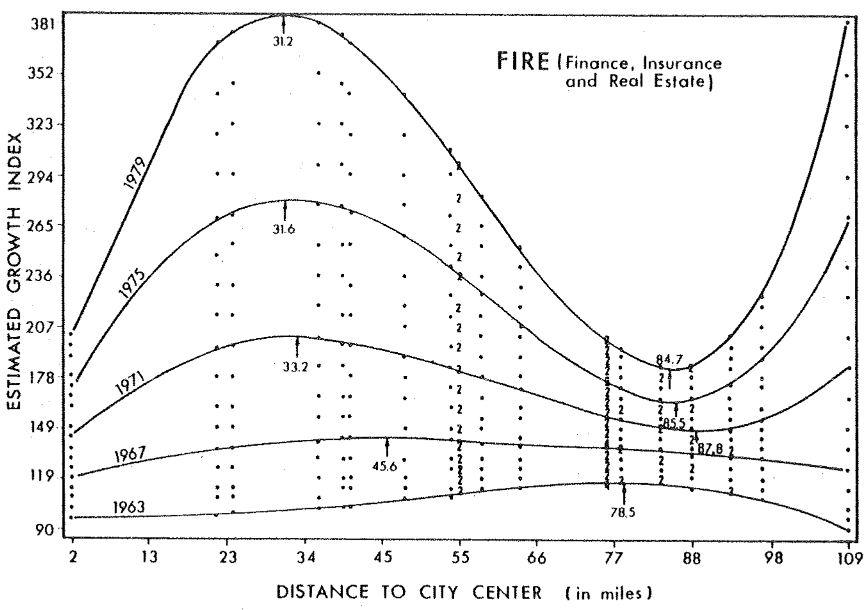


Figure 5: Spatiotemporal structure of differential growth of employment in Services in the urban field of Chicago.



The suggested decentralization definition combined with the adopted methodology has another advantage over most other decentralization studies; namely, the capability to make the findings subject to statistical analysis. Although the model does not imply explicit behavioral relationships between the dependent and independent variables, it is beneficial to evaluate the quality of the results by some summary statistics. For instance, of the five economic sectors presented in Figures 2-6, the wholesaling sector has the lowest R^2 value, indicating that the statistically-fitted spatiotemporal surface has a high level of variability unaccounted for by the model. On the other hand, the variability accounted for in retail trade is more than twice as high; hence, measurements performed on the resultant spatiotemporal surface will more accurately resemble the pattern embedded within the raw data.

Figure 6: Spatiotemporal structure of differential growth of employment in FIRE in the urban field of Chicago.



This list of measurements presented in Table 1 is not exhaustive. It is equally possible to measure the decentralization components at the trough point or at the peripheral peak point. One may further opt for wave analog measurements (Blumenfeld, 1954; Boyce, 1966), such as: distances between peak and trough points, the difference between their growth levels, and the average slope of the curve connecting these two points. Still another possibility is to compare the actual extent or proportion of a linear urban field that has passed a certain critical growth level such as national or state averages. In fact, each of these measurements may serve as a dependent variable in further studies attempting to explain decentralization processes and their components.

Although an idiosyncratic discussion of the case of Chicago was not the objective of this study, highlighting some specific results may further enhance the potential contribution of the multi-component definition. Examination of the results, reported in Table 1 and portrayed in Figures 2-6, conveys the impression that the prevailing trends of employment decentralization in Chicago, when generalized over a period of almost twenty years, are trends of spatial backwash rather than spread. It seems that during this period, and especially during the last decade of the 1970s, the decentralization process reached a stage identified by Erickson (1983) as an infilling stage. In the case of four out of the five economic sectors, the results seem to support the notion that a massive convergence of multi-sectoral dynamic growth took place in a zone ranging from 30 to 36 miles away from the city center of Chicago. It is only in the case of wholesaling that the point of the highest growth intensity has been located at distances ranging between only 16.8 to 19.3 miles from the city center. This finding might be attributed to the agglomerative properties of O'Hare International Airport.

Further comparisons of the five economic sectors yield some interesting clues regarding the multi-stage and multi-sectoral decentralization process (compare to Kellerman and Krakover, 1986). While the location of the peak in the case of the wholesale trade is the closest to the central city, its growth intensity is the highest, peaking to 620 growth index points. Also, the average annual pace of backward shifts of wholesaling, as well as of manufacturing and the retail trade, is slow—ranging between .138 to .283 miles. In contrast, the backward shift of the peak of services and FIRE sectors is much faster, amounting to 1.625 and 1.2 miles per annum, respectively. The faster pace of locational adjustment observed in these two sectors may be attributed to the usually smaller size of the individual firms and the limited amount of fixed capital involved. Further analysis concerning the processes of spatio-temporal reorganization of growth would be beyond the scope of this conceptually and demonstratively oriented paper. Indeed, many suggestions made in this paper are rather hypothetical and their validation may require a more detailed empirical study.

SUMMARY AND CONCLUSION

This study presents an extended, multi-component definition for decentralization and applies a method that is capable of its measurement. For these purposes, the urban environment is perceived as an urban space subdivided into differentially growing geographical units. It is argued that the differential growth environment may be comprehended by the examination of six components: distance, space, time, pace, direction, and intensity. The polynomial power series regression model that has been applied to employment in five economic sectors in the urban field of Chicago has demonstrated the possibility of taking into account all components except space. The adopted method results in a visual presentation of the spatiotemporal structure of differential growth, as well as in quantitative measurements and statistical assessment of the decentralization components. These properties not only provide a fuller comprehension of the complex decentralization phenomenon, but also yield measured indicators of various aspects of the decentralization trend.

Although the suggested definition and accompanying methodology seem to present improvement over existing methods, there is still room for further modifications. Major considerations should be directed toward the incorporation of the two-dimensional space component. Other problems involve the selection of an appropriate length of the period under investigation, the selection of proper geographic research units, and the way distance is measured. Statistically, it might be desirable to look into possible influences of spatiotemporal autocorrelations, or into the degree of distortion which may have been introduced by boundary effects. Nonetheless, the suggested extended definition combined with the adopted methodology seems to provide tools for a comprehensive insight into the complex process of decentralization in urban areas.

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