Identifying Neighborhood Thresholds: An Empirical Exploration

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Abstract

In this article, we investigate the threshold-like effects of four aspects of neighborhood environment: poverty rate, adult nonemployment rate, female headship rate for families with children, and secondary school dropout rate. We used a sample consisting of virtually all census tracts from U.S. metropolitan areas. The relationship between the value of numerous neighborhood indicators in 1980 and subsequent changes in each of the four dimensions of neighborhood quality of family life from 1980 to 1990 was evaluated statistically using a regression model with a spline specification to test for nonlinear, threshold-like processes.

Stressing the exploratory nature of the study, we find evidence of threshold-like effects in an endodynamic relationship (poverty rate and subsequent changes in that rate), and in exodynamic relationships (occupational status and rental rates and subsequent changes in several neighborhood quality indicators). Implications for research and a spatially targeted neighborhood reinvestment policy are derived from the analysis.

Keywords: Neighborhood; Quality; Urban planning

Introduction

Scholars, planners, and policy makers have had a long-standing interest in neighborhood dynamics, typically demographic, racial, and income changes and the resulting alterations in patterns of real estate investment and valuations. Attention has increasingly turned, however, to the role that neighborhood plays in shaping the behavior of its residents, especially youth. Recent research has shown that the neighborhood affects a variety of outcomes, including propensities to participate in the labor market, engage in illegal activities, bear children as teens out of wedlock, drop out of secondary school, and use illegal drugs. These studies have been reviewed by Briggs (1997), Brooks-Gunn, Duncan, and Aber (1997), Ellen and Turner (1997), and Quercia and Galster (2000).

Given the significance of the neighborhood in shaping a variety of social outcomes, policy makers are tempted to ask several obvious questions:

1. How do “unhealthy” neighborhood environments get that way?

2. Are there key indicators of neighborhood well-being that allow one to predict statistically the course of the neighborhood over the ensuing decade?

3. Are there certain social conditions that tend to build on themselves in a way that rapidly generates massive neighborhood problems?

4. Is there a point of no return, a critical value of an indicator past which the neighborhood begins a spiral of inevitable decline in the quality of life it offers?

Unfortunately, we know little about the answers to these questions. Despite their unchallenged importance, the processes by which neighborhoods are transformed into more or less desirable environments have rarely been the subject of statistical investigation. The one exception is in the area of changing racial composition of neighborhoods, often referred to as the “tipping” literature (Galster 1990; Galster and Keeney 1993). However, only a handful of studies have attempted to statistically model changes in neighborhood poverty rates (Carter, Schill, and Wachter 1998; Galster and Mincy 1993; Galster, Mincy, and Tobin 1997; Vandell 1981). Even fewer have attempted to model changes in other neighborhood-level indicators of the environments confronting families and their children (Krivo and Peterson 1996; Krivo et al. 1998). To begin filling this void, we identified in recent articles ample theoretical reasons to suggest that the sorts of changes associated with urban neighborhoods are characterized by “threshold effects” (Quercia and Galster 1997, 2000). That is, when a neighborhood reaches a critical value of a certain indicator, it may trigger more rapid changes in that neighborhood’s environment.

In this article, we undertake an exploratory empirical investigation to determine whether four key aspects of a neighborhood’s quality of life—poverty rate, adult nonemployment rate, female headship rate for families with children, and secondary school dropout rate—are subject to these threshold effects.[1] Using a sample consisting of virtually all census tracts from U.S. metropolitan areas, we statistically evaluate the relationship between the value of numerous indicators measured in 1980 and subsequent changes in each of these dimensions of neighborhood quality of life during the following 10 years. We employ a regression

[1] These indicators are conventional measures of key dimensions of neighborhood quality of family life (Krivo et al. 1998). Poverty rates and female headship rates have grown more spatially concentrated in the inner cities during the 1980s (Krivo et al. 1998).

model with a spline specification to test for nonlinear, threshold-like processes. In this fashion we can ascertain the existence of a critical value or values for the particular variable observed in 1980 that was systematically associated with large changes in any of the indicators of neighborhood quality of life during the ensuing decade.

We emphasize that this investigation is designed to identify statistically significant patterns and raise questions, not definitively test hypotheses. We do not attempt to develop structural models of neighborhood dynamics that clarify patterns of causation. Rather, our goal is to ascertain whether certain neighborhood changes are associated, in a reduced-form sense, with clear threshold effects that might direct future modeling efforts and ultimately serve as guideposts for strategic neighborhood policy interventions.

The remainder of this article is divided into four sections. We begin with a discussion of the concept of threshold effects as it relates to neighborhood change and summarize the theoretical foundations of these effects. We next provide a brief, intuitive overview of our data and empirical methods. We then summarize key findings related to the major threshold effects we found. In the last section, we use the findings to derive implications for future research and policy.

Threshold effects and neighborhood change: Conceptual underpinnings

Definition and types of thresholds

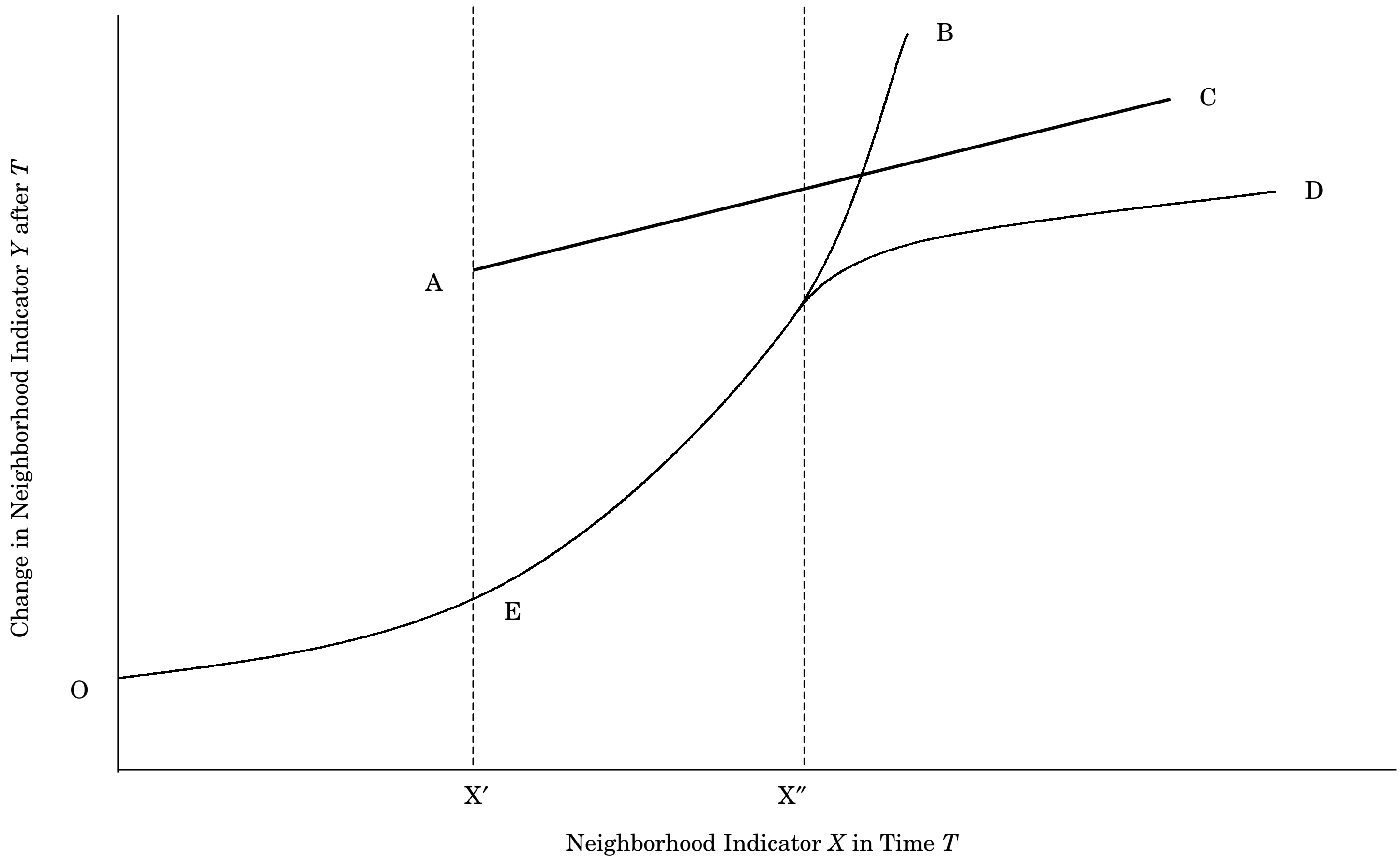
Defined formally, threshold effects are a particular sort of causal relationship in which the magnitude of the causal influence changes dramatically past some critical point. Expressed graphically, a threshold effect involves an extremely nonlinear relationship between independent (X) and dependent (Y) variables past some value of X (see figure 1). This nonlinear relationship can be a continuous mathematical function, as in lines OEB or OED in figure 1, or a discontinuous relationship, as in line segments OE and AC. Point X′ indicates the threshold point, with point X″ portraying a second one for relationship OED.

Two general classes of these neighborhood change threshold effects can be specified:

1. *Endodynamic relationship*: As an indicator of neighborhood quality of life reaches a critical point, it subsequently causes (directly or indirectly) a much greater change in itself.

2. *Exodynamic relationship*: As an exogenous factor affecting an indicator of neighborhood quality of life reaches some point, it subse-

Figure 1. **Illustrations of Threshold Effects**



quently causes (directly or indirectly) a much greater change in the indicator.

Behavioral mechanisms of neighborhood change thresholds

A change in an aggregate population characteristic in a neighborhood, whether endo- or exodynamic in nature, must imply tautologically a change in one (or more) of three constituent groups: the number and composition of out-movers from the neighborhood, the number and composition of in-movers to the neighborhood, and the behavior of residents who remain in the neighborhood during the period. According to various theories, the behavior of the individuals comprising these groups may be influenced in ways that involve threshold effects.

We briefly review below four distinct, but not mutually exclusive, mechanisms suggested by extant theory through which these thresholds may be produced: collective socialization, gaming, preference, and contagion models.[2] One can analyze out-migration behavior through collective socialization, gaming, and preference models, in-migration behavior through gaming models, and behavior of residents who remain through collective socialization, gaming, and contagion models.

Collective socialization. Sociologists have developed theories of collective behavior that implicitly incorporate thresholds. These theories focus on the role that social interactions exert on shaping an individual's attitudes, values, and behavior (e.g., Simmel 1971; Weber 1978). The tenet of this collective socialization approach is that a sufficiently powerful social group can influence others to conform to its customs, norms, and behavior. Such an effect can occur to the degree that (1) the individual comes in social contact with the group and (2) the group can exert more powerful threats or inducement to conform to its positions than competing groups.

These two preconditions imply the existence of a threshold. Given the importance of interpersonal contact in enforcing conformity, if the individuals constituting the group in question are scattered thinly over urban space, they are less likely to be able either to convey their positions effectively to others with whom they might come in contact or to exert much pressure to conform. It is only when a group reaches some critical mass over a predefined area that it is likely to be effective in shaping others' behavior. Past this threshold, as more members are recruited, the group's power to sanction nonconformists probably grows nonlinearly. This is especially likely when the position of the group becomes so dominant as to become normative in the area.

[2] For a complete review, see Quercia and Galster (1997, 2000).

More modern sociological treatises closely related to collective socialization also suggest thresholds, among them Wilson's (1987) contention that as a critical mass of middle-class families leaves the inner city, low-income African Americans left behind become isolated from the positive role models that the erstwhile dominant class offered. Economists have also developed several mathematical treatises involving collective socialization effects in which thresholds often emerge as solutions to complex decision problems under certain assumptions (Akerlof 1980; Brock and Durlauf 1999).

Gaming models. The tenet of gaming models is that, in many decisional situations, the costs and benefits of alternative courses of action are uncertain and depend on how many other actors choose various alternatives. That is, an individual's expected payoff varies depending on the number or proportion of other actors who make a decision before that particular individual does. Thus, the concept of threshold amount of observed prior action is central in this type of model. The well-known prisoner's dilemma is the simplest form of gaming model (Schelling 1978).

Schelling (1978) develops a more sophisticated model of collective behavior that results from what he calls the multiperson prisoner's dilemma. Expanded to a situation with more than two actors (say n), Schelling contends that there is some number k, such that if at least k individuals choose their nonpreferred alternative and the rest do not, those who do are better off than if they had all chosen their preferred alternative. If the number is less than k, this is not true. Thus, k can be interpreted as a threshold, that is, the smallest size of the group that, though resentful of free riders (who follow their own preferences without regard for the group), can be profitable for those who join.

Granovetter (1978) develops a different gaming model of collective behavior that results from the aggregation of the distribution of individually defined thresholds in the population. He contends that for a particular actor there is a threshold where net expected benefits begin to exceed net expected costs. Beginning with a frequency distribution of thresholds, Granovetter derives the ultimate or "equilibrium" number making each decision. Slight modifications in one or more of these distributions can produce large changes in the aggregate behavior of individuals in a neighborhood. Subsequent work by Granovetter and Soong (1986) builds on and generalizes this work for various dimensions of neighborhood change.

Preference models. The tenet of preference models is that actors in a residential environment will respond if the aggregate behavior of others (or an exogenous event) raises an undesirable neighborhood attribute above the level they find tolerable. An endogenous process can be triggered once the attribute reaches the critical value (threshold). The trigger occurs because actors in a neighborhood are assumed to have different levels of tolerance, with the least tolerant responding first. If additional change in the neighborhood attribute results from the course of action taken in response to the initial event by those with the lowest tolerance, the new level of the neighborhood attribute may now be above the tolerance level of some of the less tolerant remaining actors. The process may continue with new rounds of attribute change and actor adjustment until the process is completed. At the extreme, the process may end when all the original actors in a neighborhood have responded. Uncertainty is not assumed to play any significant role in preference models.

The theoretical development of preference models has focused on changes in a neighborhood's racial composition, though extensions to preferences for other sorts of neighborhood attributes are straightforward. Seminal work in this vein has been conducted by Schelling (1971, 1978), Schnare and MacRae (1975), and Taub, Taylor, and Dunham (1984).

Contagion models. The basic tenet of contagion models is that if decision makers live in a community where some of their neighbors exhibit nonnormative behaviors, they will be more likely to adopt these behaviors themselves. In this way, social problems are believed to be contagious, spreading through peer influence.

Crane (1991) proposes a formal contagion model to explain the incidence and spread of social problems. He contends that the key implication of the contagion model is that there may be critical levels of incidence of social problems in populations. He states that if

> the incidence of problems stays below a critical point, the frequency or prevalence of the problem tends to gravitate toward some relatively low-level equilibrium. But if the incidence surpasses a critical point, the process will spread explosively. In other words, an epidemic may occur, raising the incidence to an equilibrium at a much higher level. (1227)

Crane (1991) identifies two conditions believed to determine the susceptibility of a community to epidemics of social problems: the residents' risk of developing social problems and their susceptibility to peer influence. Associating these two conditions with declining neighborhoods, Crane states that social problems should increase as neighborhood quality declines, but not at a constant rate. He contends that somewhere near the bottom of the distribution of neighborhood quality, there should be an extremely large, sharp increase in the incidence of social problems.

Caveats. Unfortunately, the data on census tracts analyzed here impose limitations on our empirical ability to sort out the theoretical issues described above. First, because we arguably do not have any measures that are purely exogenous to the neighborhood, our explorations of exodynamic processes must be interpreted cautiously. Second, the aggregate nature of the data does not permit us to distinguish the contributions to the observed aggregate change in the tract made by in-movers, out-movers, and stayers. Third, we cannot identify the precise behavioral mechanism through which any observed threshold effect occurs.

Neighborhood indicators, data, and empirical methods

In this section, we turn to methodological and data considerations. First, we identify the four neighborhood quality of life indicators that will be examined for the presence of threshold effects. Second, we will describe the data set used in the examination. Finally, we will present a brief description of the empirical methodology used to identify threshold effects.

Indicators of neighborhood quality of life

We investigate the patterns of 1980–90 changes in four crucial quality of family life indicators for all census tracts across all U.S. metropolitan statistical areas. Certainly there are other important dimensions to quality of neighborhood environment, but the four we analyze are frequently cited in the literature and consistently available for all census tracts in the nation over time.[3] The indicators are as follows:

1. Percentage of persons below the poverty level

2. Percentage of households that have children (under age 19) and are headed by a woman

3. Percentage of persons ages 16 to 19 neither enrolled in school nor graduated from high school

4. Percentage of persons over age 16 not employed (i.e., either unemployed or not in the labor force)

We also investigate whether five additional census variables that plausibly might be deemed predetermined or causally prior predictors of

[3] Although an important consideration, the racial/ethnic composition in a neighborhood is not a quality of life indicator. Thus, it is not included in the study. Furthermore, the database did not contain information on crime perpetration/victimization, another important consideration.

these quality of family life indicators demonstrate any exodynamic relationships involving thresholds. That is, we explore whether a threshold relationship between each of these indicators is evinced with the following variables individually:

1. Percentage of persons who moved into their dwelling since 1975 (a measure of community transience and instability)

2. Percentage of workers not employed in professional or managerial jobs (a measure of lower occupational status and potential for income growth)

3. Percentage of occupied dwelling units with no car available (a measure of constrained accessibility to jobs and other vital destinations)

4. Vacancy rate for year-round housing units (a measure of weakened incentives for owners to maintain their properties or, in the extreme, abandonment)

5. Percentage of dwellings specified as renter occupied (a measure of expected lower home upkeep, pride in and attachment to the neighborhood, and wealth)

We recognize that our classification of certain variables as indicators of neighborhood quality of life and others as predictors of neighborhood quality of life is arbitrary. We justify it on the basis of consistency with the prior literature cited earlier. Moreover, we recognize that the patterns of causality between the two sets of variables are not at all straightforward and will certainly not be elucidated by the empirical procedure described later. Nevertheless, we deem it valuable to explore whether a series of variables predetermined in 1980 predicts subsequent threshold-like changes in a series of variables conventionally viewed as comprising key components of neighborhood quality of life.

Data

Data for conducting these explorations come from the so-called Under Class Database, which was constructed by the Urban Institute and contains all the aforementioned variables for all U.S. metropolitan area census tracts. Of special note is the fact that the geographic boundaries of all tracts in 1990 have been made to correspond to their 1980 boundaries, thus permitting the types of longitudinal analyses conducted here. We deleted from our analysis sample atypical tracts: those that had populations greater than 9,999 or less than 525, consisted of a military vessel, or had more than 12.7 percent of their population residing in institutions.[4] The resulting sample had 34,706 observations (census tracts).

Empirical methodology

On the basis of prior empirical work, we employ the spline specification of a regression model to test for threshold effects (see Clark 1992; Crane 1991; Duncan, Connell, and Klebanov 1997; Vartanian 1997, 1998, 1999). Details of this model are presented in the appendix. Suffice it to note here that this statistical procedure allows the regression line fitted to the scatter of data points to break into a series of linear segments, each of which may have a distinct slope and level. A variety of complex, nonlinear forms representing the relationship between two variables can be approximated in this manner (Johnston 1984).

The power of this estimation procedure can be illustrated with the help of the hypothetical data portrayed in figure 2. Observations of combinations of variables X and Y are shown as asterisks. In a typical ordinary least-squares regression procedure, the straight line AB would represent the "best fit" of the scatter of data points. Were spline break points to be specified at X values corresponding to points S and T, however, the spline regression model would have fit the data with the piecewise linear CDEF. Clearly, the spline model reveals the existence of thresholds at points S and T that would have been obscured by the traditional regression approach.

The weakness of the spline model is that, in the absence of theoretical guidance, the choice of break points is typically arbitrary, and the results are often sensitive to this choice. In the current application, we have no theory to guide our selection of break points where thresholds are most likely. Thus, we take an exploratory approach designed to minimize the chances that a significant threshold will be obscured or overlooked. Specifically, in our preliminary analyses we specified nine break points for each variable; this divided the given distribution of values into deciles. Subsequent experimentation indicated that we could simplify by combining the first four deciles into a single spline but that we should specify two additional break points at the 95th and 99th percentiles to reveal all potential thresholds of note.

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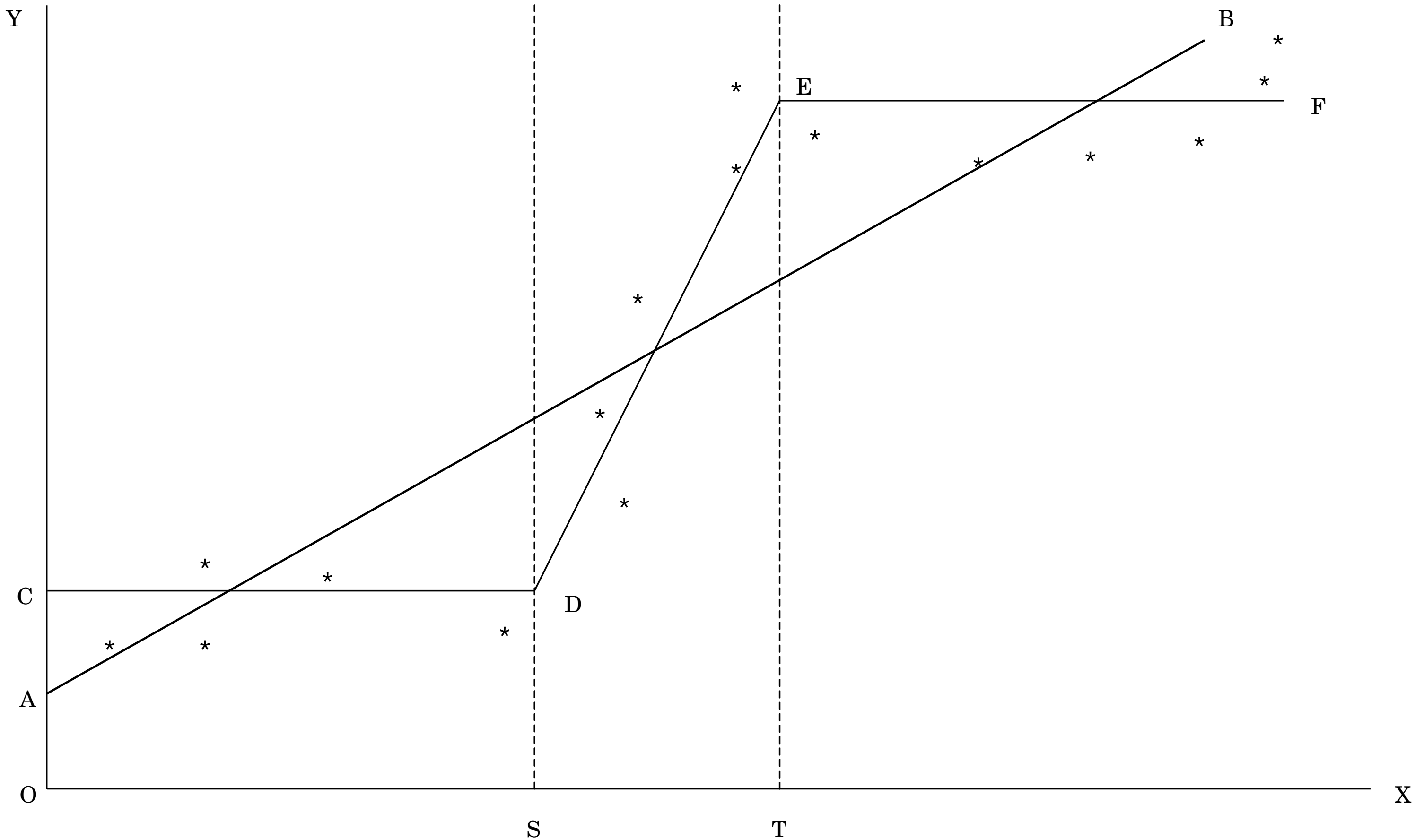
[4] This parameter was chosen because it represented two standard deviations above the mean value of population percentage in institutions or group quarters for all census tracts. We believe that neighborhoods where unusually large fractions of residents live in such institutional settings may evince atypical patterns of change over time and thus should be excluded from our analysis.

Figure 2. **Hypothetical Illustration of Linear and Spline Function Fit to Data**



Do neighborhood quality of family life indicators trigger greater changes in themselves?

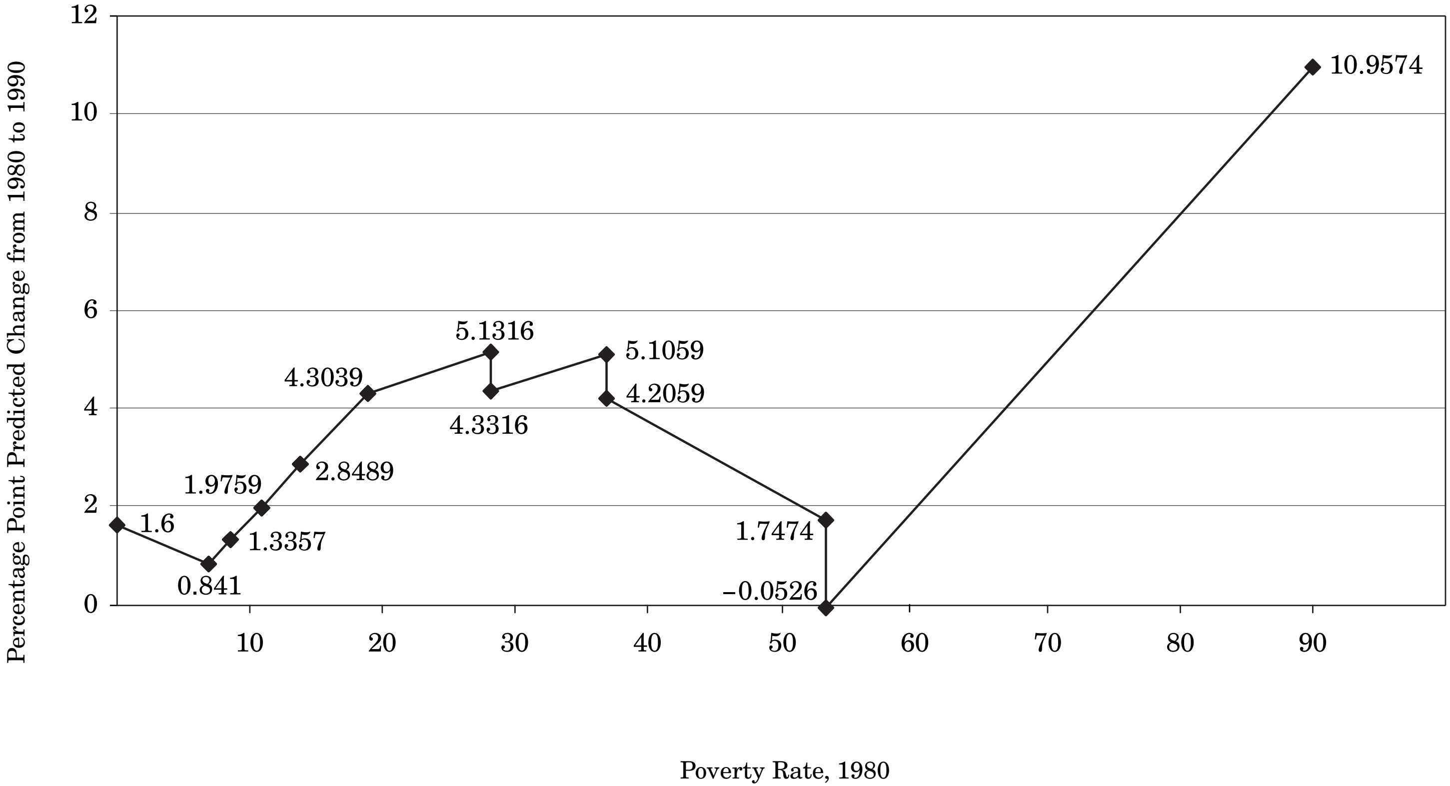
In this section, we present the empirical results of our analysis of the endodynamic relationships. Before we consider any graphs, a little explanation is in order. Each graph measures on the vertical axis the predicted 1980–90 change in the variable of interest (in percentage points) and on the horizontal axis the 1980 value of the same variable (measured as a percentage). Each point that is plotted represents the end of a spline segment. The first segment represents observations in the lowest 40th percentile of values, then the next segments represent successive deciles until the final three, which represent the 91st–95th, 96th–99th, and above 99th percentiles, respectively. Next to each plotted point is listed the value of the predicted 1980–90 change associated with the corresponding 1980 value of the variable. When the line changes slope or shifts discontinuously at one of these points, it signifies that the given spline parameter(s) was significantly different from zero.

When we analyzed patterns for our entire sample of census tracts, we found a threshold similar to trend OEB in figure 1 for only the poverty rate. For the other variables (not shown), we find highly nonlinear effects in the incidence of female headship rate for families with children, but not the sort indicating the hypothesized type of threshold. Moreover, the relationship between changes in high school dropout and nonemployment rates, respectively, and the 1980 value of the corresponding variable can be represented essentially by a straight line with a negative slope.[5]

Quite a different conclusion emerges when we examine the endodynamic relationship associated with neighborhood poverty rate changes (see figure 3). The predicted change function shows a modest negative relationship for neighborhoods with a poverty rate of less than 6.9 percent, but this turns positive for poverty rates between 6.9 and 36.8 percent. The maximum predicted increase in poverty for this range (5.1 percentage points) occurs in neighborhoods starting the decade with 28 or 37 percent poverty rates. However, the function becomes negatively sloped for neighborhoods with a 36.8 percent poverty rate, such that by the

[5] A note about the Y-intercepts is warranted. For graphing purposes, the Y-intercept for all endodynamic processes is as reported on the regression analyses. However, for the exo- and interdynamic processes, we did the following calculation to graph the Y-intercept. (Note that each regression contains two independent variables: One is the 1980 lag variable of the 1990 dependent variable, while the other independent variable is subdivided into its respective spline values.) We subtracted 1 from the coefficient of the lag variable to represent change in the dependent variable. We next multiplied this value by the 1980 mean value of the lag variable. The product of this multiplication was then added to the Y-intercept reported on the regression analysis to produce the final Y-intercept.

Figure 3. **Predicted Change in the Poverty Rate from 1980 to 1990**



time a neighborhood reaches a poverty rate of 53.3 percent, it is predicted to have virtually no further change (–0.0526 percentage points). So far the picture is one of stability, somewhat like the one for households headed by women. But what is decidedly distinct here is a clear threshold in extremely poor neighborhoods. What is implied by the strong positive slope over the poorest neighborhoods is that a rapid and ever-increasing growth in poverty will likely be manifested if a neighborhood exceeds a poverty rate of about 54 percent (a relatively rare event).[6]

Do other determinants trigger greater changes in neighborhood quality of family life indicators?

In this section, we present the empirical results of our analysis of exodynamic relationships. We analyzed the degree to which 1980–90 changes in each of the quality of family life indicators were related to 1980 levels of five variables often cited as important determinants of these indicators: (1) percentage of persons who moved into their dwelling since 1975; (2) percentage of workers not employed in professional or managerial jobs; (3) percentage of occupied dwelling units with no car available; (4) vacancy rate for year-round housing units; and (5) percentage of dwellings specified as renter occupied. We employ nonprofessional instead of professional occupations and rental instead of ownership rates to maintain consistency in our figures, wherein we have portrayed indicators measuring reputedly less desirable characteristics of neighborhoods.

Of the 25 trials, approximately half revealed distinct nonlinear relationships. Several yielded noteworthy threshold effects, which are discussed below.[7] The two explanatory variables producing these interesting results involve neighborhood occupational status and ownership tenure of housing.

Neighborhood occupational distribution and changes in quality of family life indicators

The percentage of workers not employed in professional or managerial jobs in a neighborhood in 1980 proves to be a robust predictor of

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[6] In our sample, there are 319 census tracts (less than 1 percent of the sample) with poverty rates exceeding 53.3 percent.

[7] For this series of trials we simplified by not estimating any spline breaks at the 99th percentile of the distribution, inasmuch as preliminary runs did not identify any important thresholds at this point.

threshold-like changes in three of our four key dimensions of neighborhood quality of family life: families with children headed by women, nonemployment rate, and poverty rate. Even more noteworthy, in all three dimensions, significant thresholds occur in a narrow range, that is, when the percentage of nonprofessionals in a neighborhood ranges from 77 to 83 percent.

Consider first the changes in the percentage of families with children headed by a woman (see figure 4). A distinct increase in slope occurs when the percentage of nonprofessional workers is 83.1 percent of what was essentially an up-sloping relationship. This finding means that for census tracts with less than 83.1 percent of workers in nonprofessional occupations, a change of 10 percentage points is predicted to yield a change in the female headship rate of 1.01 percentage points. After surpassing the threshold, however, a further increase of 10 percentage points is predicted to yield a change in the female headship rate of 4.85 percentage points.

Variations in the 1980 percentage of workers not employed in professional/managerial occupations are associated with significant thresholds of change in nonemployment rates. These thresholds occur when the percentage of nonprofessionals reaches 77 and 83 percent (see figure 5). There is a discontinuous shift up in the relationship beyond 74.2 percent in nonprofessional occupations, and then the slope gets significantly steeper from 77.5 to 80.3 percent. At 83.1 percent nonprofessionals, there is an increase of about 0.6 percentage points. Beyond the 91.1 percent nonprofessional worker threshold, increases in the growth of nonemployment cease, but the percentage of nonprofessional workers continues to grow.

Finally, the relationship between 1980–90 changes in neighborhood poverty rate and the 1980 percentage of workers not employed in professional/managerial occupations is portrayed in figure 6. It indicates that poverty increases once a neighborhood has more than 83.0 percent of its workers in nonprofessional/nonmanagerial occupations, and once again when it has more than 88.7 percent. Past 91.1 percent of residents in nonprofessional/nonmanagerial occupations, the growth continues, but at a slightly diminished rate. This means that, for neighborhoods with less than 83 percent nonprofessional workers, a 10 percentage point increase in such occupations would be predicted to yield a 0.39 percentage point increase in the poverty rate. Past 83 percent, a similar change would yield on average a 4.60 percentage point increase in the poverty rate.

Taken as a whole, these findings suggest that neighborhoods that have relatively few professional/managerial employees among their workforce are much more likely to see increases in several problematic in-

Figure 4. **Relationship between the Percentage of Households with Children That Are Headed by Women and the Percentage of Workers Not Employed in Professional/Managerial Occupations from 1980 to 1990**

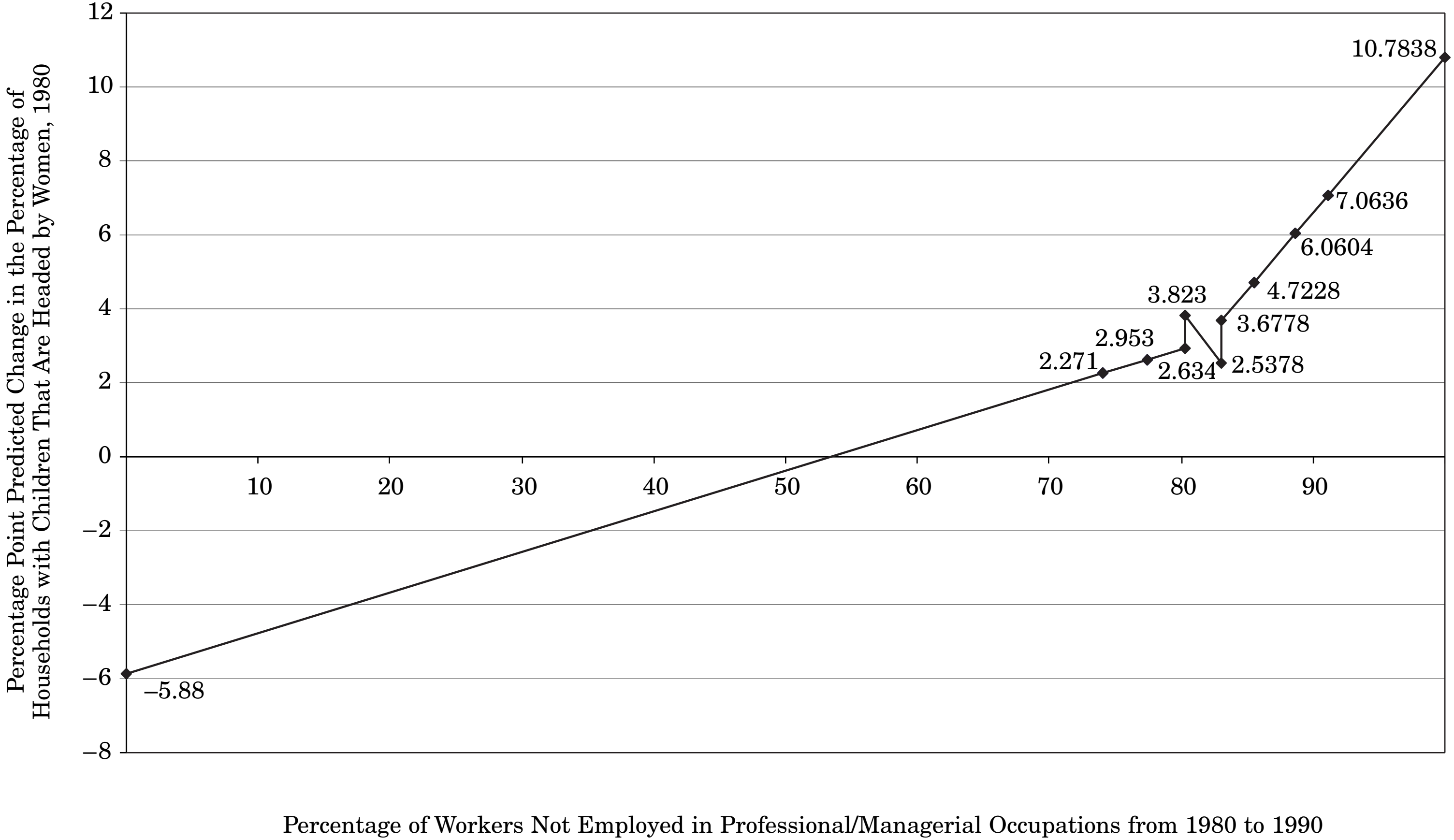


Figure 5. **Relationship between the Percentage of Persons Not Employed and the Percentage of Workers Not Employed in Professional/Managerial Occupations from 1980 to 1990**

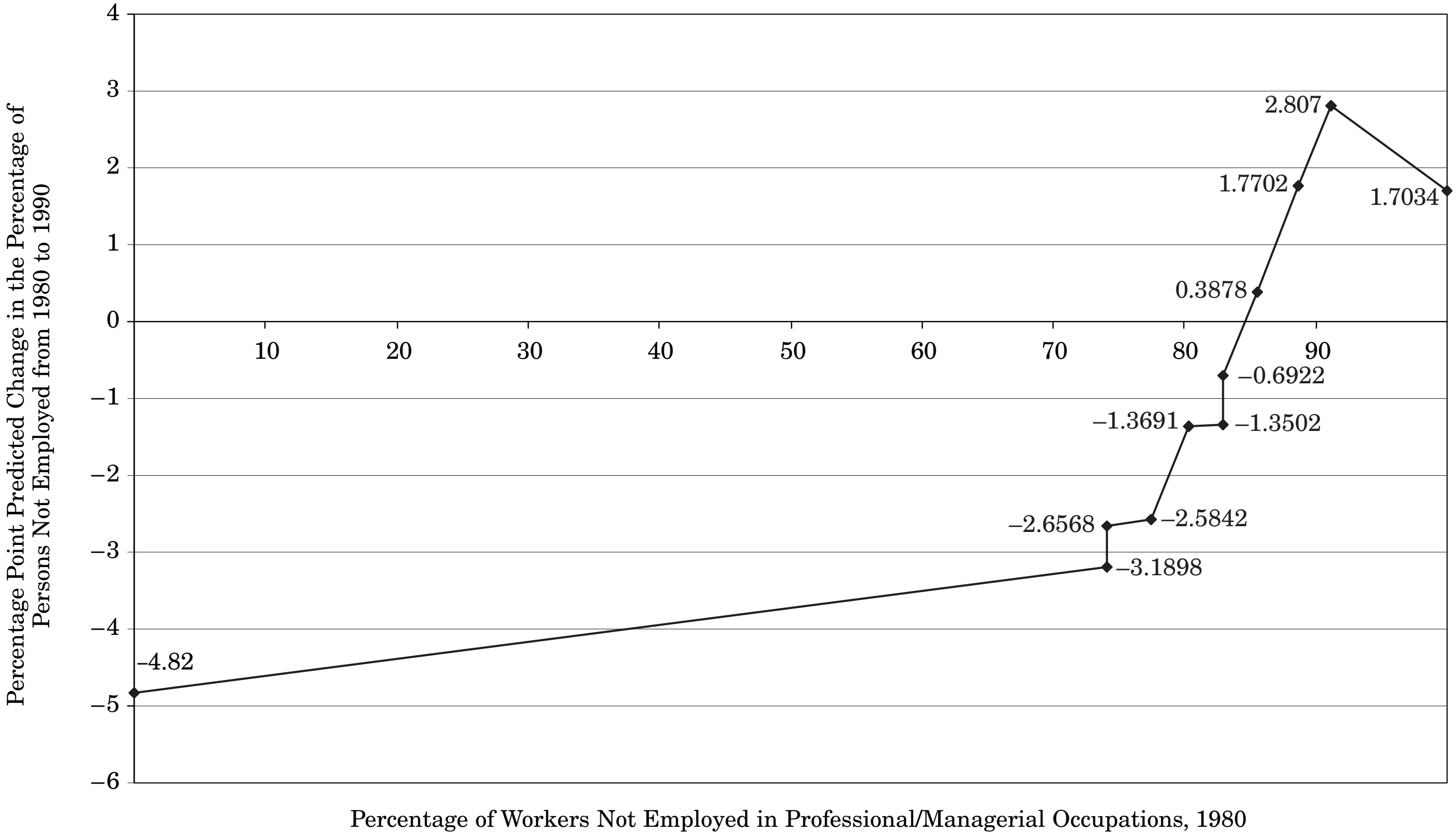
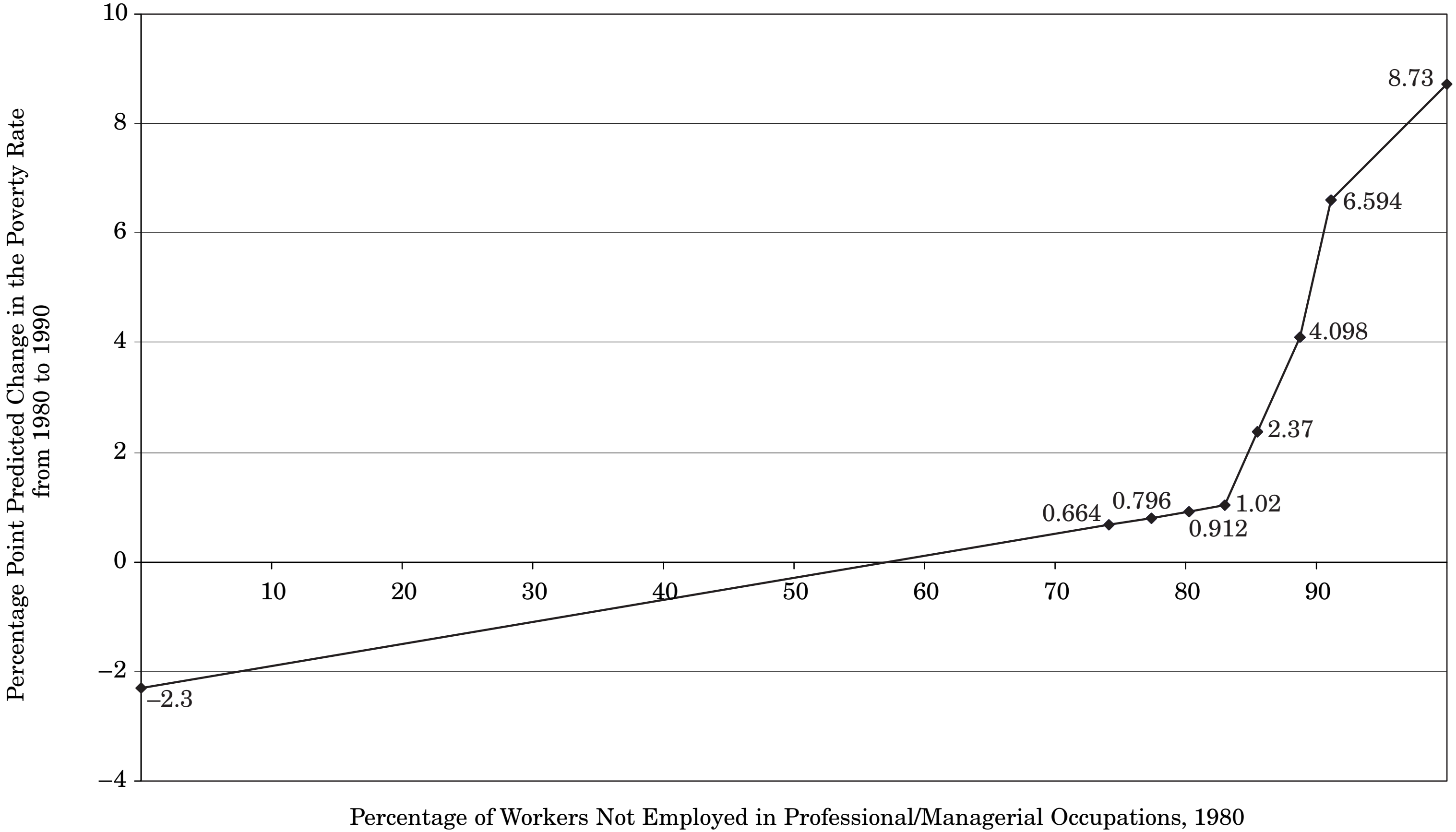


Figure 6. **Relationship between the Poverty Rate and the Percentage of Workers Not Employed in Professional/Managerial Occupations from 1980 to 1990**



dicators of eroding quality of life. Specifically, threshold effects are manifest in the range of 77 to 83 percent of nonprofessional workers.[8]

Neighborhood housing tenure patterns and changes in quality of life indicators

Figures 7 through 9 show how 1980–90 changes in the three neighborhood quality of life indicators discussed in the previous section relate to the 1980 degree of renter occupancy. All three demonstrate a common threshold. In census tracts having more than 85.5 percent of their units renter occupied, all three indicators rise 2 to 4 percentage points, with a clear threshold.

Figures 7 and 8 involving female headship and nonemployment rates evince similar shapes. In lower ranges of neighborhood rental rates, there is a direct relationship between the indicator and rental rates. This finding is consistent with the conventional wisdom that higher rental rates are disadvantageous for a neighborhood. This relationship reaches a peak, however, and then reverses itself. For nonemployment, the relationship becomes inverse at about a 60 percent rental rate (32 percent in the case of female headship) and continues until the aforementioned threshold beyond 85.5 percent renter occupied.

The pattern involving changes in poverty rates is distinctive and conforms to conventional expectations (see figure 9). With one minor exception, higher rental rates are associated with larger subsequent increases in poverty rates in the neighborhood. In neighborhoods where more than 85.5 percent of households rent, higher rental rates are associated with even larger increases in poverty.

Overall, these findings suggest that the relationships between rental tenure rates and various indicators of neighborhood quality of family life are neither uniform nor neatly meshed with current nostrums. Results for all three indicators suggest that they are less likely to become problematic in neighborhoods with no renters than in neighborhoods

[8] These findings can be contrasted to previous threshold studies, although results are not strictly comparable because prior work has examined the impact of neighborhood characteristics on individuals, not on neighborhood aggregate changes. Vartanian (1998) identified a somewhat higher threshold (90th percentile) for neighborhood percentage of nonprofessional workers and their relationship to an individual's income. He did identify, however, thresholds at the 10th, 34th, and 90th percentiles of this variable for an individual's duration in poverty. Crane (1991) found that teen childbearing (the closest to our female headship variable) for African-American and white girls rose dramatically in neighborhoods with more than 95 percent nonprofessional workers. He also found that dropout propensities were higher in such neighborhoods, a finding not replicated here.

Figure 7. **Relationship between the Percentage of Households with Children That Are Headed by Women and the Percentage of Renter Occupancy from 1980 to 1990**

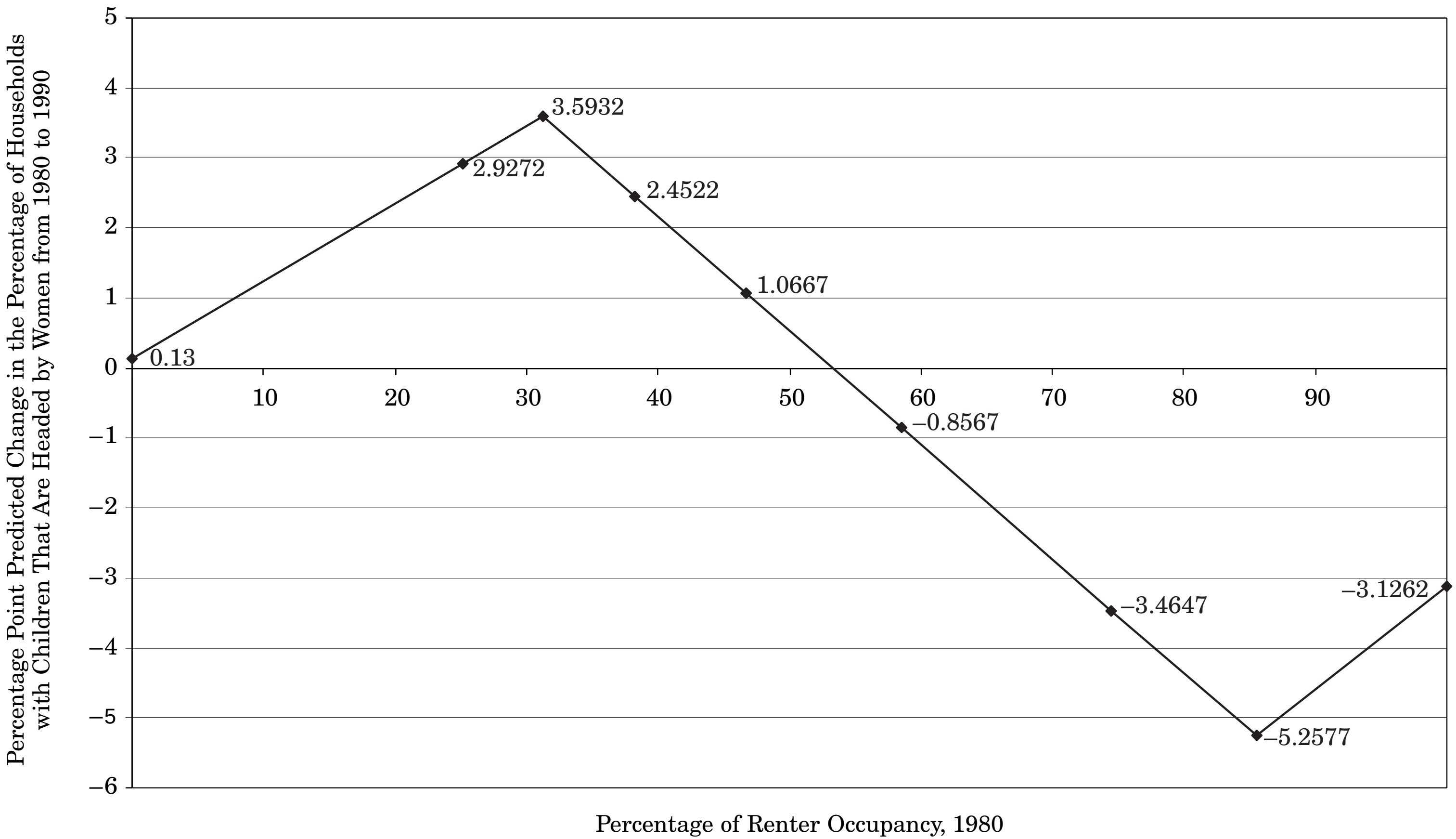


Figure 8. **Relationship between the Percentage of Persons Not Employed and the Percentage of Renter Occupancy from 1980 to 1990**

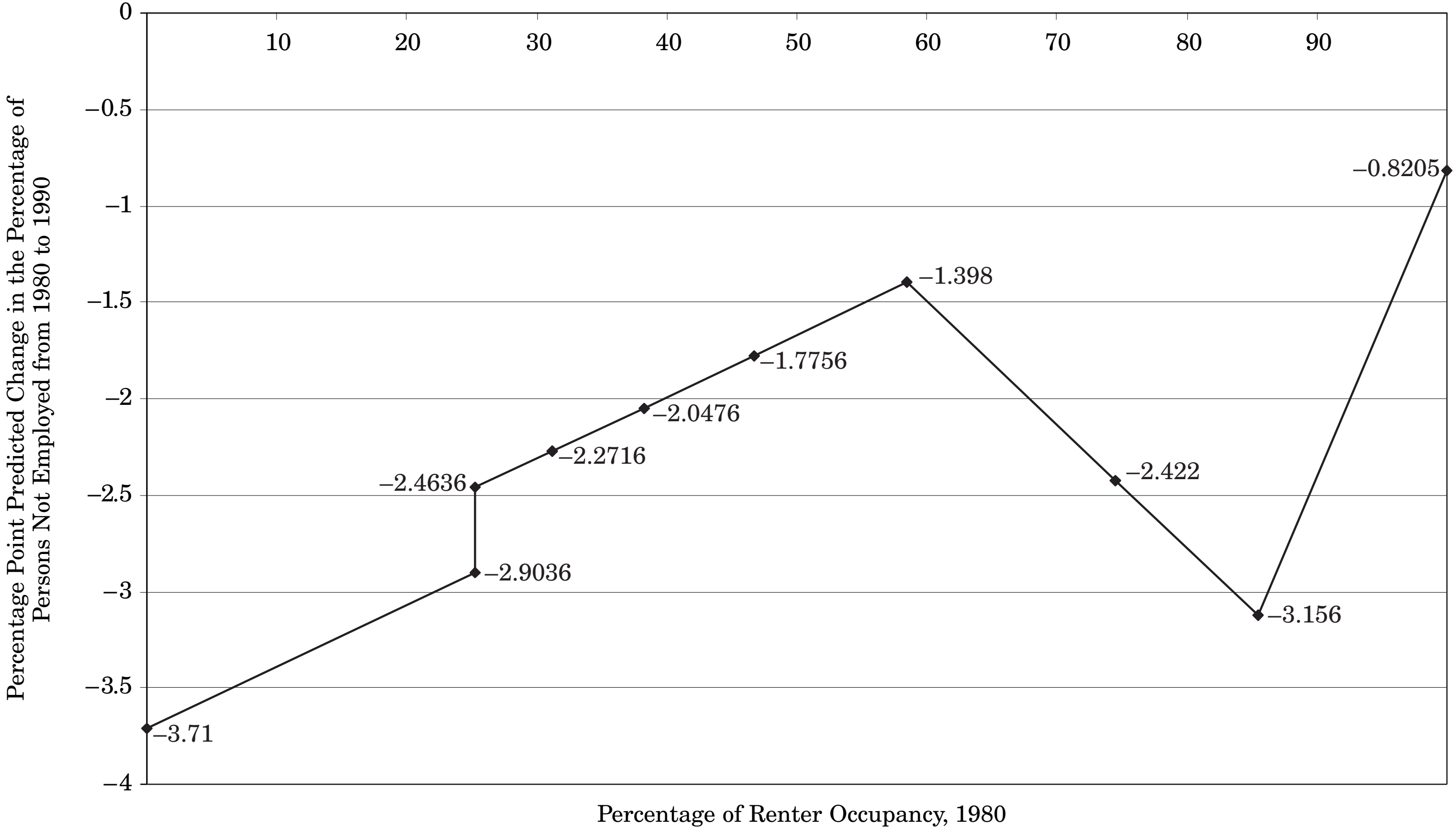
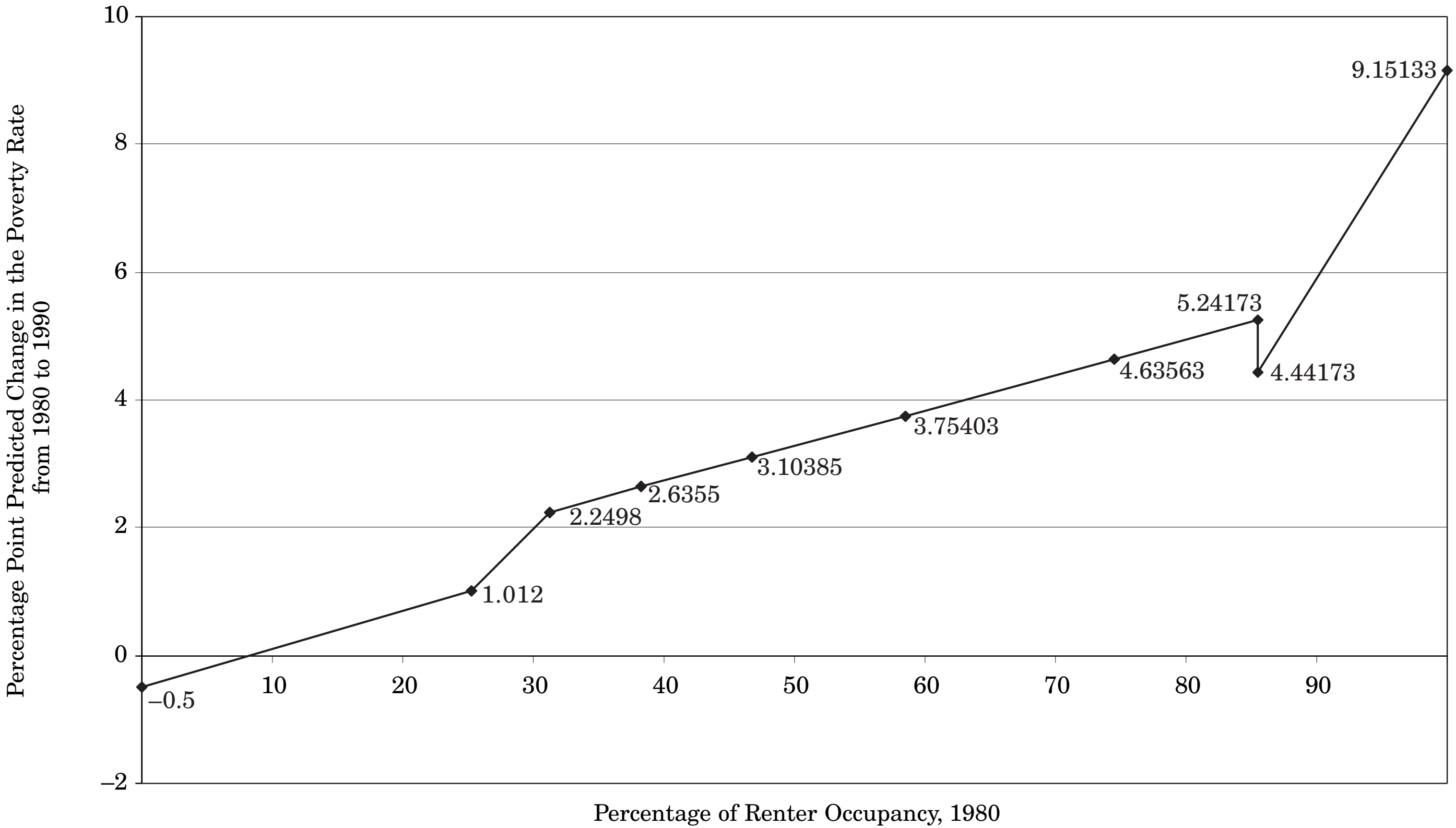


Figure 9. **Relationship between the Poverty Rate and the Percentage of Renter Occupancy from 1980 to 1990**



in which at least a third of the residents rent. Moreover, there is cross-indicator consensus that undesirable consequences more likely transpire if the neighborhood has virtually no homeowners. Yet in the vast range of diverse-tenure neighborhoods—that is, most U.S. metropolitan neighborhoods—the patterns are less consistent. For example, growth in female headship is considerably smaller, on average, in neighborhoods having a 95 percent rental rate than in those having no renters!

Conclusions

In this study, we investigated the threshold-like effects related to four aspects of the neighborhood environment: poverty rate, adult nonemployment rate, female headship rate for families with children, and secondary school dropout rate. Following Quercia and Galster (1997), we contend that a threshold effect is present when a neighborhood reaches a critical value of a certain neighborhood indicator that triggers more rapid changes in that neighborhood's environment. We used a sample consisting of virtually all census tracts from metropolitan areas. The relationship between the value of numerous neighborhood indicators in 1980 and subsequent changes in each of the four dimensions of neighborhood quality of life during the next 10 years was evaluated statistically using a regression model with a spline specification to test for nonlinear, threshold-like processes. In this fashion, we were able to determine whether there was a critical value for a particular 1980 variable that was systematically associated with magnified changes in any of the indicators of neighborhood quality of family life during the ensuing decade. The study findings are summarized in table 1.

Stressing the exploratory nature of the study, we find evidence of threshold-like effects in both endo- and exodynamic relationships. First, with regard to factors correlated with greater changes in themselves once they reach certain values (endodynamic relationships), we find that overall nonemployment and secondary school dropout rates exhibit no threshold-like effects. We find highly nonlinear effects in the incidence of the female headship rate for families with children, but not the sort indicating the hypothesized type of threshold. For all three indicators, we find that on average, neighborhoods beginning the decade with lower values of these social problem indicators experience a greater increase in the problem indicator during the subsequent decade but that neighborhoods starting with higher values experience decreases in the indicator. This observation suggests that no self-generating process appears to inexorably drive neighborhoods that exceed some

Table 1. **Summary of Findings**

	Key Threshold Value(s)	Sign of Effect
Endodynamic Processes		
High school dropout rate	None	
Nonemployment rate	None	
Female-headed households with children	< 12.1% female headship	negative
	12.1–52.7% female headship	positive
	52.7–70.7% female headship	negative
	> 70.7% female headship	negative
Poverty rate	< 6.9% poverty rate	negative
	6.9–18.8% poverty rate	positive
	18.8–36.8% poverty rate	less positive
	36.8–53.3% poverty rate	negative
	> 53.3% poverty rate	positive
Exodynamic Processes		
Nonprofessional/nonmanagerial employment Female-headed households with children	83% nonprofessional employment	positive
Nonprofessional/nonmanagerial employment Nonemployment rate	74.2% nonprofessional employment	positive
Nonprofessional/nonmanagerial employment Poverty rate	83% nonprofessional employment	positive
Renter-occupied units Female-headed households with children	< 32% renter-occupied units	positive
	32 to 85.5% renter-occupied units	negative
	>85.5% renter-occupied units	positive
Renter-occupied units Non-employment rate	< 60% renter-occupied units	positive
	60 to 85.5% renter-occupied units	negative
	>85.5% renter-occupied units	positive
Renter-occupied units Poverty rate	<85.5% renter-occupied units	positive
	>85.5% renter-occupied units	positive

threshold to ever-higher incidences of these three indicators.[9] Nevertheless, we do find a distinct threshold effect when neighborhoods exceed a poverty rate of about 54 percent. For neighborhoods above the threshold, there is a rapid and, apparently, ever-increasing growth in poverty over time. For neighborhoods with lower poverty rates, however, the pattern is one of relative stability.

[9] We are aware that this effect may be the result of a so-called regression artifact (Frankfort-Nachmias and Nachmias 1992). In our case, the regression to the mean bias tilts the entire regression line toward a more negative slope, producing a pseudo-self-regulatory effect. We estimate that 50 percent (in the case of high school dropouts) and 15 to 25 percent (for the other variables) of the distance from the no-regression point to the population mean is the result of this statistical artifact. Thus, for all the variables, except for poverty, the predicted change in the same variable over the decade due to causal forces is not as severe as that implied by our regression estimate. For poverty, the predicted change is underestimated because the postthreshold slope is positive.

Second, with regard to factors correlated with greater changes in neighborhood quality of life indicators (exodynamic relationships), we find two noteworthy patterns. The percentage of workers not employed in professional or managerial jobs in a neighborhood is found to be a robust predictor of threshold-like changes in three of the indicators: the female headship, unemployment, and poverty rates. In all three dimensions, the significant threshold occurs in a narrow range, that is, when the percentage of nonprofessional employment reaches from 77 to 83 percent. It is interesting to note that the degree of renter occupancy is also found to be a good predictor of threshold-like changes in the same three indicators. Although renter occupancy is not the only threshold value, in census tracts having more than 85.5 percent of their units renter occupied, all three indicators rise 2 to 4 percentage points after this clear threshold is exceeded. Overall, the rental pattern involving changes in poverty rates conforms to conventional expectations: Higher rental rates are associated with larger subsequent increases in neighborhood poverty rates. By contrast, the pattern involving changes in the other two indicators shows consistency with the conventional wisdom only at lower ranges of rental rates. At these low ranges, the relationship is both direct and disadvantageous. However, the relationship reverses itself at about 60 percent rental for overall nonemployment and at about 32 percent for female headship. In these intermediate ranges, higher rental occupancy in 1980 is not associated with disadvantageous changes in neighborhood quality of life over the ensuing decade. We tested several additional predictor variables, including percentage of persons who moved into their dwelling since 1975, percentage of dwelling units with no car available, and residential vacancy rate, but did not find any threshold effects for them.

It is possible to offer potential explanations for findings that are not consistent with the conventional wisdom. For instance, there are plausible reasons why poverty rates exhibit endodynamic threshold effects, while other indicators do not. Poverty rate may be the most visible of the quality of life indicators and thus may be most likely to affect household mobility. Alternatively, poverty rate may exhibit endodynamic threshold effects because it is the most comprehensive measure of neighborhood quality of life, while the other indicators capture neighborhood fortunes only along a single dimension.

Increasing rental rates may not appear to be consistently correlated with all of the quality of neighborhood life indicators because other uncontrolled factors confound this relationship. It may be, for instance, that neighborhoods that are exclusively renter or owner occupied have distinct regional, intrametropolitan, or jurisdictional characteristics related to structure type, density, or public service quality that are only spuriously related to tenure but strongly affect quality of life.

Implications for future work

We therefore caution against the temptation to definitively explain the patterns derived from our simple spline regression estimations. In this article, we showed only that the "black box" represented by bivariate correlations between aggregate-level neighborhood indicators exhibits threshold relationships. Future work needs to model neighborhood change in all its complexity. This would entail developing and estimating multiequation, multivariate structural models to sort out the interrelated forces that determine neighborhood fortunes. We believe that probing inside the black box is the next logical research step.

Future work needs to take into account important local variations. Unlike the few previous studies of nonlinear neighborhood changes,[10] our intent in this article was to see whether any *nationally* generalizable threshold patterns emerged, despite cross-sectional variation in metropolitan economic conditions, racial segregation and demographic composition, and other factors. We are aware that our observed threshold patterns might not be apparent if we were to control for local variations or stratify the data along important dimensions. For instance, central-city neighborhoods in the Midwest or Northeast are likely to differ in important characteristics from central-city areas in the West. Moreover, most of the census tracts with poverty rates above 54 percent are disproportionately located in the central cities of the Northeast and Midwest (Jargowsky 1997). Stratifying the analysis by census region may attenuate the subsample variation in poverty rates, thus making the 54 percent threshold less obvious, if not impossible to identify. For this reason, since it has been shown that nationally generalizable threshold patterns exist, future research needs to probe whether the general threshold patterns identified in this article are robust in various stratifications. We believe that future work needs to explicitly examine important cross-sectional variations, by stratifying the data by location (census region, central city/suburb), demographic characteristics (racial/ethnic composition), and other factors.[11]

Finally, future work will probably need to complement the modeling exercise we have described with qualitative field research. As noted above, a change in an aggregate characteristic in a neighborhood must imply tautologically a change in the number and composition of outmovers and in-movers, and the behavior of residents who remain in the neighborhood during the period. Each of these groups may poten-

[10] See Quercia and Galster (2000).

[11] It would be of interest to incorporate additional quality of life variables such as crime and quality of schools information at the neighborhood level in the analysis. Unfortunately, we are not aware of a publicly available data set that contains neighborhood-level information on these variables except for a few cities.

tially be influenced in ways that involve threshold effects. Although econometric modeling may shed light on some of these influences, a qualitative or ethnographic study may be needed to fully understand the individual changes implied in aggregate threshold patterns.

Policy implications

The effects associated with neighborhood change are not merely an academic curiosity. On the contrary, such dynamics hold critical implications for the well-being of households and those who would devise policies for building supportive neighborhood environments. The complexity of the study findings summarized in table 1 makes it difficult to derive simple, straightforward programmatic implications, but we believe that important conclusions can be drawn nonetheless.

We recognize that our results are preliminary and need further replication and refining. However, accepting that the results suggest that thresholds should be adopted as a working hypothesis, what *general* implications/import for policy makers can we offer?

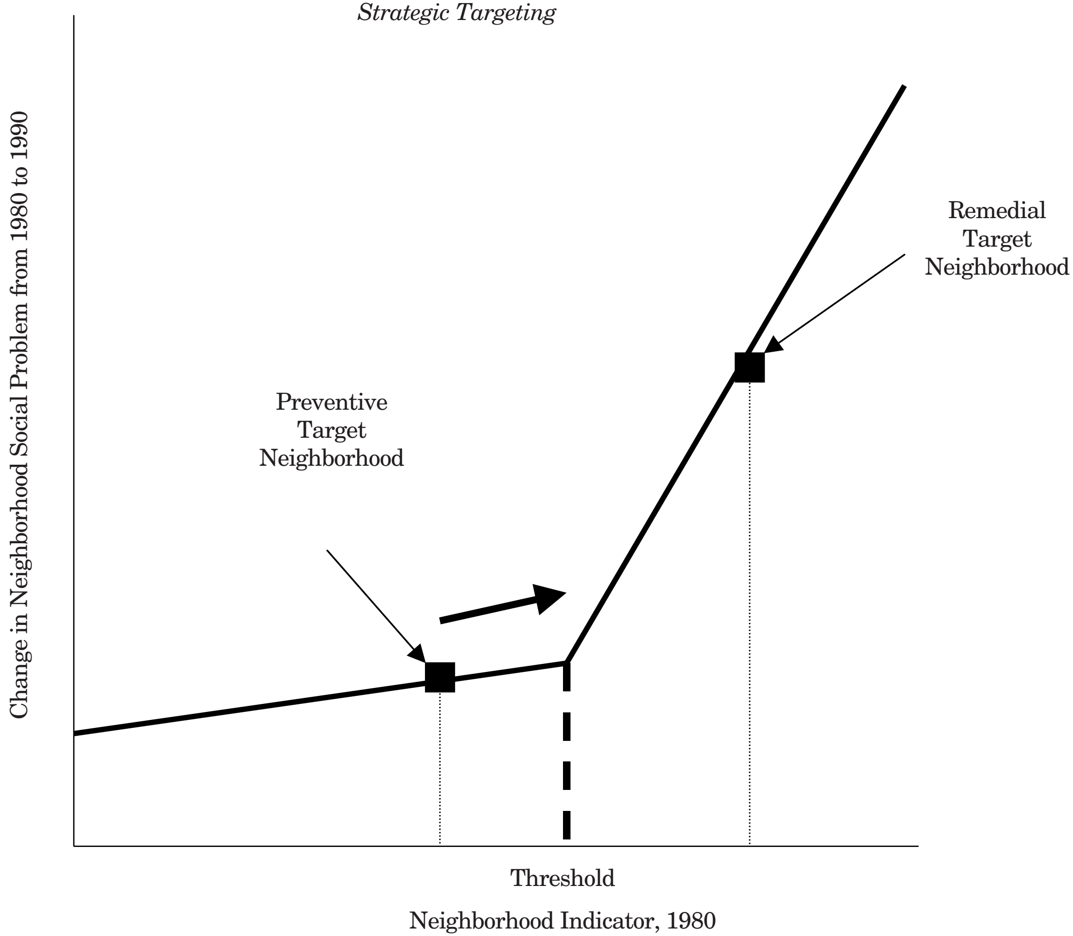
Overall, the findings imply that neighborhood interventions should be *targeted.* Because trajectories of neighborhood quality of life are nonlinear, interventions are likely to produce substantially different payoffs depending on where in this trajectory they are directed. This suggests two broad types of programmatic approaches: preventive and remedial. Preventive initiatives should target neighborhoods with *rising* values of a predictor variable (e.g., rental rates) that has not yet exceeded its threshold value (figure 10). The goal of this type of initiative should be to prevent neighborhoods already in a trajectory of decline from exceeding the critical threshold value past which decline will accelerate.

By contrast, remedial programs should target neighborhoods with a *stable* value that is above the threshold for a given predictor variable. The goal of this type of initiative should be to reduce the value of this indicator to its threshold, because not to do so would expose the neighborhood to continued high growth in the problem indicator. We cannot of course recommend whether a preventive or remedial approach is more appropriate in any particular case. It depends on the efficacy of the vehicle for changing the predictor variable, relative to the payoffs from changing the indicator.

We can propose, however, a general rule for deciding whether to institute preventive versus remedial efforts. The basic rule for maximizing the impact of intervention is to allocate scarce public policy resources on the margin to the neighborhoods where the reduction in the given social problem indicator will be greatest. Where it will be the greatest

Figure 10. **Implications for Policy Makers**

Strategic Targeting



will be determined by the product of two factors: (1) the change in the social problem indicator associated with a unit change in the predictor variable that is being shaped by public policy (rental rates, for example) and (2) the change in the predictor variable that can be garnered from a certain amount of policy resources invested. For example, a certain type of neighborhood may evince huge reductions in social problems if a small amount of owner-occupied housing could be introduced. But if it is incredibly expensive to do so (because of huge subsidies), it may not be the wisest use of funds. The exodynamic analysis we have presented provides suggestive evidence about the first of the two factors (the payoffs from changing a predictor variable) and thus delineates a benchmark against which policy makers can compare the relative efficiency of accomplishing programmatically induced changes in different sorts of neighborhoods.

Appendix

Details of the Spline Model

The following discussion is based on Johnston (1984). The procedure for specifying a piecewise linear function that joins at each of the break points is as follows. Let X be the independent variable and Y be the dependent variable; then the specification for a three-spline model is

$W_1 = X$

$W_2 = 0$ if $X \leq \mathrm{a}$; $X - \mathrm{a}$ if $\mathrm{a} < X$

$W_3 = 0$ if $X \leq \mathrm{b}$; $X - \mathrm{b}$ if $\mathrm{b} < X$

where a and b are values of X arbitrarily chosen as break points. The regression estimated via ordinary least-squares is

$$Y = \phi + \alpha W_1 + \beta W_2 + \delta W_3 + \varepsilon \qquad (1)$$

where ϕ, α, β, and δ represent parameters to be estimated, and ε represents a random error term with the usual assumed statistical properties.

Testing the statistical significance of α is equivalent to testing whether there is a non–zero slope between X and Y in the range of X between zero and a. Testing the significance of β is asking whether the slope of the X-Y relationship in the range a to b is the *same* as it was in the range zero to a. Testing the significance of δ is asking whether the slope of the X-Y relationship in the range of X greater than b is the *same* as it was in the range a to b.

The foregoing serves to estimate a regression that potentially has a different slope in each of its three spline ranges, but still is constrained to connect at each break point. To remove this restriction and thereby estimate a more flexible functional form that could more readily identify discontinuous shifts in the function (like OEAC in figure 1), we specify dummy equivalents to the spline slope variables above. Specifically, let

$D_2 = 0$ if $X \leq$ a; 1 if a $< X$

$D_3 = 0$ if $X \leq$ b; 1 if b $< X$

Then the regression we estimated via ordinary least-squares is

$$Y = \phi + \alpha W_1 + \beta W_2 + \delta W_3 + \chi D_2 + \varphi D_3 + \varepsilon \tag{2}$$

For the endodynamic process explorations, X is simply the value of Y in the census tract 10 years earlier. When we graph the change in Y during the decade as a function of its beginning-of-decade value (X), as shown in the text, we simply subtract X from both sides of Equation 2, and plot

$$Y - X = \phi + (\alpha - 1)W_1 + \beta W_2 + \delta W_3 + \chi D_2 + \varphi D_3 + \varepsilon \tag{3}$$

For the exodynamic process explorations, X is some explanatory variable different from Y, and Z is the value of Y in the census tract 10 years earlier. The regression estimated is

$$Y = \phi + \mu Z + \alpha W_1 + \beta W_2 + \delta W_3 + \chi D_2 + \varphi D_3 + \varepsilon \tag{4}$$

When we graph the change in Y during the decade ($Y - Z$) as a function of the beginning-of-decade value of the explanatory variable (X), as shown in the text, we subtract Z from both sides of Equation 4, simplify by letting Z assume its mean value for 1980, Z', and plot

$$Y - Z = \phi + (\mu - 1)Z' + \alpha W_1 + \beta W_2 + \delta W_3 + \chi D_2 + \varphi D_3 + \varepsilon \tag{5}$$

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