

Quantitative Studies in Social Relations

# SOCIAL DYNAMICS

Models  
and Methods

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Nancy  
Brandon

TUMA

and

Michael T.

HANNAN

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# **SOCIAL DYNAMICS**

## **Models and Methods**

## QUANTITATIVE STUDIES IN SOCIAL RELATIONS

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# **SOCIAL DYNAMICS**

## **Models and Methods**

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To  
George, Katie, and Clare from NBT,  
and to  
Chris, Kevin, and Tim from MTH

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## Preface

Once again the study of social change—how and why social systems and actors within systems change over time—is moving to center stage in sociology. This shift in substantive concerns has placed new demands on sociological methodology and on the practice of sociological research. Although the structural-equation and log-linear models routinely used in empirical sociological research are exceedingly useful for the study of statics (i.e., relationships at a point when change is not occurring), they are ill equipped to accommodate the renewed interest in social dynamics. Of course, models and methods for static analysis may be extended to provide a basis for dynamic analysis. But such extensions are neither as simple nor as obvious as they may seem at first glance. Basic principles must be reconsidered, and old prejudices and intuitions reexamined. Then standard techniques need to be revised or replaced.

Some progress toward these extensions has already occurred. Our survey of current practice and recent developments (reported in Chapter 2) suggests, however, that progress toward the satisfactory analysis of change has been very uneven. We believe that without a broad framework for thinking about and conducting quantitative, empirical studies of social change processes, most advances will remain isolated and idiosyncratic. This book is the result of our efforts to build such a framework.

Any attempt at forging a systematic framework for the empirical study of social change must confront two issues. One involves the development of *dynamic* models—models that describe the time

paths of change in phenomena. The other involves the development of *causal* models—models that describe how change in some properties induces change in still other properties. Sociologists have rarely used models that deal with *both* of these issues, that is, dynamic models that reflect arguments about causal relationships. We try to move in this direction. In doing so we rely heavily on the use of formal models to guide attempts at testing hypotheses about the processes and causes of change.

One barrier to progress in developing procedures for the empirical study of social change is the common failure in sociology to distinguish *models* from *methods* and *data* from *observation plans*. By a *model* we mean an abstract image of reality whose construction has been guided by theory, empirical generalizations from past research, and perhaps hunches. In contrast, *method* refers to the set of procedures used to estimate and evaluate a model from data. An *observation plan* is a scheme for systematically collecting information pertinent to the phenomenon being studied. The adverse consequences of failing to distinguish models from methods have been compounded by inattention to the fact that multiple observation plans can be used to collect data in order to estimate and evaluate a model. When models and methods are not distinguished, there is a tendency to view a hybrid of a method and a model (e.g., least-squares regression) as a universal tool for data analysis rather than to see a model as a picture of reality that can be tested by *various* methods using data collected under *many* different observation plans.

In our opinion one consequence of the blurring of these distinctions has been that sociologists have tended to rely heavily on discrete-time models of change. Discrete-time models are certainly appropriate for describing phenomena that change only at fixed, discrete time intervals (e.g., consequences of an annual budgetary process, job changes in labor markets in which annual contracts are universal, political party dominance in a system with regular elections). But such phenomena are much less common than ones in which changes can occur at any moment. True, a discrete-time observation plan is used almost always in the case of quantitative (metric) outcomes and quite often in the case of qualitative (discrete) outcomes. Still, as an image of reality, a model should mirror the way changes *can* occur, not the way data are collected. The relative

rarity of phenomena that can change only at discrete time points, coupled with our belief that models should attempt to fit reality and not be dictated by the observation plan used to collect data, led us to concentrate on a framework that is unconventional in sociology: continuous-time models. In any case, discrete-time models are simply a special case of continuous-time models, and good treatments of discrete-time models are already available.

Another obstacle to a broad treatment of dynamic models and methods is the very different treatment given to qualitative and quantitative outcomes in the extant literature. Sociologists routinely apply stochastic models in modeling change in qualitative outcomes. In contrast, they invariably use deterministic models of change in quantitative outcomes, with randomness entering only at the estimation stage. We think that much can be gained from treating both types of outcomes consistently. In particular, this consistency seems necessary to develop models of change in coupled qualitative and quantitative outcomes. Therefore, we again depart from sociological convention: we propose a *stochastic* treatment of both discrete and metric outcomes.

Thus, we had four main goals in writing this book:

1. To clarify and develop models and methods for causal analysis of dynamic social processes
2. To formulate continuous-time models of change in both quantitative and qualitative outcomes and to develop suitable methods for estimating these models from the kinds of data commonly available to sociologists
3. To develop a stochastic framework for analyzing both qualitative and quantitative outcomes
4. To alter the way that sociologists think about the empirical study of social change processes

We think we have made a promising start in meeting the first and second goals. We have formulated a variety of continuous-time causal models of change in both quantitative and qualitative outcomes, and we have also indicated how to estimate these models from event histories (in the case of qualitative outcomes) or panel data (in the case of quantitative outcomes). We wish that we had been more successful in the development of methods for estimating continuous-time causal models of change in *qualitative* variables from

panel data, but this problem is a thorny one. We decided to say very little at all about this topic rather than present methods that we consider unsatisfactory.

The third objective has also been tougher to achieve than we had hoped. Our treatment of change in qualitative outcomes is completely stochastic. But because of the complexity of stochastic models of change in quantitative outcomes, we also include an extensive discussion of deterministic models of such outcomes. We have sketched possible extensions of these models to the stochastic case, but we have done little more than scratch the surface of potential applications. Still, we hope that the strategy we have outlined will strike a responsive chord and stimulate further work on the important problems involved in developing continuous-time stochastic models of change in quantitative outcomes.

We cannot judge how well we have achieved our fourth main goal; only our readers can decide that. Our own thinking about the study of social change has certainly been transformed as we have pondered and written about the topics covered in this book. We hope that after reading this book, others will also gain a new perspective on how and why to study social dynamics.

This book is addressed primarily to sociologists interested in the empirical study of social change, but other social scientists with similar concerns should also find it germane. Although the material in this book appears, at least at first glance, to be very technical by current sociological standards, it is directed at *all* sociologists involved in quantitative empirical research, and not just the narrow circle of “mathematical sociologists.” The key points of the book are contained in the verbal discussions of the social-scientific motivations for the various models and methods that we discuss, and these are illustrated, wherever possible, by applications from our own research. These include studies of job mobility, impacts of negative income tax programs on marital and employment stability, growth and decline processes in organizations, organizational mortality, changes in political structures, and expansion of national systems of education. In using earlier versions of this manuscript in sociology classes at Stanford and Berkeley, we found that students can acquire a basic understanding of our approach by studying these empirical applications even if they are unable to master all technical details.

We admit, however, that some parts of this book contain

fairly complicated material, especially Chapters 9, 12, 14, and 15. But most sections presume only a background in applied social statistics, elementary probability theory, matrix notation, and the calculus. Some familiarity with ordinary differential equations is also helpful in places. To help readers from getting bogged down by mathematical complexities, we have placed an asterisk before the titles of sections containing the more mathematically complicated discussions; these may be skipped without loss of continuity.

Since our potential audience also includes mathematically sophisticated scientists who are interested in applications of stochastic models to sociological problems, we must also make clear that we proceed rather informally. We make no pretense to mathematical rigor: we state important results without proof and refer to standard technical treatments. Insofar as technical, mathematical, and statistical matters are concerned, we view this book as an introduction and an orientation to a huge and growing technical literature. Anyone who wishes to gain a deeper understanding of the technical aspects of the models and methods that we discuss should consult the numerous works to which we refer.

This book is divided into three parts. Part I provides a general background for what follows; it includes both a discussion of the substantive importance of dynamic analyses in sociology and a review of models and methods previously used by sociologists interested in the empirical study of social dynamics. Part II contains eight chapters on models and methods for analyzing change in qualitative outcomes; it concentrates mainly on methods based on analysis of event-history data. Part III contains six chapters on comparable models and methods for analyzing change in quantitative outcomes; it focuses primarily on methods based on analysis of panel data. Although some of the chapters in Part III build on the material covered in Part II, Part III can largely be read independently of Part II.

Readers of books with more than one author often like to attribute different parts of a book to one author rather than the other(s). Often this attribution is justified. But, although some sections of *Social Dynamics* were first drafted by Tuma and others were first drafted by Hannan, each of us revised and rewrote—sometimes extensively—what the other had drafted first. We want readers to consider all chapters of this book as written by both of us, and not to think of some chapters as Tuma's and others as Hannan's.



Finally, we wish to note that the ordering of our names on the title page was decided by a coin toss, as we had decided when we first planned this book. We believe that this is appropriate given the nature of our collaboration and our firm commitment to probabilistic methods.

## Acknowledgments

Since we began work on this book in 1978, we have received invaluable assistance from many people and organizations. We would like to acknowledge this assistance and express our thanks.

Our greatest debt is to the many people with whom we have discussed the issues raised in this book. Several of these deserve special mention. Our work on this book began when we were deeply involved in analyzing data gathered in the Seattle and Denver Income Maintenance Experiments (SIME/DIME), and our conversations with the others sharing in this task were an important context for our work on this book. In particular, numerous discussions with Lyle Groeneveld concerning how best to analyze the marital histories gathered in these experiments had considerable impact on Part II of this book. We thank Lyle for sharing his ideas with us and also for suggesting the title of this book. Our discussions with Lyle and Burton Singer concerning how to analyze interdependencies between changes in marital status and changes in family income using marital histories and monthly reports on family income were a major impetus to Part III of this book. Part III was also motivated by Hannan's collaboration with John Freeman on the study of growth and decline in sizes of school personnel components (see Chapter 11). Our earlier work with François Nielsen and Alice Young on estimation of discrete-time models of change in quantitative variables proved to be very useful when our attention turned to continuous-time models of change in such variables (see Chapter 13). Glenn Carroll and Lawrence Wu are two others with whom we discussed extensively

the issues raised throughout this book. We wish to acknowledge especially Glenn's earlier work on nonlinear models of change in quantitative variables, which was the primary factor leading us to devote a whole chapter to this topic (see Chapter 14). Finally, examples from our substantive research over the past decade are scattered throughout this book, and we wish to acknowledge our collaborators' contributions to these examples and also to our general ideas about models and methods for studying social dynamics. These individuals include: Stephen Beaver, Glenn Carroll, Mary Fennell, John Freeman, Lyle Groeneveld, Philip Robins, Gary Sandefur, Louise Smith-Donals, Aage Sørensen, Barbara Warsavage, and Katherine Yaeger.

We also wish to express our thanks for the expert research assistance that we received from Linda Jean Cutshaw, Charles Denk, Sonalde Desai, Linda Drazga, Helen Garrison, Beverly Lauwagie, Katherine Lyman, Camille Marder, John McClure, Edward Mendelsohn, Susan Olzak, John Peterson, Carlisle Shoemaker, Evan Tanner, Peggy Thoits, Marlos Viana, and Joseph Waight. Douglas Crockford and subsequently David J. Pasta made significant contributions through their programming of RATE (see Tuma, 1979), the computer program used to estimate all models in Part II. François Nielsen provided a program for applying Henderson's method, which we used in the empirical examples in Chapter 11.

Donna Mar did an expert job of typing the first draft. We then decided to produce camera-ready copy using Donald Knuth's (1979, 1984) marvelous  $\text{\TeX}$ , a computer program for typesetting books and other documents, on the Stanford Computer Science Department's SAIL computer. This book also uses type fonts developed by Don Knuth (1979) with his METAFONT computer program. Once this decision had been made, Katie Tuma spent many hours preparing the text to be read by  $\text{\TeX}$ , as well as incorporating our numerous editorial changes. Katie's amazing accuracy and willingness to work at odd hours for long periods of time has earned our deepest appreciation. Camille Marder helped us decipher how to typeset tables using  $\text{\TeX}$ , and Clare Tuma helped put the references in a format that  $\text{\TeX}$  could read. At a still later stage we decided to produce most of the figures for the book using the interactive plotting program developed by Ivor Durham of Carnegie-Mellon University. We are extremely grateful to Ivor not only for adapting his

program to meet our precise requirements but also for making these changes quickly over a holiday weekend. Finally, George Tuma proofread the penultimate version of the manuscript when our energies had vanished.

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We also owe a great debt to our colleagues in the Stanford sociology department. They have set an extremely high standard of sociological scholarship and have provided superb collegial support.

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We would also like to express our appreciation for permission to reproduce and adapt portions of our previously published papers. An earlier version of Chapter 2 appeared in the *Annual Review of*

*Sociology*, Volume 5 (Hannan and Tuma, 1980). We drew heavily on Tuma's (1982) chapter in *Sociological Methodology 1982* in preparing Chapters 3 and 8, on Tuma and Hannan's (1978) chapter in *Sociological Methodology 1979* in preparing Chapter 5, and on Tuma's (1980a) chapter in *Sociological Methodology 1980* in preparing Chapter 9. Section 9.2 summarizes work first reported in Tuma, Hannan, and Groeneveld (1980). Section 6.2 summarizes results in the volume by Groeneveld, Hannan, and Tuma (1983). Section 7.4.2 gives a condensed version of work reported by Freeman, Carroll, and Hannan in the *American Sociological Review* (1983). Section 10.1 reports findings from a paper in the *Journal of Human Resources* by Robins, Tuma, and Yaeger (1980). Sections 10.2 and 10.5 are adaptations from a paper in the *American Journal of Sociology* (1979) by Tuma, Hannan, and Groeneveld. Section 10.4 is based on a paper in the *American Sociological Review* (1981) by Hannan and Carroll. Section 13.6 draws on the chapter by Hannan and Young (1977) in *Sociological Methodology 1977* and a paper by Tuma and Young (1976). Glenn Carroll has given us permission to reproduce two tables from his unpublished (1979) paper in Section 14.5.

# *Part I*

## **Introduction**

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## Why Dynamic Analysis?

Sociological theories have become increasingly concerned with social change, and temporal data are becoming widely available. Yet empirical social research still addresses primarily questions about static relationships (associations among phenomena at a single time point) and focuses mainly on cross-sectional analysis. Even when time-series or panel data are analyzed, their temporal structure is often ignored—the data are treated as though they are cross-sections with some additional methodological complications involving autocorrelations. That is, the focus is on change from one equilibrium level to another, as measured, for example, by levels of variables at successive waves of a panel.

The current distribution of effort in sociology might suggest that there is no pressing need for methods for studying change. But current practice is a poor indicator of need. The paucity of dynamic analysis may reflect a lack of information about how to study change empirically as much as a lack of interest in change.

In subsequent chapters we consider models and methods for analyzing the actual time paths of change in attributes of individuals and social systems. These models and methods are useful for answering questions about the detailed structure of social change processes. Since the most convincing evidence of the value of dynamics analysis comes from research practice, subsequent chapters discuss applications in which the use of dynamic models and methods seems to have enhanced our capacity to formulate and test sociological arguments.



These applications illustrate both how to think about the study of social dynamics and how to do it.

Even though many sociologists are already convinced of the need to study social change processes, there is by no means a consensus. And those who do perceive this need do not always agree on the reasons. Because of these disagreements, this chapter discusses the value of dynamic models and methods in general terms. Naturally we hope that those who currently do not see the value in dynamic analysis will come to appreciate it. But we also hope that those who already appreciate it will acquire an expanded understanding of its value.

Since models and methods are selected partly because they mesh with theoretical concerns, we find it useful to distinguish between theories dealing with static relationships and those dealing with social change. The former attempt to describe and explain why various attributes of social actors or social systems are associated in particular ways at some moment. The latter try to describe and explain how an individual or social system changes over time.

It seems clear that explanations of social change are studied best by dynamic analysis. Section 1.1 reviews some of the theoretical emphases in sociology that seem to mandate dynamic analysis wherever possible. At first glance dynamic analysis may seem irrelevant to those interested in explaining static relationships. In Section 1.2 we challenge this view. Having stated as forcefully as we can in Sections 1.1 and 1.2 why dynamic analysis is valuable, in Section 1.3 we try to counter common objections to dynamic analysis when its intrinsic value is not disputed.

### **1.1 Dynamic Analysis for Studying Change**

Although realism of description is one element controlling choice of models and methods, their fit to larger theoretical objectives is another. It is not surprising that the corpus of modern quantitative methodology in sociology is static—it was developed in a period in which static images of social structure dominated American sociology. However, theoretical currents have shifted toward a greater concern with processes of change. The standard static methods are ill equipped to address questions about the time-paths of change. Thus one reason for pursuing the study of dynamic models

and methods is to adapt research practices to important theoretical concerns of the discipline.

The classical sociological theorists struck a reasonable balance between problems of order and problems of change. Because these theorists wrote at a time when industrial capitalism was transforming western Europe, not surprisingly they devoted considerable attention to the forces that created industrial capitalism, to those that shaped its institutional forms (state bureaucracy, factory enterprise, and so forth), and to the effects of rapid social change on individuals. Although their attitudes toward the changes accompanying industrialization varied, most of the classic theorists placed problems of social change at center stage.

Subsequent sociological theorists, especially in the United States, tended to emphasize order and to deemphasize change. The stress on problems of order was so complete during the heyday of functionalist theory that "social change" became identified as a substantive subfield on a par with institutionally defined subfields such as political sociology, sociology of the family, and sociology of religion. That is, change was not a major focus; instead it was one possible outcome to be explained within the context of an overarching theory based on the notion of an equilibrium.

The dominance of structural-functional theory broke down during the late 1960s. Since then new theoretical perspectives have multiplied. Some new theoretical directions retain a strong emphasis on equilibrium; others emphasize disequilibrium and change.

One important development exemplifying the former is the effort to apply the framework of neoclassical price theory to a broad range of social behavior. Initial steps in this direction were made by sociologists; two important examples are Emerson's (1962) and Blau's (1964) theories of power and social exchange. Subsequent developments have seen economists applying neoclassical price theory to traditional sociological subjects, such as marriage and family life (Becker, 1981). In fact, during the 1970s convergences between sociology and microeconomics began to occur—compare the role of schooling in the status attainment model developed by Blau and Duncan (1965) and refined by Duncan, Featherman, and Duncan (1972) with Becker's (1975) theory of human capital, or Hannan, Tuma, and Groeneveld's (1978) model of marital dissolution with Becker's (1981) theory.

At first glance the development of a sociological perspective built on a synthesis of sociology and microeconomics would seem to keep the equilibrium assumption at the core of sociological theory. Within the social sciences, the faith in equilibrium analysis has been nowhere stronger than in microeconomics. The assumption that markets function efficiently, so that social systems are almost always in equilibrium, has often directed attention away from a serious interest in processes of change in the social system. Nevertheless, the interest of many sociologists and some radical economists in multiple labor markets acts as a force against this. Moreover, whatever the view of system-level change, the long-standing interest of sociologists in social mobility clearly fosters concern with change processes on the individual level. And microeconomists working within the neo-classical framework (e.g., see Ghez and Becker, 1975; Heckman and Willis, 1976; MaCurdy, 1981) have done some sophisticated research on life-cycle patterns of individual behavior.

The recent interest in the life course of individuals in general and in their careers in particular also gives hope that an infusion of microeconomic theory into the study of individual behaviors is unlikely to stress static analysis. The notion of a life course or a career suggests a focus on the dependencies among the successive states occupied by an individual. For example, an employment career is more than a list of the jobs held by an individual. It consists of the sequence and timing of the various jobs and their association with other events, such as changes in marital status and geographical residence. Thus studies of careers (or the life course) focus on the contingencies that pertain to the possible transitions in a career line. For example, sociologists and economists have begun to explore how characteristics of early employment and unemployment affect future employment (Corcoran, 1979; Panel on Youth, 1973; Spilerman, 1977). Others have investigated how changes in husbands' and wives' labor force behavior unfold over time (Tuma, Robins, and Smith-Donals, 1980). Although the rapidly proliferating research on the life course and individual careers has a variety of substantive foci, it reveals a common interest in studying individual histories.

Many contemporary sociological theories emphasizing change are not based on an equilibrium perspective at all. American sociologists' renewed attention to Marx in the late 1960s has been a major force promoting the development of theories that stress change and

its historical context. Although most Marxist and neo-Marxist sociologists are hostile to positivist research and prefer a case-oriented historical approach, standard quantitative methods have been used to address some of the issues prominent in this theoretical tradition (for some examples, see Meyer and Hannan, 1979). Some of this research is static; it concerns the *absence* of much change in capitalist social structures to date. But some emphasizes processes of societal change; for example, see Paige (1975).

Theoretical developments on social movements have also begun to emphasize dynamics. Tilly (1978) and Skocpol (1979) have been especially prominent in redirecting attention to the organizational bases of collective protest and revolution. Rejecting the assumption that collective violence occurs when social structures are falling apart, both argue that local social organization is crucial in understanding these manifestations of social unrest. Collective violence is not an aberration but a natural by-product of social organization whose forms change as the distribution of power changes. Forces that challenge and perhaps overturn the existing order can arise even when a system is apparently stable. Such shifts place theoretical emphasis squarely on dynamics. For example, a key theoretical problem is understanding how changes in the strength of contending groups, the repressive power of a state, and the nature of the relations of a state to its neighbors affect collective violence and social revolution. Understanding the timing of collective protest and its changing forms requires dynamic analysis.

The theoretical trends sketched above, along with many others concerned with change, are fairly recent. Moreover, interest in explaining how and why social actors and social systems change over time seems to be gaining momentum. What some view as disarray in contemporary sociology may partly reflect the pluralism and struggle involved in moving from questions and arguments about static relationships to the interrelated forces for change. If movement continues in this direction, as we think it will, the need for dynamic models and methods will grow.

## 1.2 Dynamic Analysis for Studying Static Relationships

As we mentioned at the outset, sociologists who wish to explain static relationships—associations among properties of social actors or social system at a point in time—may believe that they

can safely forego the effort of learning and applying dynamic models and methods. In this section we argue that this belief is erroneous for two main reasons.

First, explanations of static relationships almost always assume that these relationships are unchanging, but this assumption is usually implausible, as we argue below. In such situations, static analysis can be misleading. Since dynamic models have implications for relationships at a point in time, dynamic analysis is of great value to those who wish to explain static relationships but suspect that these are not in equilibrium during the period for which data are collected.

Second, dynamic analysis has several methodological advantages over cross-sectional analysis that mean this powerful analytic tool has value for studying static relationships, even if a steady state does exist. The remainder of this section is organized around a discussion of these two themes.

### 1.2.1 How Often Does an Equilibrium Occur?

Two types of situations must be considered. In one, the phenomena to be explained does not appear to have a nontrivial stable equilibrium, and change is continual.<sup>1</sup> In the other, a stable equilibrium may exist, but the fraction of time spent near it is small. Generalizing about relationships at some moment on the basis of cross-sectional analysis is apt to be very misleading in either case.

*Case 1: Continual Change.* As an example of the former, consider the relationship among various attributes of individuals—their family background, schooling, income, marital status, health, happiness, and so forth. Both socially and physiologically, the human individual is continually changing—first growing rapidly and expanding its many capacities and activities; then declining rather gradually until death. Norms usually specify how the social lives of individuals should change over the life course. Anthropologists (e.g., Foner and Kertzer, 1978) report that age-related rites of passage occur in almost every society they have studied. In modern industrial societies individuals move from the parental home to school to employment to retirement to death in a well known fashion, despite

<sup>1</sup>By nontrivial we mean an equilibrium that is scientifically interesting. For example, death of a person or extinction of a species are stable but trivial equilibria.

deviations from the normative order (Hogan, 1978, 1980; Winsborough, 1978). That change is an enduring and important feature in studying characteristics of individuals is demonstrated by the almost universal finding of age as an important explanatory variable, no matter what personal characteristic or behavior is considered.

Change seems to be the rule rather than the exception for other kinds of phenomena studied by sociologists. Most businesses are organized around efforts to increase sales and profits, which indirectly lead to an expanded work force in most instances. Many churches try to win converts as well as socialize children of adult members. Cities (at least in the United States) not only actively promote growth in population size and territory but typically regard stability as a sign of incipient decay (another form of change); see Molotch (1976). Historically many states have also tried to expand in population size and territory. Modern states typically seek to increase literacy, educational levels, health, and overall economic development (Meyer, 1980). Indeed, many social organizations of all types seem organized around a program of growth and expansion, not stability. Naturally such a program is not always successful, but with such manifest goals it is advisable to be cautious about assuming that an equilibrium currently exists.

*Case 2: Stability May Exist.* Persistence over time does seem prevalent in some realms of social life, suggesting that a steady state is possible. For example, the culture of primitive societies is widely regarded as being intrinsically conservative, that is, designed to reproduce itself and to resist innovation. (But at least some aspects of the culture of modern societies seem far from stable.) The power and class structures of societies often seem to change relatively slowly, and it is tempting to interpret persistence as a steady state. (However, Marx's forecast of cataclysmic change for the class structure under capitalism and Pareto's notion of cyclical shifts in the composition of elites alert us to be watchful for change in these social institutions.)

In areas in which we observe considerable persistence over time, the key methodological question is, What fraction of time are the phenomena being studied very near an equilibrium? If the fraction is close to unity, then dynamic analysis is not essential. But if the fraction is small, the choice between static and dynamic analysis matters a great deal. Even sociologists who wish to address static

arguments are well advised to conduct dynamic studies and infer static relationships from them.

A system is unlikely to spend much time near an equilibrium when it confronts a volatile environment and adapts slowly to changed circumstances. Above we mentioned several aspects of the modern world that seem organized to promote change and which indeed seem to be changing rapidly. During this century the world's population has grown enormously; the speed of communication and transportation has increased substantially; and boundaries among societies that were formerly relatively isolated have been weakened. In short, not only has the pace of change quickened, but interdependencies have increased. As Simon (1978, p. 4) put it,

When the system is complex and its environment is continually changing (i.e., in the conditions under which biological and social evolution actually take place), there is no assurance that the system's momentary position will lie anywhere near a point of equilibrium, whether local or global.

By itself the observation that social phenomena change continually does not vitiate static analysis. If typical changes are either small or predictable, adaptations may occur rapidly and readily so that departures from equilibrium are brief. What matters is the *pattern* of change, especially the magnitude and regularity of change.

Large, irregular (and therefore unpredictable) changes are especially significant because an extended period of disequilibrium is likely to follow them, which limits sharply the value of static analysis. Consider, for example, the situation of positions at the bottom and top of organizational hierarchies. Those at the bottom are usually specialized to deal with small, repetitive, and predictable changes; in contrast, those at the top deal with less certain, larger, and less frequent changes (Barnard, 1938; March and Simon, 1958). Thus, static models might describe well the activities of clerical and industrial workers, but not the activities of chief executive officers and other top managers.

The speed of response of social actors and social systems also affects the value of steady-state analysis. If adjustments to changed circumstances are quick, even large disturbances may produce only short periods of disequilibrium. Although we know little