The Ecology of Organizational Founding: American Labor Unions, 1836-1985

Author(s): Michael T. Hannan and John Freeman

Source: *American Journal of Sociology* , Jan., 1987, Vol. 92, No. 4 (Jan., 1987), pp. 910-943

Published by: The University of Chicago Press

Stable URL: https://www.jstor.org/stable/2780043

The Ecology of Organizational Founding: American Labor Unions, 1836–1985[1]

Michael T. Hannan and John Freeman
Cornell University

This paper analyzes the founding rate of national labor unions in the United States for the period 1836–1985. It investigates the effects of competitive processes and environmental effects on this rate. A number of stochastic models embodying different assumptions about the ecology of foundings are estimated. The best-fitting models posit that the effect of density (the number of unions in existence) and the number of recent foundings on the founding rate is curvilinear. Analysis of more complicated models reveals that the growth of industrial unions inhibited the founding rate of craft unions. However, the founding rate of industrial unions was unaffected by the number of craft unions in existence.

Structural theories in sociology direct attention to patterns of relations among established actors (usually organizations and collectives). In such theories, social change means changing relations among fixed actors. But this is not the only—or even the most prevalent—form of change. The set of collective actors is rarely stable in society. Social movements and new organizations arise continuously. Understanding social change requires analyzing the dynamics of processes produced by the addition of new actors (and the demise of old ones).

Some processes producing organizational actors appear to be idiosyncratic to institutional sectors and historic periods. Clearly, some of the sources of revolutionary movements and business enterprises differ. While such differences must be acknowledged, the possibility that generic organizational processes also constrain the formation of new collective actors should not be overlooked. Our understanding of processes of change may be advanced by exploiting the fact that guerrilla armies, millenarian movements, and business firms are all organizations. Their

[1] The research reported here was supported by National Science Foundation Grant SES-8510227 and by the Institute of Industrial Relations at the University of California, Berkeley. Glenn Carroll and Susan Olzak made helpful criticisms of an earlier draft.

0002-9602/87/9204-0006$01.50

organizational character may impose a common structure on rates of initiation of the otherwise diverse actors.

Strikingly little research has examined organizational founding rates, partly because social scientists tend to theorize about individual organizations.[2] The individual organization is not the appropriate unit for analyzing foundings—the population of organizations is the unit to which such processes pertain (see below). Even researchers who take a population perspective have given far more attention to organizational mortality than to founding rates, with the notable exception of Delacroix and Carroll (1983). Thus, we know little about how social change affects founding rates and about how founding processes shape organizational populations.

From a structural perspective, foundings are important because they affect the diversity of organizations in society. They do so in two main ways. Some foundings initiate an entirely new form and thus contribute qualitatively to the diversity of organizations in society. Most foundings replicate an existing form and contribute quantitatively to diversity. Although both kinds of events affect the diversity of organizations, it may be useful to consider the two separately in early investigations because the causal structure affecting the rate of creation of new forms and founding rates within forms may differ considerably.

The "clocks" defining the relevant processes surely differ. The clock associated with the rise of new forms keeps time with the history of the larger system within which forms of organization arise and disappear. The one associated with the founding rate within populations keeps time with the history of the population. It is usually much easier to tell when the latter kind of clock starts. For example, in the case of national labor unions studied here, it is not obvious when the United States first became "at risk" of having its first national labor union. Any attempt to construct a clock for the rise of this form of organization is at least somewhat arbitrary. However, the first national unions began in 1836. This marks the beginning of the clock of the process pertaining to foundings of subsequent unions. We focus here on foundings within existing populations. In so doing, we implicitly condition on the time of creation of the form (in 1836) and begin the clock at that time.

Building on prior theory and the limited available research, we propose specific models for organizational founding rates. We estimate these models using data on national labor unions. Unions are particularly interesting for this kind of analysis because they combine elements of social movements and formal organization and because they have had particularly combative histories in the United States. Can population-ecology

[2] Carroll (1984) reviews the previous research on this topic.

arguments be applied fruitfully to such organizations? It is sometimes claimed that population-ecology theory applies only to populations of small and powerless organizations. Some labor unions, of course, have managed to amass millions of members and have accumulated enormous political power. Analysis of unions is one way to explore the limits on the scope of ecological theories of organizations. Foundings of national labor unions can be studied for a period of 150 years, during which enormous social and economic changes have occurred. The richness of these data makes it possible to learn whether the population-ecology perspective on organizations can explain long-term change in an interesting and important population of organizations.

The population-ecology perspective seeks to understand how environmental conditions and interactions within and between populations shape the diversity of organizations in society. We have argued elsewhere that both internal and external arrangements and the character of selection processes impart inertial pressures to organizations (Hannan and Freeman 1977, 1984). When inertial forces are strong, change in organizational populations depends mainly on the creation of new and diverse organizations and the disappearance of old ones. If the founding rate became zero, organizational diversity could only decline over time as various forms of organization lost competitive struggles. Thus, the founding rate constrains the dynamics of diversity and the speed of organizational evolution.

FOUNDING RATES AND CARRYING CAPACITIES

This paper tries to clarify the role of founding processes in explaining a puzzling empirical regularity regarding carrying capacities for organizational populations. A carrying capacity for a form of organization is the limit on the size of an organizational population that can be sustained in society. Many kinds of organizational populations seem to have relatively stable carrying capacities. For example, the number of organizations in these populations grows to the neighborhood of a carrying capacity and then fluctuates within a relatively narrow range (see Carroll 1984 for examples). The puzzle is that the size of the population remains stable over periods when environments seem to have changed dramatically.

Figure 1 shows that the number of national labor unions in the United States stabilized about 40 years before membership in unions began to grow explosively. Moreover, the figure shows that the number of unions fluctuated within a relatively narrow range from 1910 to 1985. There are a number of plausible explanations for this pattern. One that deserves more attention than it has received is that founding rates are sensitive to the density of organizations in the population (relative to the carrying

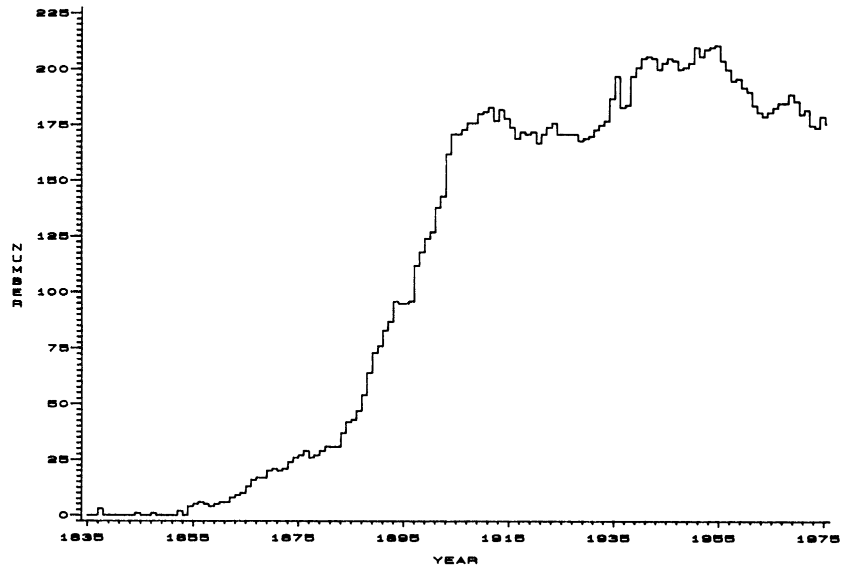

FIG. 1.—Number of unions by year

capacity). Below we discuss a number of reasons for suspecting such density dependence.

The decision to study founding rates follows from a particular—perhaps unusual—conception of the size of organizational populations. Foundings obviously affect the number of organizations in the population. However, foundings may have little, if any, effect on other dimensions of the size of a population, such as the number of employees or members or the capital and other resources controlled by the population. It is important not to conflate these various dimensions of scale of an organizational population and to acknowledge that changes in different dimensions may have different causes.

Virtually all published research on growth and decline in the population of labor unions takes aggregate membership as the dimension of interest. Sociologists, economists, and labor historians have sought to explain fluctuations in the total number of union members in the society or, more commonly, fluctuations in the fraction of the labor force that union members constitute. From this perspective, questions concerning carrying capacities focus on the availability of members and legal and social constraints on the process of organizing members. Such research, even when it does not employ the idea of a carrying capacity, recognizes that changes in the social composition of the labor force, in the industrial composition of the economy, and in laws regulating conditions of collective bargaining affect the number of members that could be mobilized by the population of unions at a particular moment. (It may well be that, under certain conditions, this carrying capacity is the size of the labor force.)

Although we agree that the dynamics of aggregate membership involve interesting social processes, we do not think that understanding such dynamics is the only way—or even the best way—to analyze change in the world of labor unions. We think that the number of unions in a society is an interesting sociological variable in its own right. A society in which, say, all union members belong to a single union has a quite different structure from one in which the same number of members are organized into a thousand unions. For one thing, the average (and maximum) size of unions differs greatly in the two cases, and size is associated with a great many dimensions of internal structure. For another, the totality of collective actions by unions will obviously be more diverse in the second case than in the first.

Size of the population of unions, measured by the number of distinct organizations, can vary largely independently of other dimensions of scale of the population. In particular, figure 1 suggests that fluctuations in numbers of unions had almost nothing to do with fluctuations in total membership in unions in the United States. Some readers may find the lack of association between number of unions and total membership surprising. However, it is surprising only if one assumes that all (or most) unions have striven to obtain a very large membership and have ceased operations if they did not succeed in doing so. This has clearly not been the pattern for most American unions. Many unions have attempted to organize a small segment of the labor force. For example, the International Association of Siderographers (founded in 1899 as the Steel Plate Transferers Association and still active in 1985) has successfully organized all the workers in its jurisdiction—skilled printers of currency and stock certificates. However, its size has never exceeded 300 members, but this does not mean that this union was unsuccessful. It just happens to be small.

Here, we study one of the possible causes of growth and decline in numbers of unions rather than the consequences of changing numbers (and changing diversity) for the larger society.[3] We based our research design on a strategic bet that there are regularities in the processes that constrain growth and decline in numbers of unions (and of other kinds of organizations) and that analysis of such regularities can illuminate basic processes of organizational ecology.

Because we define population size in terms of number of organizations,

[3] Hannan (1986) suggests that the diversity of organizations in society affects the speed with which it can adjust to uncertain, changing environments.

we conceptualize carrying capacities in terms of processes that limit the number of organizations of a type that can be sustained in the society. Since little theory and research have taken this perspective on labor unions, we do not know much about the details of these processes. However, we do think that there are good reasons to think that there are limits to the expansion of the number of labor unions. We discuss some of them below as they pertain to founding rates.

THEORETICAL BACKGROUND

Sociological treatments of organizational foundings have concentrated on the effects of large-scale social change. They have emphasized two processes: institutionalization and resource mobilization.

Institutional Processes

Creating an organization means mobilizing people and resources for specific purposes. As Weber (1978) emphasized, social and political environments affect the mobilization process. Recent institutional theory has reemphasized the importance of the rise of modern institutional structures as a source of rational organization building (Meyer and Scott 1983). These modern institutional structures provide "rationalized and impersonal prescriptions that identify various social purposes as technical ones and specify in a rulelike way the appropriate means to pursue these technical purposes rationally" (Meyer and Rowan 1977, pp. 343–44). The existence of such prescriptions simplifies the job of constructing organizations.[4] That is, the strength of institutional rules endorsing rational organization as the appropriate vehicle for attaining collective goals affects ease of founding. In particular, when the social forces reflecting such views gain ascendancy, waves of organization building should occur, as in the Progressive Era in the United States (see Chandler [1977] for discussion of the case of "modern" industrial administration).

Availability of Resources

Institutionalization of rational organization (or of particular organizational forms) affects the likelihood that organizational solutions to collective action problems will be tried. But success in building a concrete organization depends on the availability of resources, both human and material. There are two issues here: (1) existence of resources for building

[4] Meyer and Scott (1983) also argue that the existence of rational organizations reinforces the development of the rational "myths" sustaining them.

organizations and (2) the degree to which these resources are controlled by other social units. The founding rate rises when levels of resources rise and when changing balances of power among contending groups frees resources from previous uses. The best-known examples of the first process are population growth and economic development. The preeminent example of the second process is social revolution (Stinchcombe 1965).

Expansion of the resource base can affect both the founding rate and the diversity of new ventures. Durkheim's (1947) theory of the causes of the division of labor in society is one version of an argument relating change in the resource base to organizational foundings. According to Durkheim, expansion of a market (due to population growth or increased efficiency in transportation and communication) increases the size of interacting populations and the level of "moral density." Durkheim argues that, "if work becomes divided more as societies become more voluminous and denser, it is not because external circumstances are more varied, but because the struggle for existence is more acute" (1947, p. 266). He describes a set of isolated communities whose economic enterprises have expanded to the limits of the local markets and local competitive interactions. When these isolated communities are brought into close contact (by changes in the costs of communication and transportation), a competitive struggle ensues:

> There is always a considerable number of enterprises which have not reached their limits and which have, consequently, power to go further. Since there is a free field for them, they seek necessarily to spread and fill it. If they meet similar enterprises which offer resistance, the second hold back the first. . . . But if some of them present some inferiority, they will necessarily have to yield ground heretofore occupied by them, but in which they cannot be maintained under the new conditions of conflict. They no longer have any alternative but to disappear or transform, and this transformation must necessarily end in a new specialization. . . . Although the preceding examples are drawn particularly from economic life, this explanation applies to all social functions indiscriminately. [Durkheim 1947, pp. 268–70]

To the extent that new specializations come about through the creation of new enterprises, this argument implies that increased moral density increases the founding rate, at least until some new equilibrium is reached (see also Hawley 1950).

Both social revolutions and political crises that end short of revolution invariably change the mix of organizations in society. Breaking the grip of ruling groups means destroying the organizations by which they rule and extract economic value. Resolving political crises means constructing new organizations either to repress dissent or to incorporate contending groups into the polity. Social revolutions normally involve both the destruction of existing organizations and the creation of new ones on a large scale. Institutional response to political and social crises usually involves the addition of new organizations and new organizational forms without the destruction of much existing organization. Periods of social crisis and political transformation affect especially the timing of waves of organization building. In an important sense, these periods transform broad and cumulative social and economic change into bursts of organizational activity. Although the events surrounding the crisis may do little more than signal fundamental changes in the power balance among contending groups, responses to the crisis may affect the world of organizations profoundly. If organizations are imprinted with the milieu of their founding period, as Stinchcombe (1965) and others claim, then the timing of social and political crises (and their attendant waves of foundings) controls the distribution of imprinted structures. That is, processes of political transformation filter the effects of broad economic, demographic, and social change for organizational populations.

Density Dependence

The seemingly natural models for birth processes in many fields assume that the birthrate depends on the number of units in a population. Since the dimensions of systems are usually assumed to be fixed in such cases, increasing population size implies increasing density. Therefore, such processes are referred to as density-dependent processes.

As we noted above, the capacities of social systems to sustain organizations of a type are often relatively fixed, at least in the short run. For example, the resources necessary to sustain organizations often are stable or grow only slowly. When carrying capacities change slowly, it makes sense to think of increases in the number of organizations as increases in density. Moreover, in the empirical research reported below, we control statistically for the levels of several factors assumed to affect the carrying capacities for the organizations under study. We assume that carrying capacities are stable over time, net of these measured factors (and, in some specifications, of period effects). Given these assumptions, we can explore the effects of intrapopulation interactions on founding rates by investigating the relationship between founding rates and density. Positive dependence on density means that the founding rate increases with the size of the population.

An argument for positive density dependence concerns the effect of availability of the knowledge and skills necessary to generate an organization. Knowledge about organizational strategies and structures is often available only to insiders (those already participating in such organizations). This is commonly the case when organizational functioning is shielded from direct view and when essential features of the organizational form have not been institutionalized. In such situations, existing organizations are the only training grounds for organization builders. The number of foundings in such populations should then be proportional to the number of jobs in existing organizations that give the requisite training. Marrett (1980) argues that high density increases the founding rate by widening and strengthening the networks that connect persons with the inclination and skills to succeed in creating a certain kind of organization.

If institutionalization means that certain forms assume a taken-for-granted character, then simple prevalence of a form ought to legitimate it. Those who attempt to create a form must fight for legitimacy and, in so doing, not only argue for the special purposes to which the organizational form is dedicated but also justify the design of the form. Once a sufficient number of instances of the form exist, the need for justification (and thus the cost of organizing) declines. Other things being equal, legitimation of a form increases its founding rate. If, as we argue here, legitimacy increases with prevalence of the form in society, then legitimation processes produce positive density dependence.

A plausible argument for negative density dependence involves competition within populations; the more numerous the competitors, the smaller the potential gains from founding an organization (and the bigger the cost to potential competitors) at a given level of demand for products and services. Fewer resources are available, and markets are packed tightly in densely populated environments. For these reasons, collectives with the knowledge and skills to build organizations are less likely to do so in densely populated environments. Capital markets and other macro structures often reinforce this effect. For example, investors may be reluctant to participate in new ventures in dense markets. Likewise, professional associations often try to restrict entry when density is high.

In general terms, increasing density implies increasing strength of competitive interactions within populations dependent on limited resources for organizing (when levels of such resources have been controlled). As density grows, the supplies of potential organizers, members, patrons, and resources become exhausted. Moreover, existing organizations respond to increasing competitive pressures by opposing attempts at creating still more organizations. For both these reasons, the founding rate should decline as the number of organizations in the population increases.

We predict that the founding rate rises initially and then falls with increasing density. If we are correct, the number of organizations in the population tends to stabilize at some level. In other words, such a founding process implies the existence of a carrying capacity for the population. Thus, it is important to learn whether founding rates vary with density and, if they do, whether the dependence is nonmonotonic. If the process turns out to be nonmonotonic, we can infer that competitive effects on founding rates contribute to the apparent stability of numbers in organizational populations.

Rate Dependence

Delacroix and Carroll (1983) report that the founding rate in populations of newspaper organizations in Argentina and Ireland depends on the number of recent foundings. Foundings in one period increase the rate in the next period, but this effect declines with the number of foundings (see also Carroll and Huo 1986). Delacroix and Carroll (1983) suggest that this pattern is consistent with an imitative process: potential entrepreneurs treat a surge of foundings as a signal that opportunities are favorable, but they also respond to apparent oversaturation of the market.

The substantive motivations for expecting recent foundings to affect the rate are quite similar to those discussed above for density dependence. Because Delacroix and Carroll (1983) did not include density in their empirical analyses, we do not know whether there are two separate effects. Perhaps their findings reflect only the fact that large populations have high crude founding rates.[5]

We explore this issue by estimating models that incorporate effects of both density and the number of recent foundings. As we noted above, organizational demography appears to be more sensitive to the size and composition of the population than to external events. Thus, we devote primary attention to issues of density dependence and rate dependence. However, we use models of these processes that contain simplified representations of environmental changes that ought to affect carrying capacities (and thus founding rates) at given densities.

MODELS FOR FOUNDING RATES OF ORGANIZATIONAL POPULATIONS

A first step in building models of organizational founding processes is to establish the appropriate unit of analysis. Much casual discussion of founding processes assumes that the set of potential founders (or entrepreneurs, in discussions of the world of firms) is the relevant actors, those at risk of founding organizations. From this perspective, one must identify the set of possible founders, which may be individuals or collectives, and build models for each actor's rate of founding. Research on such founding processes would seek to explain why some actors have higher founding rates than others.

[5] It is unlikely that Delacroix and Carroll's findings reflect mainly this confounding since there are a single peak of density and multiple waves of foundings in their data.

If we took this view, we would focus on collectives of workers as the actors with the potential to create one or more unions. We would then relate the founding rate of each collective to its characteristics (such as skill levels, geographical concentration, etc.) and to characteristics of the work environment (such as concentration of employers, rate of technical change in the industries organized, etc.). Such specification would be appropriate for explaining why some collections of workers had higher founding rates than others.

Although we think that research of this kind would be interesting, we doubt that it can be done meaningfully. The problem lies in the first step—defining, a priori, the set of actors. How do we partition the work force into a meaningful set of actors such that these actors and no others could have formed unions? For example, should we treat the population of carpenters and joiners as a unitary actor? Or should we distinguish them? Or should we include them in the broader population of skilled construction workers or the broader population of all construction workers? What about ethnic, racial, and gender differences? Should the unit be German-speaking carpenters?

The usual answer to this question is to let the data (the historical record) determine the relevant actors. Indeed, carpenters and joiners acted together. And, although German-speaking cabinetmakers founded their own union, this did not occur among carpenters and joiners. Why not then define the set of possible actors in terms of the realized outcomes? Doing so involves a logical error from the perspective of explaining variations in founding rates. It is a classic example of endogenous sampling or sampling on the outcome. In order to make inferences about the causal structure of founding rates (as in any attempt to explain why some collectives and not others succeeded in creating unions), one must begin research by defining the set of actors at risk of founding unions and then analyze the variation among them in success. Working backward—defining the set of actors who might have formed unions by noting which ones did—cannot provide useful information about the processes that shape founding rates defined at the level of collectives.

The logical problem is even more serious in the case of unions than in the usual case of analyzing actions of individuals. Each worker has multiple identities. Identities at very different levels of generality have been used at various times in defining the jurisdictions of unions. A particular worker might be identified as a skilled seamstress, a millinery worker, a ladies-garment worker, or a garment-trades worker, to take a hierarchical set of identities. But the same worker can also be mobilized as, say, a woman, a Socialist worker, or a Yiddish speaker in the garment trades. Since unions have organized on many dimensions such as these at different times, there is no unique partition of the population of workers into unitary actors characterized by a founding rate (or any other rate).

Because these problems are serious ones, we do not attempt to analyze founding processes at the level of collectives of workers. Rather, we treat foundings as events occurring in the population of unions. We assume that many different collections of workers have planned or tried to create unions. But we do not try to analyze the process at this level. We assume that the flow of attempts and successes in creating unions is influenced by the ecology of the population of unions and by macroeconomic and macrosociological processes. We focus on the entire population (and the socioeconomic system in which it is located) and analyze the rate at which new members enter the population. We relate this rate to characteristics of the population and of the social, economic, and political environment. In other words, the unit of analysis in our study is the population of unions.

An organizational founding process (at any level of analysis) can usefully be considered an instance of an arrival process. Arrival processes consider (usually in continuous time) the flow of arrivals to some state, such as events of radioactive decay, arrivals to a waiting line, events of cell division, and births. We denote the cumulative number of foundings by time t with the random variable $Y(t)$. A founding process concerns the stochastic behavior of increments to $Y(t)$.

The natural baseline model for arrival processes is the Poisson process, which assumes that the rate of arrival is independent of the history of previous arrivals (including the time of the last arrival) and of the current state of the system. Among other things, this assumption implies that the order of the event does not affect the arrival rate. If the rate at which new organizations arrive in the population follows a Poisson process, then the rate is a time-independent constant. That is, the rate of arriving at state (count) $y + 1$ at time t is

$$\lambda_y(t) = \lim_{\Delta t \downarrow 0} \frac{\Pr[Y(t + \Delta t) - Y(t) = 1 | Y(t) = y]}{\Delta t} = \lambda, \qquad (1)$$

under the assumptions of a Poisson process.

Although we use the model in (1) as a baseline for testing hypotheses, it hardly seems a plausible substantive model. If our theoretical arguments are correct, founding rates vary in response to changes in density and in environmental conditions affecting carrying capacities. Therefore, we concentrate on models in which the rate varies in some explicit way. Most of our modeling effort was devoted to specifying density dependence. We began with the simple and classic Yule process,[6] often used to model

[6] Karlin and Taylor (1975, pp. 119–23) provide background on this process.

phenomena for which each element can be assumed to have the same probability of producing a "birth" in a period, such as radioactive decay or births in bacterial populations. The Yule process assumes that the per-capita founding rate is a constant:

$$\lambda(t) = cN_t, \tag{2}$$

where N denotes the number of elements in the population, which may not equal the number of previous arrivals due to mortality: organizations disband and merge with other organizations. Inspection of data on union foundings suggest that the per-capita founding rate is not constant (see below). Instead, the rate rises initially and then slows at higher densities. Therefore, we relax the assumption of constant per-capita rates in the Yule process, using what we call a generalized Yule model:

$$\lambda(t) = cN_t^{\alpha}. \tag{3}$$

Dividing both sides of equation (3) by N shows that the per-capita rate, $\lambda(t)/N_t$, varies with N_t. If $\alpha = 1$, this model is identical to a Yule process. If $\alpha > 1$, the rate rises at an increasing rate with population size; if $0 < \alpha < 1$, the rate rises at a decreasing rate with population size. Finally, if $\alpha < 0$, there is negative density dependence; the rate falls with population size.

Above, we predicted that density dependence (and possibly rate dependence) in organizational founding rates is positive at low densities but that exhaustion and competition interfere with the founding process at high densities. Such arguments, if they do not imply that the rate actually declines at high densities (see below), are consistent with a model with the form of (3), in which α lies between zero and unity. In this case, the rate rises with density but at a decreasing rate (the first derivative of the rate with respect to density is positive, but the second derivative is negative).

Although the scenario just described is plausible, our ecological theory implies that competition processes actually depress the founding rate at high densities. We predict that imitation, spin-off effects, and institutional processes produce positive density dependence at low densities but that exhaustion and competition processes eventually dominate at high densities. Thus, we expect the rate to rise with increasing density to some critical level (the carrying capacity) and then to decline with further increases in density. In contrast to the generalized Yule model, we predict that the effect of density on the rate is nonmonotonic. A simple model consistent with our theory holds that

$$\lambda(t) = N_t^{\alpha} \cdot \exp(\beta N_t^2 + \boldsymbol{\pi}'\mathbf{x}_t), \tag{4}$$

where $\mathbf{x}_t$ is a vector of covariates, which includes a constant. We predict that

$$\alpha > 0 \text{ and } \beta < 0,$$

in which case the founding rate rises with increasing size initially but eventually falls toward zero.

Owing to the log-linear form of (4), the founding rate never equals zero in this model at nonzero densities. Thus, this model cannot imply a carrying capacity in the usual sense of zero growth rates. Nonetheless, if the parameters have the signs predicted by our theory, the founding rate begins to fall at some level of density and approaches zero at high densities. If the decline is rapid within the observed range of density, something like a classic carrying capacity exists. We explore such effects qualitatively in discussing our findings.

Delacroix and Carroll (1983) estimated a quadratic relationship between prior foundings and the number of foundings in a year. We use a related specification for the effect of prior foundings (B) on the rate:

$$\lambda(t) = N_t^{\alpha} \cdot \exp(\beta N_t^2 + \gamma_1 B_t + \gamma_2 B_t^2 + \pi \mathbf{x}_t), \tag{5}$$

where B denotes the number of foundings in the previous year. We hypothesize that a wave of foundings increases the rate but that a very large number of recent foundings exhausts the supply of resources needed to build new unions. That is, we hypothesize that the effect of recent foundings is also nonmonotonic:

$$\gamma_1 > 0 \text{ and } \gamma_2 < 0.$$

In developing qualitative implications of models like (5), we use the fact that its multiplicative structure allows it to be expressed as a product of several terms. When focusing on the effects of density, we refer to the multiplier of the rate due to the effect of density. That is, we express (5) as

$$\lambda(t) = N_t^{\alpha} \exp(\beta N_t^2) \cdot \exp(\gamma_1 B_t + \gamma_2 B_t^2) \cdot \exp(\pi' \mathbf{x}_t) \tag{6}$$

and refer to $N_t^{\alpha}\exp(\beta N_t^2)$ as the multiplier of the rate given by the effects of the other variables included in the model. Similarly, we refer to $\exp(\gamma_1 B_t + \gamma_2 B_t^2)$ as the multiplier effect of prior foundings.

The last topic we investigate concerns the linkages between founding rates in one population of unions and the demography of other populations of unions. We explore such links for a single partition into populations of craft and industrial unions (see below). We begin with the model in (5) as a representation of the founding process in isolation, that is, when the other population is absent. We add two cross effects to the model in (5), the effect of the density and recent foundings of the second population on the founding rate of the first. We suspected that these cross effects were monotonic. After exploring the fit of several monotonic and nonmonotonic specifications, we found that the following model works well:

$$\lambda_i(t) = N_{it}^{\alpha_i} \cdot \exp(\beta_i N_{it}^2 + \gamma_{1i} B_{it}^2 + \gamma_{2i} B_{it}^2 + \theta_i N_{jt} + \zeta_i B_{jt} + \pi_i' \mathbf{x} t), \tag{7}$$

where i and j denote the two populations. In this model the parameters α_i and β_i tell the effect of "own" density on the rate; the parameter θ_i tells the cross effect—the effect of "other" density. The cross effect of density captures the effect of interpopulation competition. Since we think that populations of craft and industrial unions compete in attempting to mobilize resources, we predict that the cross effect of density (θ_i) is negative for both populations.

We do not make any prediction about the cross effect of prior foundings (ζ_i). We can construct plausible arguments predicting both positive and negative effects. A surge of recent foundings in one population may exhaust the mobilizing resources available to both of them, implying that the cross effect would be negative. Alternatively, a surge of foundings in the other population might be taken as a signal that the time is ripe for initiating organizations of all forms, implying that the cross effect would be positive.

DATA

The data used here were collected as part of a larger project on the ecology of labor unions that sought to identify and collect histories on all national labor unions that have existed, however briefly, in the United States (Hannan 1980). We began by constructing a list of unions, using listings for the following years: 1887 (New Jersey Bureau of Labor Statistics 1888), 1893 (Finance 1894), 1901 (Industrial Commission *Report* 1901, vol. 17), 1926 (U.S. Bureau of Labor Statistics 1926), 1936 (Stewart 1936), 1944 (Peterson 1944), 1956 (National Industrial Conference Board 1956), 1962 (Troy 1965), 1975 (Fink 1977), and 1985 (Gifford 1985). We supplemented this list with annual reports of the Bureau of Labor Statistics for the period 1932–85 and with standard labor histories, especially Commons et al. (1927), Perlman (1932), Foner (1947), and Fink (1977). The coders searched for information on the history of each union on the list and recorded names of additional unions encountered in the search. This process eventually yielded usable histories of 633 unions. The first national unions we identified began in 1836 (the Society of Cordwainers, the Society of Journeymen House Carpenters, and the National Typographic Society). The histories extend to 1985.

New unions arose in several ways. Some were formed by the merger of two or more existing unions. Others were formed by factions that left an existing union. For example, in 1909, the National Woolsorters and Graders Union was formed by a faction of the United Textile Workers. At other times, a new union record begins when a formerly independent national union leaves a merger. For example, the Tailors National Trades Union, founded in 1883, merged in 1914 with the Amalgamated Clothing Workers Union (under that name), but most of the original members of the tailors union bolted and formed the Journeymen Tailors Union in 1915. Finally, many unions were begun as entirely new organizations. Often, these national unions were formed by local organizations of workers from several cities, as in the case of the unions formed in 1836. At other times, collections of previously unorganized workers were organized into a new national union, as in the case of many industrial unions.

The causal dynamics of these various events presumably differ. Some events refer to actions by existing national organizations; others refer to the creation of an organization for the first time. Since we are interested in the latter phenomenon here, we restrict our attention to events in which some collection of workers takes the step of forming a national labor union. This definition of a founding yields 479 events over the 1836–1985 period. Figure 2 shows how the events are distributed by year. Note the surge in foundings beginning in 1883 and continuing until 1906. This is the most important period of union building from the point of view of the creation of national unions. The peak years were 1897 and 1903, with 19 foundings each. A second peak occurs during the 1930s.

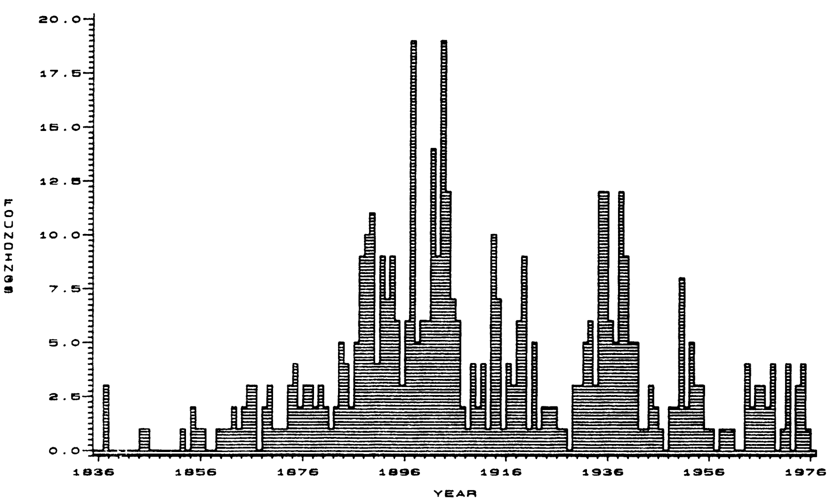

FIG. 2.—Labor union foundings by year

We recorded the exact dates of foundings and other events when this information was available. We learned the exact founding date for slightly less than half of the cases and only the year of founding for the rest. With this mixture of data, two strategies for analysis make sense: (1) ignore the information on exact timing and analyze only year-to-year variations in numbers of foundings and (2) use some scheme for allocating events with missing information on month and day to some date within the known year of founding. Rather than throwing away information, we chose the latter strategy. When the timing within a year was not recorded, we assigned a time using a random number uniformly distributed over the year.[7]

This procedure has implications for measuring density and number of recent foundings. When dates within years are unknown, the ordering of events within the year is also unknown. Therefore, we defined density (N) for all spells beginning in a calendar year as the number of unions in existence on January 1 of the year in question.[8] Similarly, we defined the number of foundings in the prior year B as the count in the calendar year prior to the year in which the interval begins. Each interval in the same calendar year is assigned the same values of N and B, those pertaining to the density at the beginning of the year and the count of foundings in the prior year.

The number of unions in existence (N) reflects the cumulative numbers of foundings and ending events (disbandings, mergers, and absorptions). Figure 1 shows how the number of unions (density) varied over the period of interest. The number fluctuated near zero until the Civil War era. It rose modestly until about 1881 and then grew explosively until 1905. From that point on, growth in numbers was slower and more erratic until the series reached its peak of 211 in 1954. The last portion of the series shows consistent contraction in the number of unions. This pattern is consistent with the presence of a carrying capacity that is relatively stable in time if the number of unions at its peak overshot the carrying capacity. Indeed, the number of unions in existence is stable during a period in which the number of union members grew explosively and numerous changes occurred in the polity and economy. This pattern suggests that the operation of the carrying capacity refers to the ecological processes

[7] It is unlikely that this choice affects qualitative inferences. In order to learn whether our estimates are sensitive to the timing of events within years, we repeated the main analyses with another set of randomized dates within years for those cases in which only the year of founding is known. These estimates agreed very closely with those reported here.

[8] Foundings are not the only source of variation in N. During this period, 203 unions disbanded; 270 were absorbed or entered into mergers. Thus, we are not simply relating the founding rate to the cumulative number of prior foundings.

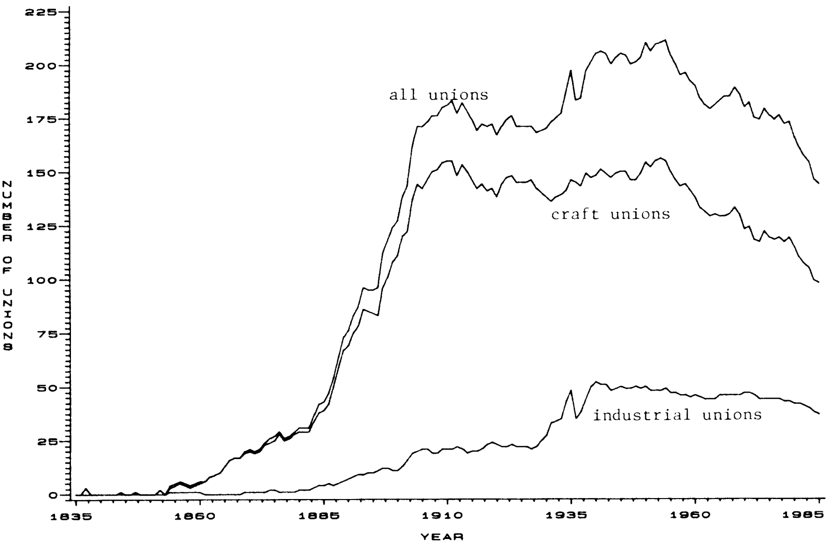

FIG. 3.—Prevalence of union forms over time

within the population of unions rather than to stability in the social, economic, and political environments.

Comparison of figures 1 and 2 suggests that the number of foundings is not simply proportional to the size of the population. The rate was highest during a period in which density was considerably below its maximum, and the number of foundings is quite low in the period of peak density. Figure 3 shows the growth in number of the two most commonly distinguished forms of union organization—craft and industrial unionism. The craft union form has its roots in the guild. It consists of journeyman craftsmen organized collectively for the purpose of controlling conditions of work, including regulating the flow of new members into the trade and training new members (apprentices). A key feature of the craft form is that workers at a work site were organized into several different unions. We classify unions as using the craft form when they define their target membership in terms of occupations (rather than industrial locations). The craft form, defined this way, has not been restricted to the highest skill levels; semiskilled and unskilled workers often formed narrowly defined unions in industries dominated by the craft form of organization (e.g., the Union of Hodcarriers and Building Laborers, formed in 1893). As figure 3 makes clear, most unions have had the craft form. Consequently, the growth of craft unions closely follows the pattern for the whole population. The number of craft unions reached a peak of 156 in 1953 and has dropped slightly since that time.

The industrial union form ignores differences among occupations and skill levels. Unions with this form seek to organize all production workers at work sites. The first clearly industrial union in our data, the American Labor Union, was founded in 1853. The number of industrial unions, always much smaller than the number of craft unions, began to grow gradually in the 1890s and spurted during the 1930s. It reached its peak of 52 in 1940 and has remained quite stable since that time.

Our research strategy capitalizes on knowledge of the full history of the population of national unions. Inspection of figure 2 makes clear that little would be learned about the underlying dynamics by focusing on the late stages of the history. Analysis must include the middle of the 19th century to capture the growth from low to high density. This means that the set of covariates available for use in analysis is limited to those whose series cover this crucial period. Since most of the commonly used time series on industrial activity—wage levels, strike activity, and so forth—begin in 1890 or even 1930, this is a severe restriction. In fact, only a few measures of environmental conditions are available for most of the 1836–1985 period.

For this reason, we conducted much of the empirical analysis using period effects. That is, we assumed that the founding rate varied by historic periods but was constant within periods (net of the effects of density and the flow of recent foundings). We tried a number of sets of periods and obtained best results with a three-period model. The first period runs from 1836 to the passage of the Wagner Act in 1935, which gave extensive legal protection to union-organizing efforts. The second period runs from 1935 to 1955, when the American Federation of Labor and the Congress of Industrial Organization ceased their competition and merged into one association. The third period runs from 1955 to 1985.[9] We estimate the effects of the second and third periods relative to the first (i.e., the first period is the baseline).

We also explored the effects of several measures of general economic conditions (available in *Historical Statistics of the United States* [U.S. Bureau of the Census 1975], unless indicated otherwise). These include an index of real wage rates for common laborers compiled by David and Solar (1977) for the period from 1870 to 1974, the number of business failures (1857–1982), gross national product per capita (1889–1982), indexes of the value of new building permits (1868–1939), and an index of

[9] We also explored the effects of breaking the series in 1886 when the American Federation of Labor began, in 1947 when the Landrum-Griffin Act repealed some of the gains that organized labor had won with passage of the Wagner Act, and distinguishing war years from others. None of these modifications added significantly to the fit of the models or affected estimates of the parameters of interest.

railroad construction (1830–1925). We also used the number of patents issued for inventions (1830–1982), an index of productivity per man-hour in manufacturing (1860–1914), and an index of capital investment (1865–1982) as indicators of the rising mechanization of production. None of these measures has any systematic and sizable effect on the union-founding rate when the measures discussed below are included in the model.

The variables that turned out to have interesting and systematic effects in our analysis characterize the tightness of labor markets. The first two are the flow of immigrants (1836–1983) and changes in the level of immigration from year to year. The third is an index that identifies years of economic crisis and depression (Thorp and Mitchell 1926), which we supplemented to 1985.

ESTIMATION

To this point, we have noted that (1) the data consist of a sequence of times of union foundings and (2) we regard this sequence of times as a realization of an arrival process driven by a set of covariates. In this section, we discuss how we use the time series of events to estimate parameters of the relevant processes.

After conditioning on the time of the first observed founding, the set of durations between adjacent events conveys the essential information about the process. Therefore, we break the period from 1836 to 1985 into 479 intervals defined by the sequence of 479 founding times (there are 478 intervals between events and a last, censored interval that ends in 1985). We associate with each interval the values of all covariates at the beginning of the interval. That is, we specify that the rate holding within the interval beginning at time t_i depends on the level of environmental conditions measured at t_i and on the density of the population and the number of foundings in the year prior to t_i:

$$\lambda(t) = \exp(a'\mathbf{z}_{t_i})h(t - t_i), \; t > t_i, \tag{8}$$

where t_i is the time of initiation of the spell (the time of the previous event), and $\mathbf{z}_{t_i}$ is a vector of all covariates (including density and prior foundings) measured at t_i. Because most intervals are short relative to changes in environmental conditions (and the number of prior foundings is constant within intervals), we treat the covariates as constant within intervals (fixed at the levels that held when the interval began).

We estimated models like (8) using Cox's (1975) partial likelihood (PL) method. The PL estimator assumes that the transition rate (the founding rate in this case) equals an exponential function of the measured covariates, as in equation (8), multiplied by a nuisance function, $h(t - t_i)$.

The nuisance function is assumed to vary over duration in an arbitrary fashion but similarly for all observations; it is a nonparametric specification of duration dependence.[10] The PL estimator uses only the ordering of the observations (in terms of durations in this case) and assesses the contributions of the measured covariates in explaining the observed ordering. So, for example, if intervals that begin in periods of high density tend to be short (to appear early in the rank ordering in duration), the PL estimator will report that density increases the rate, net of the effects of other covariates and the nuisance function.

As we noted above, use of the PL estimator requires that the rate be expressed as a log-linear function of the covariates. In order to estimate parameters of the generalized Yule process, we use the (natural) logarithm of N as a covariate in the log-linear model, because $\exp(\alpha \log N) = N^{\alpha}$. We label the rows reporting coefficients of this type with "log N" in the stub of the table. All the other coefficients in the tables have the usual interpretation as effect parameters in a log-linear rate model.

The last portion of the analysis reported below considers interactions between populations of craft and industrial unions, using variations of model (7). Twenty-eight unions, whose position on the craft/industrial distinction could not be determined from available data, were excluded from these analyses. We analyzed the time series of founding dates of the 355 craft unions and of the 96 industrial unions separately. We calculated the durations between adjacent foundings separately within each population. However, to explore competitive links between populations, we included the density of each form and the number of prior foundings within each population as covariates in analyzing the rate for each population. In other words, the covariates associated with each interval between adjacent craft (industrial) foundings include the densities of craft and industrial unions and the number of recent foundings of each type at the time that the interval began.

RESULTS

Our empirical analysis deals with four questions: (1) Does the founding rate of labor unions depend on density, and, if so, what is the form of the dependence? (2) Does the rate also depend on the number of recent found-

[10] It is not clear that duration-dependence is likely for the process we study. If the rates do not vary with the duration since the last event, the nuisance function will be close to unity. In fact, maximum likelihood estimates of models that ignore duration-dependence are very similar to those reported here, suggesting that this is the case. Also similar are nonlinear least-squares estimates of regression of completed durations (excluding the last censored interval) on the relevant exponential functions of the covariates (see Tuma and Hannan 1984, p. 162 for motivation of this approach).

ings? (3) Do effects of density and recent foundings persist when environmental effects are included in the models? (4) Does competition between forms affect the founding process?

In considering density and prior findings, we are particularly interested in contrasting monotonic and nonmonotonic models. As we noted above, a monotonic relationship is consistent with theories that stress institutionalization, imitation, and spin-off effects (such as density increasing the supply of those with organizing skills). Nonmonotonic effects support theories that argue that effects of institutionalization, imitation, and spin-offs are also countered by strong competitive processes. Thus, comparisons of the two kinds of models provide information about the strength of intrapopulation competition on the founding process and the role of founding processes in stabilizing numbers in the population.

Table 1 reports PL estimates for the period from 1836 to 1985. The models differ in how they specify the effects of density, recent foundings, and environmental variations. Column 1 reports estimates of model (3), in which the effect of density on the rate has the generalized Yule form and the rate varies across three periods, as discussed above. The estimate of the density-dependence effect differs significantly from zero and falls in the (0,1) interval as predicted. According to these estimates, the founding rate increases at a (rapidly) decreasing rate as density increases. Column 2 reports estimates of model (4), which adds the second-order effect of density. The first-order effect is still positive as predicted; it still differs significantly from zero. The second-order effect is negative as predicted; it too differs significantly from zero. Moreover, the likelihood ratio test of the model in column 2 against the model in column 1 has a χ^2 statistic of 21.9, with one degree of freedom. Allowing the effect of density to be nonmonotonic increases the fit significantly.

The second question concerns the effects of recent foundings on the founding rate. Column 3 reports estimates of the parameters of model (5), which adds a log-quadratic specification of the number of foundings in the prior year to the model whose estimates appear in column 2. With this specification, all four theoretically relevant terms differ significantly from zero in the predicted directions: both the effects of density and recent foundings are nonmonotonic. Moreover, adding a nonmonotonic effect of recent foundings improves the fit significantly. A likelihood ratio test of the model in column 3 against the model in column 2 has a χ^2 statistic of 22.7, with two degrees of freedom, which differs significantly from unity at the .01 level.

The models whose estimates have been discussed so far include two period effects. Estimates in columns 1, 2, and 3 reveal that the founding rate fell following passage of the Wagner Act (the start of period 2). However, the estimated effect does not differ from zero at the .10 level,

TABLE 1

PL Estimates of Effects of Density and Prior Foundings on Founding Rate, 1836–1985

Independent Variable	Model (1)	(2)	(3)	(4)
log N	.286***	.554***	.397***	.423***
	(.043)	(.084)	(.082)	(.083)
$N^2/1000$		−.030***	−.022***	−.021***
		(.007)	(.006)	(.006)
B			.127***	.117***
			(.035)	(.035)
B^2			−.004**	−.004**
			(.002)	(.002)
Period 2:				
1935–54	−.391***	.062	.010	−.143
	(.132)	(.168)	(.169)	(.192)
Period 3:				
1955–85	−.767***	−1.02***	−.697***	−.632***
	(.214)	(.217)	(.228)	(.236)
Imm				−.035*
				(.021)
ΔImm				.066*
				(.036)
χ^2	80.3	102.2	124.9	129.4
df	3	4	6	8
Spells	479	479	479	479

Note.—Asymptotic standard errors in parentheses.
* $P < .10$.
** $P < .05$.
*** $P < .01$.

suggesting that the rate for the first two periods does not differ greatly. But the rate did drop sharply (and significantly) after the merger of the AFL and the CIO (the start of period 3). For example, the estimated effect of the third period in column 3 implies that the rate was only half that of the first period (that is, exp[−.697] ≈ .50).

Only one pair of the several covariates we used affected the founding rate significantly over the 1836–1985 period (net of the effects of density, prior foundings, and the period effects): immigration and change in immigration. The model whose estimates are reported in column 4 of table 1 adds the level of immigration in 100,000s (Imm) and the change in immigration from the previous year in 100,000s (ΔImm). According to these estimates, high immigration flows depressed the founding rate, as most accounts of labor history suggest (see, e.g., Ulman 1955). But rapid increases tended to increase the founding rate, which has not been noted previously (despite the fact that each point estimate differs significantly from zero at the .10 level, the model in column 4 does not improve significantly over the model in column 3).

From the perspective of ecological theory, the most important result is that using (many) different representations of environmental variations does not eliminate the effects of density and recent foundings. In the case in point, each of the four terms concerning the theoretically relevant effects differs significantly from zero in the predicted direction in column 4. Very similar estimates are obtained when the other covariates mentioned above are used.[11] Our provisional conclusion is that estimates of effects of density and recent foundings are quite robust with respect to specification of the effects of environmental conditions on the founding rate.

Qualitative Implications

The substantive implications of these findings for the ecology of unions can be seen in plots of the estimated relationships. Figure 4 plots the estimated relationship between the number of unions (density) and the rate (as implied by the estimates of the model in column 4 in table 1). The vertical axis tells the multiplier of the rate (given by the effects of other covariates). The multiplier exceeds unity over the observed range of density, zero to 211 (indicated by the vertical dashed line). At its maximum, when $N \approx 100$, the rate is more than five times larger than the rate when $N = 0$. Because the estimated rate rises very sharply with density in the range near $N = 0$, it is probably more informative to use as a baseline of comparison the multiplier at some nonzero level of N. For instance, take the level $N = 10$ as the baseline. Then the maximum multiplier is about twice the base rate. If density increases to the level $N = 260$, the multiplier falls to approximately the level of the baseline. In other words, our estimates imply that the same founding rate holds in populations with 10 and with 260 unions and that the rate when there are about 100 unions is about 2.5 times larger. To make a different comparison, the founding rate at the observed maximum ($N = 211$) matches the rate when $N \approx 20$. Each of these comparisons shows that the estimated density effect drives the founding rate in a large population down to the level that holds in a very small population of unions. The rate rises sharply with increasing

[11] We used each of the indexes listed above as covariates in the main models reported here. None of them has systematic or statistically significant effects, net of the variables included in the models reported in the tables. More important, inclusion of these variables does not eliminate the statistically significant effects of the main substantive variables—density and the number of recent foundings.

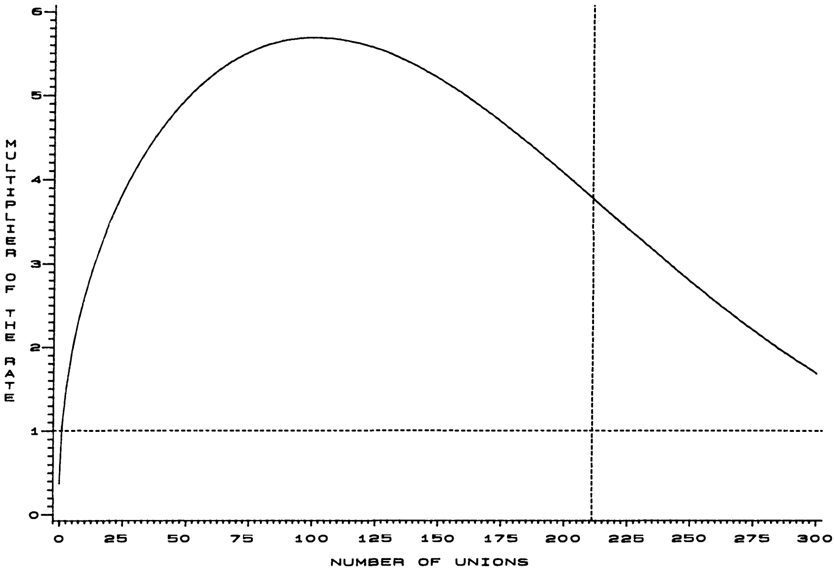

FIG. 4.—Effect of density on founding rate (estimates from model 4 in table 1)

density in the lower range and drops sharply with increasing density in the higher range, indicating that the founding rate is very sensitive to density.

What do these findings imply about the carrying capacity for unions, as determined by fluctuations in founding rates? Notice in figure 4 that the multiplier has not yet fallen to unity when N reaches its maximum observed value. At this point, the founding rate is almost four times larger than the rate at zero density and 50% larger than the rate of $N = 10$. The multiplier equals unity at about $N = 340$ and drops sharply from that point on. In other words, the operation of a founding process with these parameters is consistent with a carrying capacity of about 340 labor unions. The fact that the number of unions stabilized at a level about a third lower presumably reflects factors other than density dependence in founding rates. For example, it may be due to density dependence in rates of disbanding and merger.[12] Still, the fact that the founding rate at moderate density exceeds the rate at high density has apparently contributed to the leveling of numbers of unions. As we noted in the previous para-

[12] Elsewhere (Hannan and Freeman 1986), we show that rates of disbandings of unions also varied systematically with density. Disbanding rates fall with increasing density when density is low and then increase with increasing density when density is high. Thus, density dependence in disbanding rates apparently contribute to the stabilization of numbers revealed in figure 1.

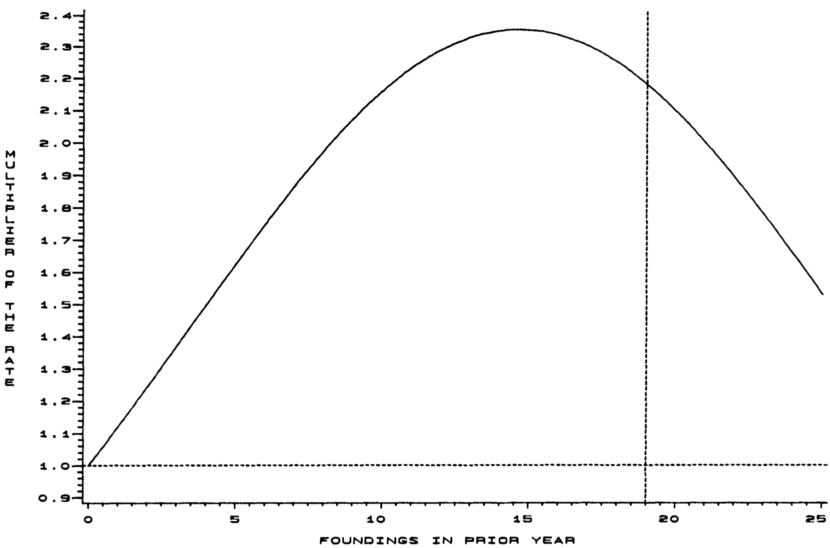

FIG. 5.—Effect of prior foundings on founding rate (estimates from model 4 in table 1).

graph, using a baseline for comparison of $N = 10$ or $N = 25$ suggests that the rate is strongly depressed by density within the observed range.

Figure 5 plots the effect of prior foundings. As in figure 4, the implied effect is positive over the observed range. This effect is weaker than the effect of density, but it is still considerable. The multiplier due to prior foundings is largest when $B \approx 15$, at which point the multiplier is 2.3 times that when $B = 0$, which is a useful baseline, since many years have zero foundings. From that level, the multiplier drops with additional prior foundings, but it is still almost 2.2 when the observed maximum ($B = 19$) is reached. The strong effect of prior foundings on the founding rate may have contributed to the wavelike pattern of observed foundings. A perturbation that produced a high level of founding activity in one year seems to raise the rate for the next year substantially when the population is below the carrying capacity.

Interactions between Craft and Industrial Populations

The final part of our analysis examines foundings of craft and industrial unions. It has two objectives: (1) to learn whether the processes differ by form and (2) to examine competition between forms. We began by estimating models for each population using the models discussed to this point and then estimate model (7), which incorporates interpopulation

TABLE 2

PL Estimates of Effects of Density, Prior Foundings, and Competition on Founding Rates of Craft Unions, 1836–1985

Independent Variable	Model (1)	(2)	(3)	(4)
log N_C	.244***	.402***	.402***	.429***
	(.079)	(.093)	(.095)	(.095)
$N^2_C/1000$	−.015	−.024*	−.048***	−.019
	(.010)	(.013)	(.018)	(.014)
B_C	.211***	.149***	.147***	.137***
	(.046)	(.051)	(.051)	(.052)
B^2_C	−.010***	−.008***	−.008***	−.008**
	(.003)	(.003)	(.003)	(.003)
N_I		−.020***	.005	−.025***
		(.006)	(.015)	(.007)
B_I		.157***	.100*	.146***
		(.047)	(.054)	(.048)
Period 2: 1935–54			−.526	
			(.360)	
Period 3: 1955–85			−.409	
			(.292)	
Imm				−.033
				(.027)
ΔImm				.074*
				(.044)
χ^2	70.7	100	104.3	103.6
df	4	6	8	8
Spells	355	355	355	355

Note.—Asymptotic standard errors in parentheses.
* $P < .10$.
** $P < .05$.
*** $P < .01$.

effects. Tables 2 and 3 report estimates for craft unions and industrial unions, respectively.

Model 1 in table 2 mimics model 3 in table 1 but with two differences. The first difference is that counts of unions and of prior foundings of all types are replaced by counts of craft unions (N_C) and craft foundings (B_C) in the model for craft-founding rates. The second difference is that no other covariates are included in the first model in table 2.

According to the estimates in column 1 in table 2, both density and number of recent foundings affect the founding rate for craft unions. Estimates of these effects are fairly similar to those for the entire population of unions (table 1). Column 2 contains estimates of the parameters of a model that adds cross effects of numbers of industrial unions and foundings of industrial unions to the model in column 1. These additions improve the fit significantly (the likelihood ratio χ^2 statistics equals 10.2 with two degrees of freedom). Moreover, estimates of both cross-effect terms (effects of N_I and B_I) differ significantly from zero. The founding rate of craft unions declines with the density of industrial unions. However, surges in foundings of industrial unions increase the founding rate of the population of craft unions.

The model in column 3 adds the two period effects to the model in column 2. Notice that adding period effects does not increase the fit significantly (the likelihood ratio test of model 3 vs. model 1 is 4.3 with two degrees of freedom, which does not differ significantly from unity at the .10 level). However, the model with period effects eliminates the effect of the density of industrial unions. Inspection of figure 3 shows that the density of industrial unions was quite small during period 1 and does not vary much during periods 2 and 3. That is, the periods and the density of industrial unions are highly collinear; they explain essentially the same variation in the founding rate of craft unions. Given our theoretical focus, we think that the rise in density of industrial unions in the 1930s explains the apparent period effect. Those with different theoretical perspectives might argue that the period effect takes priority and explains the apparent effect of density of industrial unions. Because the historical record contains only one sustained surge in density of industrial unions, empirical analysis cannot disentangle the two effects.

Replacing the two period effects with the effects of immigration and change in immigration (model 4) also fails to improve significantly the fit relative to model (3). As was true for the whole population of unions, immigration seems to have lowered the craft founding rate; large increases in a single year seem to have increased the founding rate for craft unions.

The cross effect of density (the effect of N_I) on the craft founding rate is negative and differs significantly from zero at the .05 level in column 4. Estimates of this specification agree with those in column 2 that the growth of industrial unions inhibited the founding rate of craft unions. The competitive effect is a strong one according to these estimates. The estimate in column 4 implies that the founding rate of craft unions is only about a third as large when there were 50 industrial unions as when there were none (i.e., $\exp[-.025 \cdot 50] \approx .29$). Put differently, variations in the density of industrial unions over the observed range lower the founding rate of craft unions by more than two-thirds.

The pattern of results for the population of industrial unions differs considerably. Presumably some of the differences reflect the fact that the

TABLE 3

PL Estimates of the Effects of Density, Prior Births, and Competition on the Founding Rate of Industrial Unions, 1853–1985

Independent Variables	Model (1)	(2)	(3)	(4)
log N_I	.352**	.388	.652**	.328
	(.131)	(.246)	(.279)	(.306)
$N^2{}_I/1000$	−.367**	−.400**	−.541	−.933**
	(.169)	(.178)	(.412)	(.411)
B_I	.403**	.437**	.251	−.004
	(.181)	(.189)	(.208)	(.218)
$B^2{}_I$	−.031	−.035	−.010	.013
	(.028)	(.029)	(.035)	(.037)
N_C		−.002	−.007	.011
		(.006)	(.007)	(.009)
B_C		−.020	−.032	−.039
		(.035)	(.038)	(.048)
Period 2:				
1935–54			.410	.339
			(.664)	(.613)
Period 3:				
1955–85			−2.22***	−2.12**
			(.860)	(.899)
Imm				−.161**
				(.064)
ΔImm				.285***
				(.088)
Depression year				.458*
				(.271)
χ^2	27.5	27.9	38.1	54.3
df	4	6	8	11
Spells	96	96	96	96

Note.—Asymptotic standard errors in parentheses.
* $P < .10$.
** $P < .05$.
*** $P < .01$.

small number of events in this population (there were 96 foundings) reduces the precision of estimators. Nonetheless, some of the differences are so large that they probably reflect real differences in the ecologies of the two forms of organization.

Results for industrial unions appear in table 3, whose structure parallels table 2. The estimates in column 1 show strong nonmonotonic effects of density; both density terms differ significantly from zero in the predicted directions. The number of recent foundings also has a significant, positive first-order effect. The second-order effect of recent foundings is negative, as predicted. However, it does not differ significantly from zero at the .10 level.

Next we add the cross effects of craft density and foundings. Column 2 shows that each cross effect is small and does not differ significantly from zero at the .10 level. The various other specifications used in subsequent columns of table 3 do not change this finding. This result differs sharply from the findings for the population of craft unions, where the cross effects differ significantly from zero. Apparently, the competitive processes between craft and industrial populations have been asymmetric.

The model in column 3 adds the two period effects, which improves the fit significantly. The point estimates of the period effects imply that the founding rate of industrial unions fell sharply after 1955—the rate during this period was only 10% as large as during the previous 100 years. Surprisingly, in view of the widespread claims by labor historians that passage of the Wagner Act in 1935 accelerated the spread of industrial unionism, the estimates in column 2 imply that the founding rate between 1935 and 1955 did not differ significantly from the rate during the 19th and early 20th centuries.

Several of the covariates we included had substantial and statistically significant effects on the founding rate for industrial unions. Column 5 reports the estimates of a model that includes the effects of immigration, change in immigration, and a dummy variable that distinguishes depression years. As was true for the whole population of unions, high levels of immigration seem to have depressed the founding rate, but sharp upswings in immigration flows increased the rate. We find that depressions accelerated the process of founding industrial unions. The founding rate during depressions was half again as large as the rate in other years (adjusting for the effects of all other variables in the model).

In other analyses, not reported here, we find evidence that high levels of unemployment increased the founding rate (net of the effects of the variables included in column 4). However, the high intercorrelations of the various measures of economic conditions make estimates of these effects sensitive to small variations in model specification. Nonetheless, it is clear that founding rates of industrial unions have been much more sensitive to variations in economic conditions that have founding rates of craft unions.

DISCUSSION

Our analysis of founding rates of American national labor unions yields four main findings. First, founding rates are sensitive to the density of unions. The curvilinear relationship between density and the founding rate is consistent with the argument that intrapopulation competition constrains the growth of numbers by affecting founding rates.

Second, the founding rate varies with the number of recent foundings. This relationship, too, is curvilinear. We suggested that this relationship reflects the joint operation of an imitation process and a competition process. A surge in foundings may inspire additional attempts. However, if the supply of potential organizers and organizing resources is fixed over the short run, a big surge in foundings will tend to exhaust the pool of resources for additional foundings, at least temporarily. It will be interesting to learn whether the effect of recent foundings holds up under better specification of the effects of environmental variables. It may be that this effect reflects mainly the operation of unobserved environmental conditions that change relatively slowly.

Third, environmental conditions also affect founding rates of labor unions. Changes in the economy and society shape the population of labor unions partly by altering the rates at which unions are created. We find that the founding rate of industrial unions has been particularly sensitive to these effects. From our perspective, one of the most important findings is that the estimated effects of density and the number of prior foundings appear to be quite insensitive to the specification of environmental effects on founding rates.

Fourth, founding rates also reflect interpopulation processes. The founding rate of craft (but not industrial) unions has been affected by the sizes of both populations. However, the effect of density of industrial unions on the founding rate of craft unions may be confounded with period effects, as we have discussed above.

These four findings suggest that analysis of founding rates is a useful way to explore the population ecology of organizations. Variations in such rates over long periods of time reveal patterns of environmental dependence, intrapopulation competition, and interpopulation relations. These findings also raise interesting questions of interpretation that pose a challenge to subsequent research. Two such questions deserve mention, both of which concern the nature of carrying capacities for labor unions.

Why is there a carrying capacity limit on the number of labor unions? This question is intriguing because the apparent carrying capacity has been nearly stable for a long period when such conditions as the legal standing of unions, the size of the work force, the number of union members, and the organization of the economy have changed drastically. The apparent existence of such a carrying capacity, coupled with its stability in the face of massive environmental change, suggests that some purely organizational factors are involved. That is, our analyses of the processes that determine fluctuations in numbers of unions bear as directly—perhaps more directly—on the organizational nature of the world of labor unions as the more commonly studied processes pertaining to fluctuations in membership or in various forms of support for unions or opposition to them.

Why does the carrying capacity hold at the national level? Clearly, not all the unions in the population compete with one another for members. Many are narrow craft unions organizing in one industry. Presumably, competition is more intense within industries (e.g., among garment workers' unions or service workers' unions than among the whole population of unions). Each industry or set of industries may have its own carrying capacity. In this case, the apparent carrying capacity at the national level reflects the aggregation of local carrying capacities. But there may be national-level processes involved as well. We plan to conduct analyses parallel to those reported here to investigate this issue.

The actual carrying capacity (at the national or industrial level) presumably depends on historical factors (such as the timing of waves of union building relative to waves of industrial expansion and concentration) and institutional factors (such as the political organization of the working class and the nature of state). These are the kinds of factors needed to explain why, for example, France has a small number of huge unions and Britain has very many small unions. Any exploration of these differences requires comparative analysis of the ecology of labor unions in many countries.

This paper has concentrated on the dynamics of the population of unions given some carrying capacity, which may change over time. Our results support the notion that such a carrying capacity exists and changes relatively slowly in the United States. Population-ecology analysis usually combines historical particulars with abstract generalities. We think that the forces determining the carrying capacity for any form of organization, such as national labor unions, are likely to be idiosyncratic to both the organizational form and the context. For example, different processes presumably generate carrying capacities for labor unions and producers of semiconductor electronics devices. Yet, the dynamics of the adjustment of populations to carrying capacities may be quite general. Ecological theories of organizations suggest that founding rates (and disbanding rates) of such dissimilar populations as labor unions and semiconductor producers are affected similarly by density.

REFERENCES

Carroll, Glenn R. 1984. "Organizational Ecology." *Annual Review of Sociology* 10:71–93.

Carroll, Glenn R., and Yangchung Paul Huo. 1986. "Organizational Task and Institutional Environments in Evolutionary Perspective: Findings from the Local Newspaper Industry." *American Journal of Sociology* 91:838–73.

Chandler, Alfred D. 1977. *The Visible Hand: The Managerial Revolution in American Business*. Cambridge, Mass.: Belknap.
Commons, John R., et al. 1927. *History of Labor in the United States*. 4 vols. New York: Macmillan.
Cox, David R. 1975. "Partial Likelihood." *Biometrika* 62:269–76.
David, Paul A., and Peter Solar. 1977. "A Bicentenary Contribution to the History of the Cost of Living in America." *Research in Economic History* 2:1–80.
Delacroix, Jacques, and Glenn R. Carroll. 1983. "Organizational Founding: An Ecological Study of the Newspaper Industries of Argentina and Ireland." *Administrative Science Quarterly* 28:274–91.
Durkheim, Émile. (1893) 1947. *The Division of Labor in Society*. Glencoe, Ill.: Free Press.
Finance, Maurice. 1894. *Syndicates ouvriers aux États-Unis*. Paris: Imprimerie Nationale.
Fink, Gary, ed. 1977. *National Labor Unions*. Greenwood, Ala.: Greenwood.
Foner, Philip. 1947–1972. *History of the Labor Movement in the United States*. Vol. 1, 1947; Vol. 2, 1955; Vol. 3, 1964; Vol. 4, 1972. New York: International Publishers.
Gifford, Courtney D. 1985. *Directory of U.S. Labor Organizations, 1984–85*. Washington, D.C.: Bureau of National Affairs.
Hannan, Michael T. 1980. "The Ecology of National Labor Unions: Theory and Research Design." Technical Report no. 1. Stanford, Calif.: Stanford University, Organizations Study Section, Institute for Mathematical Social Sciences.
———. 1986. "Uncertainty, Diversity and Organizational Change." Pp. 73–94 in *Behavioral and Social Science: Fifty Years of Discovery*, edited by Neil Smelser and Dean Gerstein. Washington, D.C.: National Academy.
Hannan, Michael T., and John Freeman. 1977. "The Population Ecology of Organizations." *American Journal of Sociology* 82:929–64.
———. 1984. "Structural Inertia and Organizational Change." *American Sociological Review* 49:149–64.
———. 1986. "Disbanding Rates of National Labor Unions, 1836–1985: Density Dependence and Age Dependence." Technical report no. 86-6. Ithaca, N.Y.: Cornell University, Department of Sociology.
Hawley, Amos. 1950. *Human Ecology: A Theory of Community Structure*. New York: Ronald.
Industrial Commission. 1901. Report. Washington, D.C.: Government Printing Office.
Karlin, Samuel, and Howard M. Taylor. 1975. *A First Course in Stochastic Processes*. 2d ed. New York: Academic.
Marrett, Cora B. 1980. "Influences on the Rise of New Organizations: The Formation of Women's Medical Societies." *Administrative Science Quarterly* 25:185–99.
Meyer, John W., and Brian Rowan. 1977. "Institutionalized Organizations: Formal Structure as Myth and Ceremony." *American Journal of Sociology* 83:340–63.
Meyer, John W., and W. Richard Scott. 1983. *Organizational Environments: Ritual and Rationality*. Beverly Hills, Calif.: Sage.
National Industrial Conference Board. 1956. *Sources of Union Government: Structures and Procedures*. New York: NICB.
New Jersey Bureau of Labor Statistics. 1888. *Tenth Annual Report*.
Perlman, S. A. 1932. *A History of Trade Unionism in the United States, 1896–1932*. Vol. 4. New York: Macmillan.
Peterson, Florence. 1944. *Handbook of Labor Unions*. Washington, D.C.: American Council of Public Affairs.
Stewart, Estelle. 1936. *Handbook of American Trade Unions*. Washington, D.C.: Bureau of Labor Statistics.

Stinchcombe, Arthur L. 1965. "Social Structure and Organizations." Pp. 153–193 in *Handbook of Organizations,* edited by James G. March. Chicago: Rand McNally.
Thorp, Willard Long, and Wesley C. Mitchell. 1926. *Business Annals.* New York: National Bureau of Economic Research.
Troy, Leo. 1965. *Trade Union Membership, 1887–1962.* New York: National Bureau of Economic Research.
Tuma, Nancy Brandon, and Michael T. Hannan. 1984. *Social Dynamics: Models and Methods.* New York: Academic.
Ulman, Lloyd. 1955. *The Rise of the National Trade Union.* Cambridge, Mass.: Harvard University Press.
U.S. Bureau of the Census. 1975. *Historical Statistics of the United States: Colonial Times to 1970.* Washington, D.C.: Government Printing Office.
U.S. Bureau of Labor Statistics. 1926. *Handbook of American Trade Unions.* Washington, D.C.: Government Printing Office.
Weber, Max. 1978. *Economy and Society.* Edited by Gunther Roth and Claus Wittich. Berkeley: University of California Press.