In the Bud? Disk Array Producers as a (Possibly) Emergent Organizational Form

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This article develops and tests theory on when and where a new organizational form will emerge. Recent theory holds that as the number of organizations using a particular external identity code first increases beyond a critical minimal level, the code becomes an organizational form. Going beyond this formulation, we theorize about how an external identity code is established. We argue that when the identities of individual organizations are perceptually focused, they will more readily cohere into a distinct collective identity. We develop ideas about how two observable aspects of organizations might generate perceptually focused identities in a common market: (1) de novo entry and (2) agglomeration in a geographic place with a related identity. Using comprehensive data from the market for disk drive arrays, we test these ideas and an alternative by estimating effects of different specifications of organizational and product densities on rates of entry and exit for array producers. Overall, the analysis supports the notion that firms with perceptually focused identities aid in establishing an organizational form.●

In 1986, a little-known Dutch company named Twincom introduced a software product designed to manage "disk drive arrays," which are data storage subsystems linking several (or many) hard disk drives. In the following year, disk array products were introduced by an additional seven companies: 1776, Atlantic Microsystems, Core International, Ford/Higgins, Maximum Strategy, Thinking Machines, and Micropolis, a disk drive manufacturer. Little over a decade later, disk arrays had a well-established world market and were widely used: over $12.6 billion in disk array products were sold in 1998 by 130 different producers. In a very different domain, namely beer, another new market was developing around the same time. In 1977, the New Albion Brewing Company opened in Sonoma, California. It joined the existing (but recently transformed) Anchor Brewing Company of San Francisco in offering heavier, full-flavored malt beverages (e.g., ales, porters, stouts) not found in the American market for beer. In subsequent years, others followed; by 2000, the economic contribution of mainly small "craft" breweries was estimated at $11 billion. The market includes scores of producers such as Anchor, commonly known as "microbreweries," as well as hundreds of other producers known as "brewpubs." The brewpub also makes full-flavored malt beverages using craft techniques but serves them at the site of production, usually in conjunction with food. Founded in 1987 in Hopland, California, the Hopland Brewery is widely recognized as the first brewpub in the U.S. since Prohibition.

Chances are that the microbrewery and brewpub terms will be familiar, while the disk array producer term (or anything similar that would describe specifically the firms in this market) will not be. Chances are also that it would not take much thought to name a microbrewery or brewpub, but it would take some research to name a disk array producer other than one of those listed above. The comparison thus raises two questions. First, does it matter that in the one market we have readily accessible descriptive labels to classify and distinguish participating firms while in the other we do not? Second, presuming it does matter, how can we account for the

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difference in public cognitive status of the various organizations?

Our answer to the first question is that having descriptive labels does matter. In our view, the ready accessibility of classificatory terms for types of organization derives directly from whether or not a particular type of organization constitutes an organizational form, defined as a recognizable pattern of activity that takes on rule-like standing, which Pólos, Hannan, and Carroll (2002) called a code. The term code here denotes and connotes both cognitive recognition and imperative standing. By this definition, a form is an external identity code, meaning that it is the perceptions and opinions of "outsiders" that matter. The external identity code possesses rule-like status, so that its observable violation is negatively sanctioned—it causes outsiders to drop discontinuously their valuation of the entity to which it is applied.

Our concept of organizational form implies legitimation or social-taken-for-grantedness, sometimes called constitutive legitimation. Much contemporary organizational theory treats legitimation as both privileging and constraining. An organization possessing a legitimated organizational form appears unproblematic and can be interacted with and regulated unambiguously; accordingly, it typically benefits from greater access to resources, more protection from authorities, and higher visibility—all provided that the organization does not violate any of the form-specific rules constraining its appearance and behavior (Meyer and Rowan, 1977; Zuckerman, 1999). We view establishment of legitimation as a process in which positive returns potentially increase from the first appearance of a potential organizational form up to a subsequent ceiling, signaling the organizational form's establishment. These positive returns of the form-establishment process involve ease of organizing, resulting in higher rates of organizational founding and enhanced life chances for the organizations using the potential form.

Accepting our answer to the first question means that the second question actually asks, When and where will a new organizational form emerge? In an exploratory case study of the disk array market, McKendrick and Carroll (2001) examined arguments drawn from organizational theory and juxtaposed them with basic facts of the situation. They found that the disk array organizational form had not developed, despite the presence of formal institutions representing collective action and ecological processes often associated with form emergence. They speculated that the reason the form had not crystallized lies in organizational diversity: the heterogeneous set of origin industries spawning and still supporting disk array producers (i.e., continuing to provide the bulk of many firms' revenue) makes it difficult for the disk array producer organizational form to gain perceptual recognition and take hold. The difficulty arises because form establishment is essentially about identity formation: if many firms in the market derive their primary identities from other activities and there are few firms deriving their primary identity from disk arrays, then the disk array producer identity will likely not be readily perceived by outsiders, thus impeding its coherence into a code or form.

McKendrick and Carroll's (2001) case materials suggest a reformulated specification, which we develop below, of the density-dependent process commonly thought to generate a legitimated organizational form. More precisely, an organizational form likely emanates from the density of producers with perceptually focused identities in a market, rather than the total density number typically used by ecologists, and the perceptions of outsiders will be more focused when the identities arise from (1) de novo entrants and (2) entrants that are concentrated in geographic locations that possess related identities. We used firm-level event-history data collected for every producer to enter the market for disk arrays worldwide, from Twincom's initial introduction to the end of 1998, to test these arguments in analyses of organizational entry and exit.

PRIOR THEORY AND RESEARCH ON FORMS

In her review of the literature on the evolution of new organizational forms, Romanelli (1991: 81) claimed that "no theoretical consensus exists regarding an approach to the problem" of how new forms emerge and become established and that "the conceptual approaches are diverging." More tellingly, Romanelli also found no generally accepted common definition of the organizational form concept. She determined that from the many theoretical arguments about form emergence that had been proposed, "no overarching themes for integrating these perspectives" could be identified (Romanelli, 1991: 100). Romanelli concluded on a positive note: she advised organizational theorists to embrace the conceptual diversity about forms, to emphasize differences among various conceptualizations, and to illustrate the quality of various definitions through theoretically directed empirical research.

In the period since Romanelli's (1991) review, usage of the organizational form concept has probably become even more elastic. As Romanelli (1991: 81–82) noted, at the broadest level, "the concept of organizational form refers to those characteristics of an organization that identify it as a distinct entity and, at the same time, classify it as a member of a group of similar organizations," yet many proposed definitions are so highly abstract they lack empirical bite. For example, in his pioneering book on organizational classification, McKelvey (1982: 107) first defined form as "a concept to broadly capture the character of an organization's structure, function and process." He then later redefined it as "that which is measured by taxonomic characters" and suggested that "the best strategy for selecting taxonomic characters is to measure everything possible" with an emphasis on "characters associated with dominant competence and evolutionary/ecological importance" (McKelvey, 1982: 214).

The most common type of definition uses specific features of organizations to identify and define organizational forms (Carroll and Hannan, 2000; Pólos, Hannan, and Carroll, 2002). This approach emanates from Weber's (1968) analysis of the rational-legal bureaucracy, which he defined in terms of features such as authority, procedures, and the employment relation of the official. The feature-based conception of form has developed to recognize that some features—so-called "core" features—are more important than others in distinguishing forms (Scott, 1998). Organizations with the same core features belong to the same form, by this view.

A second popular definition of organizational form is based on the presumption that distinctions among forms reflect social processes and boundary creation (DiMaggio, 1986; Hannan and Freeman, 1989). In this view, the clarity and strength of social boundaries define forms—sharper boundaries generate clearer forms. The key to understanding forms, then, involves looking at the processes that create and maintain boundaries, including social networks, technological change, closed flows of personnel among a set of organizations, changes in patterns of resource flows, and the like.

In the view of Pólos and colleagues (Pólos et al., 1998; Pólos, Hannan, and Carroll, 2002), both types of definitions of form suffer from limitations, the most serious of which is the lack of connection between forms and identities (see also Ruef, 1999; Zuckerman and Kim, 2003). In their view, the form classification rules of organizations should not be divorced from the social world, because classifying forms involves social and cultural typifications—widely agreed-upon classifications of entities into types (Meyer and Rowan, 1977; Scott, 1995). Empirical research on such processes suggests that they build on organizational identities (Zuckerman, 1999, 2000; Ruef, 2000).

Form as Identity

The research reported here followed Romanelli's (1991) suggestion to demonstrate the value of specific definitions of form through empirical research rather than try to incorporate many meanings into a single analysis. Accordingly, in asking how and when organizational forms emerge, we followed Pólos, Hannan, and Carroll (2002) in defining an organizational form as a recognizable social code that possesses rule-like standing and therefore denotes and connotes both cognitive recognition and imperative standing. So, a code can be understood as (1) a set of interpretative signals, as in the "genetic code," and (2) as a set of rules of conduct, as in the "penal code." In Pólos, Hannan, and Carroll's (2002) formulation, the key identity code for an organizational form is external. There are potentially an infinite number of forms, but only activities that acquire external recognition and are constrained by the sanctions of outsiders gain form status; forms do not exist independent of external agents. Identity codes for organizational forms typically consist of abstract features as well as composition rules about appropriate combinations of particular features.

A form identity applies to multiple organizations and persists over time. This is because once established, a form identity gets embedded in other societal institutions, such as languages, directories, and public labels. For example, the yellow pages of the phone book give a very basic set of organizational forms for many, but not all, of the entries. For form identities in more technical markets, such as that for disk arrays, one might look at how technical and buyer-oriented publications place firms into groupings, how companies refer to themselves and their products in advertisements and other public announcements, and how gatekeepers to critical resources such as capital and labor categorize firms. Many of the classifications built into these sources reflect the implicit rules about forms used by external gatekeepers to organize, evaluate, and sanction individual organizations.

Form Emergence

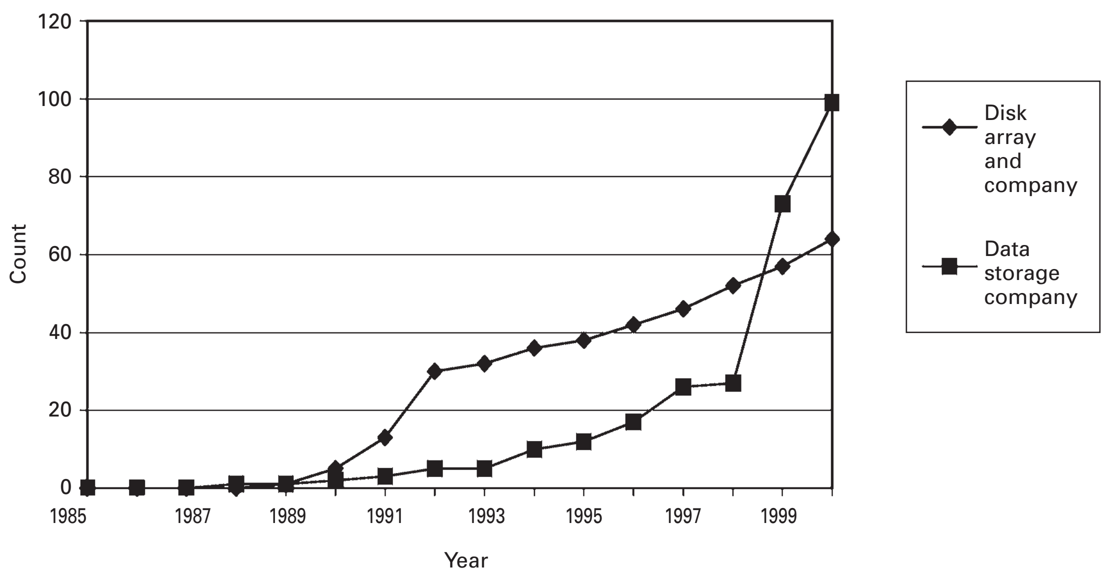
Although a particular set of organizational features might develop an external identity, this does not mean that the identity has become an organizational form, unless it has also been enforced and taken for granted by outsiders, i.e., the identity must be codified, socially embedded, and sanctioned. An implication of this construction is that it "allows us to define populations that never achieve form status and to extend meaningfully the definitions of populations back to the period of early legitimation" (Pólos, Hannan, and Carroll, 2002: 107). Thus, populations can be defined not by forms, as received ecological theory does, but instead by identities, the most specific and minimal external identities applicable.

Pólos, Hannan, and Carroll (2002) have theorized about when a specific nascent external identity will become an organizational form. They linked the form-generation process to prevalence, or organizational density, and specified a form-specific application number, $\nu(\phi)$, that marks the number of organizations to which a social identity must apply for the identity to gain organizational form status. That is, identities become forms at varying points in populations' histories, depending on $\nu(\phi)$ and their density levels. Moreover, the form-specific number $\nu(\phi)$ represents the density N_ϕ at which the legitimation-enhancing returns of new organizations joining the population reach a ceiling. This means that "the period in a population's history between its inception and the time at which density surpasses $\nu(\phi)$ is the crucial period of legitimation in the sense of taken-for-grantedness" (Pólos, Hannan, and Carroll, 2002: 107).

Applying this idea to a potential new form identity might be straightforward: from inception, one can count the number of organizations N holding the minimal identity at various periods t and then look during each period for other phenomena typically associated with a legitimated organizational form. The point at which these phenomena are first seen should coincide roughly with $N(t) = N_\phi = \nu(\phi)$. Following this strategy, McKendrick and Carroll (2001) found that the number of disk array producers entering the market rose steadily over the early years, eventually slowing down and stabilizing and, finally, declining slightly. From received ecological theory, which holds that legitimation of a population increases with density at a decreasing rate and approaches a ceiling at high levels of density (Carroll and Hannan, 2000: 222–228), it would thus be plausible to reason that the disk array identity became a form at least before the time and the density level of the population stabilized. Other compelling information made it clear, however, that the identity had yet to develop into a form, thus leading McKendrick and Carroll (2001) to conclude that the theory was deficient. For example, although the industry information service provider Disk/Trend classified disk arrays as a single industry, we know from extensive interviews with executives and others that this classification category was only one of several ways participants and outsiders perceived the market, even in the period after organizational density had stabilized. Other relevant outsiders, such as security firms' market analysts, seldom focused on a disk array (or similarly termed) industry, preferring instead to stay at the more encompassing level of "data storage" (see Hambrecht and Quist, 1998; Tucker Anthony, 1998). Moreover, these analysts' reports usually did not contain subgroupings based on the disk array form or organizational type; instead, they described individual companies and their particular technologies or product lines (e.g., video or audio streaming, transaction processing, web caching). A similar lack of consensus about appropriate form was evident among market insiders. So, for instance, companies referred to themselves variously as involved in "storage," "storage subsystems," "RAID (Redundant Array of Independent Disks)," "disk arrays," "network attached storage," and other categories. As the director of product marketing at Maximum Strategy said, "Companies are starting to go away from saying [disk arrays], and are instead talking about what they offer. We provide high bandwidth" (*Electronic Engineering Times*, 1996: 47). One prominent company even went so far as to publish a book attempting to clarify the many confusing terms in the industry (Network Appliance, 2002).

Figure 1 provides some data about this identity ambiguity from searches we conducted in LexisNexis on the various identity labels. For each year from 1985 to 2000, we searched the full texts of all business and finance articles in the business category of LexisNexis to count the number of times a particular identity label was used. Figure 1 shows two plots: one gives the count for articles that used the word strings "disk array" and "company" at the same time, while the other gives the counts for uses of the exact word string "data storage company." Usages of both terms rose in the period, suggesting possible identity formation, but while the disk array usage was more common in the early years, it was

Figure 1. Counts of business press usage of two possible identity form labels.



overtaken by the more restrictive use of "data storage company" later. This suggested to us that the disk array form was likely not yet fully established and that the identities remained in flux.

Perceptually Focused Identities

McKendrick and Carroll's (2001) case study led us to pursue a different argument and specification of the form-emergence process, taking into account the perceptions of external agents (such as financial analysts, bankers, suppliers, distributors, potential employees, and customers), because it is through these agents' perceptions and sanctions that form identities emerge and persist. It is not clear, however, when and how these external actors perceive that a set of organizations with which they potentially interact possesses a new identity that should be subject to some sanctioning. We propose that such a perception occurs when the identities of the individual organizations in a population somehow become focused on at least some of their common components. This means that the perceptions of external actors are directed to some salient common features of a set of organizations and that there is some, perhaps implicit, recognition of this commonality as a distinctive social entity (the identity or nascent form). Perceptually focused identities are important for a variety of mutually reinforcing reasons. First, focused identities mean that both insiders and outsiders will be more likely to recognize and identify something distinctive. So, focus increases salience. Second, the greater homogeneity of organizations with focused identities implies that form boundaries and exclusion rules are simpler. Simpler boundary rules make policing or sanctioning possible (Zuckerman, 1999). Third, salience and homogeneity provide the seedbed for generating solidarity and organizing for self-promotion and defense (Buechler, 2000).

If these speculations are valid, then they lead to a reformulated specification of the density-dependent form-generation process advanced by Pólos, Hannan, and Carroll (2002). We retain the core idea that identity of a form derives from the aggregated identities of individual organizations; we also retain the form-specific application number $\nu(\phi)$ for achieving form status. But rather than base this number on density per se, we base it on the number of organizations with perceptually focused identities, N^P_ϕ. Now an organizational form emanates from initial rises (when density is low) in the density of producers with perceptually focused identities in a particular market rather than from initial rises in total density. In other words, form ϕ emerges at time t when

$$N^P(t) = N^P_\phi = \nu(\phi),$$

which can be stated as a proposition:

Theoretical proposition: Establishment of an organizational form is positively related to initial rises (when density is low) in the density of organizations with perceptually focused identities.

Of course, in a newly developing market, the products of participating organizations may also be highly visible. When some organizations produce multiple products, this possibility raises the question of whether collective identities are built around products or organizations. The case for organizations comes from their multidimensional nature: identity springs from their joint presence in labor, product, and financial markets, among others (Baron, 2002). Products develop identities in more restricted arenas, but these may be very large from the perspective of individuals and reflect heavily on the underlying producer organization. Indeed, individuals' perceptions of particular organizations likely spring from experiences with products, not only in use but through advertisements, demonstrations at trade shows, press releases, and the like. If so, then organizational form identities might emerge from the number (density) of products promulgated by producer organizations. This possibility suggests an alternative proposition:

Alternative theoretical proposition: Establishment of an organizational form is positively related to initial rises (when density is low) in the density of products associated with a particular activity.

Empirical Hypotheses

For empirical research, an advantage of the theoretical proposition is that it can be readily incorporated into extant models of density-dependent legitimation. As explained above, N^P_ϕ represents the density level at which an identity acquires the character of a form, meaning that it is fully legitimated or taken for granted. Before this point, as $N^P(t)$ grows from 0 to N^P_ϕ, the taken-for-grantedness of the identity increases by at least two mechanisms (Hannan and Carroll, 1992: 41): (1) "collective action by members of the population to define, explain and codify its [potential] organizational form and to defend itself from claims and attacks of rival populations" and (2) "collective learning by which effective routines and social structures become collectively fine-tuned, codified and promulgated." Ecologists claim that the strength of both mechanisms tracks organizational density; and substantial empirical research on a variety of populations shows that as density rises from early low levels, organizational founding rates increase and mortality rates fall, exactly as increasing legitimation would lead one to expect (Carroll and Hannan, 2000). Accordingly, a similar empirical test of the theoretical proposition would consist of relating $N^P(t)$ to the vital rates of an emergent organizational population.

Fully specifying a model for empirical testing requires further conceptual elaboration, namely, linking the perceptually focused identity concept with measurable characteristics of organizations to calculate $N^P(t)$. Many sophisticated instruments or methods can be designed to measure focus in organizational identity, but a number of these would be impossible to apply to nonexisting, previously failed organizations. To overcome this obstacle, we prefer in this initial exploration to use readily identifiable, observable organizational characteristics that can be ascertained systematically from the historical record, which also facilitates comparative analysis (Carroll and Hannan, 2000). One observable characteristic is an organization's status upon entry into a market.

McKendrick and Carroll (2001) conjectured that the disk array producer organizational form did not fully take hold in the observed early phase of the market because disk array producers came from a heterogeneous set of origin industries and often retained operations in those industries, perhaps still deriving the bulk of their revenue therein. In their view, the problem resided in the externally perceived basis of firms' identities: so long as firms in the disk array market derived their primary identities from other activities and few firms derived their primary identity from disk arrays, then the disk array producer identity seemed unlikely to be perceived by outsiders. That is, the high levels of organizational diversity and diversification made it unlikely that the common disk array features would cohere into a code or form of its own; the external perceptions of identities were not focused in this context.

De novo entry. McKendrick and Carroll (2001) used these general arguments to claim that in the disk array market, de novo firms possessed greater focus than de alio firms that came into the market from a wide variety of other activities in which they often remained active. This means that initially—when density is low—a density count of de novo firms should show legitimation-enhancing effects on the whole set of producers. In this sense, focus is about perception: focus helps outsiders see and legitimate the activity, not improve the life chances of de novo firms themselves. That is, we set $N^P(t)$ to record de novo producers and hypothesize:

Hypothesis 1a (H1a): Organizational founding rates of all organizations engaged in a particular production activity will rise with initial increases (when density is low) in the density of de novo producers engaged in the same activity.

Hypothesis 1b (H1b): Organizational mortality rates of all organizations engaged in a particular production activity will decline with initial increases (when density is low) in the density of de novo producers engaged in the same activity.

This formulation is also more consistent with the market's overall empirical trends. Specifically, McKendrick and Carroll (2001) showed that, unlike total density, the annual density of de novo disk array producers did not rise to a stable point and then subside. Rather, de novo density appeared to be still in a growth phase. More importantly, because it did not level off and was still rising upward, the trajectory of de novo density did not give the general impression that the identity had been legitimated. It suggested, instead, that the identity was undergoing institutionalization and may not yet have been fully legitimated.

Although this formulation appears theoretically sound and empirically consistent with the facts of the disk array case, it contradicts one drawn from another popular perspective on legitimation. The so-called sociopolitical view of legitimation holds that endorsement by powerful actors yields advantages to organizational forms and aids in the process of legitimation (Scott, 1995). It follows logically then that if and when larger established (powerful) organizations enter a market, then legitimation should be enhanced. IBM's entry into the personal computer market is a well-known case that seems consistent with this argument. In terms of organizational density by entry mode, the prediction most consistent with this view would be that de alio density contributes the greatest to legitimation because de alio entrants are usually larger and more powerful than de novo entrants. There is an extensive prior literature about the effects of de novo/de alio status on firm mortality and failure rates (see Carroll et al., 1996, for a partial review), and a general finding is that de alio firms experience lower mortality rates, especially in their early years. This suggests, too, that de alio firms are stronger competitors. The theory developed here, however, concerns the effects of densities of de novo and de alio organizations on a focal organization, not the de novo or de alio status of the focal firm, which is the subject of almost all prior research. So, the prior literature on de novo and de alio entry is only suggestive at best in terms of the legitimation of identities.

The intuition behind hypotheses 1a and 1b comes from perceptual considerations based on viewing organizations in a focal market as whole social entities. The assumption is that external actors see or know about aspects of the participating organizations that transcend the focal market. From this perception, the common component of focal market participation (i.e., the potential new form) is more likely to dominate when more organizations operate mainly in the focal market, as de novo entrants do. By contrast, diversified firms may interact with external agents in ways that do not heighten perceptions of the focal market. For example, the financial reports of publicly traded firms may not highlight some of the smaller new markets in which the firms are engaged.

Agglomeration in a geographical place with a related identity. Another potential contributor to perceptually focused identities arises from considerations based on outsiders' views of those organizations most frequently encountered socially. If one's high-frequency interaction partners include many organizations with the potential new organizational form, then one is more likely to recognize (at least implicitly) and sanction the form. A second-order network effect may also occur: one's perception of a possible form is heightened when many of one's interaction partners interact with organizations possessing the common properties. Discerning the interaction patterns of external agents with respect to organizations and each other is extremely difficult, though, especially those occurring in the distant past. A plausible alternative is to compare the effects of organizations grouped by various geographic locations, in particular, those locations with high numbers of firms in the focal market and with place identities recognized by the market's participants and external agents. Compared with other locations, these places are likely to have identities related to the new activity, thereby providing more focus to outsiders' perceptions.

Geographers and other scholars of regions and regionalism commonly view localities as socially defined perceptual units that only exist in relation to particular criteria (Allen, Massey, and Cochrane, 1998; MacLeod, 2001). Although places have a real physical environment and a spatial dimension, they are not defined by a precise geographic boundary. Rather, they become known with regard to different spheres of social action and so may have multiple identities: political, cultural, social, and economic. In this regard, they are a medium for social interaction, and their identities are socially constructed. As Paasi (1996: 8) put it, "individual actors and collectivities are socialized as members of specific territorially bounded spatial entities and . . . more or less actively internalize territorial identities and shared traditions." The very naming of places helps to construct their identities, connecting their images with the perceptions of insiders and outsiders. Academics, journalists, regional protagonists, business executives, and politicians use language to popularize, establish, and sustain places in the consciousness of society (Carr, 1986; Paasi, 1996; MacLeod, 2001). A place explicitly comes into being and acquires an identity through these discourses (Pred, 1989).

The place identities of interest here relate to the industrial world. Social scientists have long noted that firms in the same market often agglomerate (Marshall, 1920; Weber, 1929; Hoover, 1948). By agglomerating, firms increase their interactions with each other and make collective action more likely. Agglomeration also often produces a common perception among participants and outsiders that something with an identity resides therein. A local culture emerges that defines or unifies organizational actors through a mutual awareness of their common industrial purpose (Storper, 1995). This coherence consists of a similar spirit of enterprise, organizational practices, action rules, customs, understandings, and values (Saxenian, 1994). Indeed, in describing particular agglomerations, analysts typically use language strongly suggesting that organizations derive public cognitive recognition from clustering with similar others; this is especially true for those who have written about Italian "industrial districts" (Brusco, 1982; Piore and Sabel, 1984; Becattini, 1990). Of course, many geographical places possess socio-economic identities. The sheer number of organizations and employees in a related activity can make them a coherent identifiable organizational community. But our sense is that prevalence in itself does not contribute to the emergence of an organizational form. Rather, a form often exists before a place becomes identified with it. For example, although Dalton, Georgia, is typically seen as the world's carpet manufacturing center, carpet making already existed as a form before Dalton acquired that identity.

A strong place identity can override firm differences to contribute to form emergence in two general ways. One is if the geographic area is a known place with a preexisting social identity of its own. For instance, Silicon Valley and Route 128, which feature prominently in the market for disk arrays, are known for their excellence across several technological markets. Organizations in these milieux have a collective identity as "technology firms," thereby signaling to external actors that they are members of a community known for the creation of new firms, technologies, and markets. The second way, related to the first, is if the place has a preexisting identity related to or closely associated with activities in the new market. For instance, such a place may have had a reputation as a center of data storage, and so this identity would confer greater visibility on the disk array firms located there. Forms seem more likely to emerge out of locales with preexisting related place identities because external agents already associate these places with similar kinds of activities, thereby giving the new activity greater perceptual focus. So, when firms in a particular new market agglomerate in places with related social identities, they should be more likely to generate a coherent identity of their own and thus an organizational form. This argument sets $N^P(t)$ to track the density of geographically agglomerated producers in a place with a related identity, which leads to the following hypotheses:

Hypothesis 2a (H2a): Organizational founding rates of all organizations engaged in a particular production activity will rise with initial increases (when density is low) in the density of geographically agglomerated producers in a place with an identity related to the same activity.

Hypothesis 2b (H2b): Organizational mortality rates of all organizations engaged in a particular production activity will decline with initial increases (when density is low) in the density of geographically agglomerated producers in a place with an identity related to the same activity.

Our formulation relates to other recent work in organizational ecology that has also advanced theoretical ideas about geographic boundaries and legitimation. Both Hannan et al. (1995) and Bigelow et al. (1997) argued that social legitimation of a form operates on a broader geographic scale than competition because political and physical barriers are more likely to interrupt the exchange of goods and people than they are ideas or cultural images. This argument led to a multilevel specification of density dependence, with density for legitimation counted across geographic boundaries and for competition counted only within boundaries (Bigelow et al., 1997; Hannan, 1997). Although hypotheses 2a and 2b may at first blush appear at odds with these claims, there are at least two reasons why they need not be. First, Hannan et al.'s (1995) theory can be seen as concerning the legitimation within a newly emergent population of a form previously established in another context (a type of diffusion), while the current hypotheses address the initial emergence of an organizational form in any population. Second, Hannan et al.'s (1995) argument involved claims about the exchange of information across (and thus the interdependence of) various geographic units, which are essentially about where to draw the population boundaries rather than how to count density once the boundaries are determined. In any event, neither potential complication pertains to this study, given that it is about a potentially new form in a single worldwide population.

Combined effects. The two perceptually driven processes hypothesized above may operate jointly. When de novo producers possess focused identities and congregate in a particular geographic area with a related place identity, the two processes should combine to speed up legitimation (an interaction effect) even faster than their individual effects, because the two processes operate in different ways. De novo density represents a process of simple accretion in collective identity: each member possesses (virtually) the same identity, and as more members enter the market, the identity gains force by sheer numbers. By contrast, the agglomeration process involves muting many other aspects of firm identity and causes attention to cohere around the common dimension. Although different, the two processes do not work in opposition. So, interacting regularly with many organizations possessing the same apparent features should accelerate identity formation and legitimation of a potential organizational form initially when density is low. These arguments lead to the following hypotheses:

Hypothesis 3a (H3a): Organizational founding rates of all organizations engaged in a particular production activity will rise with initial increases (when density is low) in the density of geographically agglomerated de novo producers in a place with an identity related to the same activity.

Hypothesis 3b (H3b): Organizational mortality rates of all organizations engaged in a particular production activity will decline with initial increases (when density is low) in the density of geographically agglomerated de novo producers in a place with an identity related to the same activity.

Product densities. Finally, we need to consider the alternative theoretical proposition based on product density rather than organizational density. It is rather straightforward to develop a basic pair of hypotheses linking product density to form establishment:

Alternative hypothesis 1a (Alt. H1a): Organizational founding rates of all organizations engaged in a particular production activity will rise with initial increases (when density is low) in the density of products associated with the same activity.

Alternative hypothesis 1b (Alt. H1b): Organizational mortality rates of all organizations engaged in a particular production activity will decline with initial increases (when density is low) in the density of products associated with the same activity.

Brief Background on Disk Arrays

The main technical components of a disk array are (1) a set of disk drives; (2) configuration of the drives into some kind of interdependent system; (3) the interconnect protocols in the system; (4) the storage controller; and (5) the system cache architecture. The business of disk arrays appears even more complicated because arrays are sold with varying degrees of completeness (Disk/Trend, 1999). A number of companies sell subsystems (complete arrays ready to use), but product groups also include boards (array controllers, power supplies, and other components without disk drives) and software (an individual software product providing array functionality). Thus, companies may specialize in boards or software, or they may provide complete systems. Companies may also be independent providers or captive producers making arrays for their own computer systems. Pinning down the exact first appearance of disk array technology is difficult. The technology originates in the idea of redundant, or fail-safe, computing when on-line transaction processing began to emerge in the 1960s, and multiple disk drives were bundled with computer systems for which they were specifically designed. Yet companies were slow to offer fail-safe disk storage products that worked with a variety of computers, making a market for disk drive arrays slow to develop (see McKendrick and Carroll, 2001, for a fuller account of the history).

The market for disk arrays is segmented in a number of ways, and firms differ in the scope of their offerings. Arrays are sold in four identifiable primary markets: the computer mainframe array market (e.g., computer reservation systems), the network/midrange multiuser market (the bulk of the disk array market), the single-user market, and the specialized high performance market (e.g., video servers, geophysical exploration data analysis). A disk array can have as few as two disk drives or as many as 200, though most arrays contain fewer than 100 drives.

During 1998, 134 companies offered array subsystems, boards, or software at one time or another, but three firms—IBM, EMC, and Compaq Computer—held almost three-quarters of the total market (Disk/Trend, 1999). Led by IBM and Compaq, captive sales accounted for almost two-thirds of industry revenue. EMC was the largest independent supplier, accounting for more than half of non-captive sales, followed by Data General and Hitachi Data Systems. U.S. firms held 90 percent of the market.

METHODS

We used archival data on the disk array market to identify the complete set of firms that has ever offered a product on this market at any time. In testing the hypotheses, we used information on the times of market participation to estimate rate models of organizational founding and mortality. The independent variables consisted of time-varying measures of the number of organizations in the market (density) by entry mode (de novo/de alio), the number of products on the market (product density), and several important geographically based density counts from places with a related identity (the Boston Area, the San Francisco Bay Area, and California). We also included a number of time-varying control variables in the models to help rule out alternative interpretations. These included firm tenure in the market, public/private company status, number of products, product submarkets, product distribution channels, firm size, membership in an industry association, venture capital recipient, population age at entry, density, density at founding, venture capital funding of industry, density of industry association, and industry revenue. We describe below sources and metrics of the variables.

Data Sources on Disk Array Producers

The data analyzed here covered the complete set of disk array producers serving the market worldwide, dating from the Twincom product in 1986 through the end of 1998, the last year of full coverage from the most comprehensive source of data available. The data came primarily from Disk/Trend, Inc. Disk/Trend published annual reports on disk drive arrays, as well as other kinds of storage. The first Disk/Trend report on arrays was published in 1993. The reports covered every company that made complete subsystems, boards, or software specifically intended to permit disk drives to operate as an array. The reports also listed specifications for each product a company shipped and the date of its first shipment.

In addition, we compiled event histories through extensive library and online searches for each company identified by Disk/Trend as an array manufacturer, which also turned up a few companies that made disk drive arrays prior to the publication of Disk/Trend. In some cases, the event histories revealed shipment dates that preceded those listed in Disk/Trend and provided more accurate dates for entry into and exit from the array market.

Entry and exit of array producers. A firm's first date of product shipment signified its entry into the array market. It was more difficult to determine organizational mortality or ending events, however, than entry. For organizational mortality or ending events, the most important distinctions concern (1) disbanding of the firm, (2) exit to another industry, and (3) merger or acquisition by another firm. The meaning of disbanding is unambiguous: the firm failed as a collective actor. Exit to another industry also suggests a lack of success in array manufacturing. The merger and acquisition ending events are harder to interpret. Although merger and acquisition both result in the loss of one or more organizations, firms merge and are acquired for diverse reasons. Sometimes a firm flounders, and its owners seek to recover some fraction of their investment by selling the firm. In other cases, a thriving firm's competencies command great value from potential acquirers or merger partners (Carroll and Hannan, 2000). Because of the ambiguous meaning of mergers and acquisitions, we based our analysis on the disbanding and exit to another industry and, consistent with standard practice, treated mergers and acquisitions as censored observations.

We sometimes did not know exactly what happened to firms when they dropped from the set of producers; this was often the case when spells of array production were short and when the scale of production was tiny. Our reading of the source materials and our knowledge of the market suggested that most exits of unknown type were disbandings or exits to other industries. So, we treated these two events alike: the dependent variable in this analysis was disbanding/exit to another industry, defined to include events of unknown type. Firms known to have ended by other events (merger, acquisition) were treated as (non-informatively) censored on the right at the times of these events. We identified 258 firms that entered the market. The count began in 1986 and covered all firms known to offer disk arrays up to and including eleven new entrants in 1998. Over the short history of the array market, there were 114 disbanding/industry exits and 14 mergers/acquisitions.

Firm-Level Variables

We measured a number of firm-level variables. The variable the organizations research literature labels *organizational age* is usually a measure of tenure in a particular organizational population. For the majority of array producers (212 of the 258 firms, or 83 percent), we knew the exact annual quarterly date of entry and exit in the array market, based on product shipment. For the minority of array producers without quarterly entry and exit dates (17 percent of firms), we knew the year of entry and exit and randomly assigned quarterly dates within that year. Tenures in the disk array market were then calculated based on these quarterly entry and exit data. For de novo/de alio status, we determined from the source materials whether a firm was a *de novo* or *de alio* producer. We used a dummy variable to indicate de novo status. Using a variety of sources listing public companies, we attempted to determine public/private status by identifying every public firm in our database by year of operation. This dummy variable took a value of one in the period when a company was listed as *publicly traded* and zero otherwise. We counted the *number of products* for each firm as the number of distinct products on the disk array market in a given year. We divided the market for disk arrays into four distinct product submarkets and recorded whether a firm sold a product in each of these. The submarkets were *single use*, *mainframe computer*, *networks*, and *high performance*. Participation in each submarket was measured by a dummy variable. We recorded whether the array producer was a captive firm, OEM (original equipment manufacturer), or PCM (a plug compatible manufacturer, reseller, and distributor). Preliminary analysis showed that the effects for OEM and PCM firm-level characteristics were similar and could be efficiently combined into a single dummy variable, *OEM or PCM*, which we report in estimates below; captive array producers thus represented the omitted comparison for this dummy variable.

We measured *firm size* as the firm's annual revenue from its sale of arrays. For the major array producers in the market—i.e., the top 15 to 25 annual array producers, such as EMC, IBM, and DEC, which collectively represented approximately 90 percent of all annual industry revenue—we had precise firm-specific revenue data from Disk/Trend. For the few major producers that existed prior to Disk/Trend's coverage in 1992, we linearly interpolated backwards the firm-specific revenues of their earlier annual spells, using their actual revenue trajectory post-1992 as the functional form for our imputation. For the smallest and shortest-lived array producers, Disk/Trend did not publish firm-specific revenue figures, and we were unable to find more precise disk array revenue figures for them from other sources. But Disk/Trend did record the annual aggregate revenue of these non-major, smaller array producers based on the distribution channel they used (captive, OEM, and PCM) and geographic location (companies based in the United States and those not in the United States). Since we knew which of these six different categories Disk/Trend used to classify smaller array producers, we were able to impute an annual revenue for each smaller array producer, based on the average revenue for a firm in that category. In exploratory models, we estimated models using the size variable in log form and did not find any major changes in estimation. Because the log size specification amplifies differences among small firms and the data for these firms were less reliable, we believed the other specification was preferable.

We constructed a firm-specific time-varying dummy variable to indicate whether a firm was a member in the major industry association that operated within the disk array industry during the period under study, the RAID Advisory Board (*RAB member*). To identify which firms received venture capital, we searched the SDC Platinum database constructed by Thomson Financial Securities Data and a variety of other sources listing companies that received venture capital to identify such firms in the disk array market. We used a dummy variable to indicate firms that received venture capital (*venture capital recipient*). To take into account *population age at entry*, we constructed a fixed firm-level variable that recorded the age of the organizational population at the time of market entry that took the value of one in the first year of the disk array market and then increased in increments annually. It was intended as a control for possible effects of population aging, including first-mover or order-of-entry advantages in the disk array market.

Population-level and Other Environmental Variables

Organizational density. We used the life-history information on firms to construct a variety of density counts. These variables measured the total number of firms of a particular kind operating in any given year. In most models below, we used a time-varying count of basic density, measuring all the firms in the market. We also used a time-invariant variable giving the density in the year of market entry for each firm (for justification of these specifications, see Carroll and Hannan, 2000). We used a linear specification of organizational density, since it is consistent with our theorizing, and the inclusion of a quadratic specification did not substantively affect our estimates.

Focused-identity densities. Tests of the theoretical proposition about perceptually focused identities were conducted with several different kinds of $N^P(t)$ density counts. First, we used the density of de novo firms to test H1a and H1b. We then looked at the effects of several density variables based on geography to test H2a and H2b. We focused on the three locations where disk array producers agglomerated and there was a sense of place identity operative in the market: the Boston Area (Route 128) in Massachusetts, California, and the Bay Area in Northern California, which included mostly firms in "Silicon Valley" and a few firms just north of or across the bay. Finally, we examined the effects of density counts measuring de novo producers within specific geographical areas, e.g., California de novo producers and, finally, most narrowly, the Bay Area de novo producers. These last density variables were appropriate for testing H3a and H3b.[1]

We used the information on firms' annual product counts to construct *product densities*. These variables measured the total number of products of a particular kind on the market in any given year. In the models below, we used a time-varying count of product density, measuring all the products in the market. Tests of the alternative theoretical proposition about products were conducted with several different kinds of product density counts. First, we used the product density of all producer firms to test Alt. H1a and Alt. H1b. We then test-

1
A currently popular way to incorporate spatial concerns in models of agglomeration uses the actual geographic distances of organizations from each other, sometimes as weighted density variables (see Sorenson and Audia, 2000; Sorenson and Stuart, 2001). When theoretical ideas concern the costs or frictions of spatial distance, these measures are superior to simple counts of density within specified geographic areas because they contain more detailed information. The theoretical ideas here, however, concern the interaction patterns occurring in places with related identities themselves; organizations either reside in such places or they do not, meaning that the relevant theoretical distinction is categorical in nature. Hence, we used densities grouped by geographic area in examining the possible effects of agglomeration in such places.

ed a refinement of these hypotheses using more narrowly defined counts of product density that might be related to product visibility and identity: the density of products for the non-captive array market of original equipment manufacturers or plug compatible manufacturers, resellers, and distributors.

We examined the effects of the percentage of array firms that were members of the RAB on rates of array producer entry and exit (*percentage of firms in RAB*). In exploratory analyses, we used an alternative specification of the quarterly or annual density of RAB firms in lieu of the percentage of RAB members on rates of entry and exit; both specifications yielded virtually identical estimates. We recorded the total annual funding of disk array companies by venture capital firms (*venture capital array funding*) based on the information we obtained from the SDC Platinum database of Thomson Financial Securities Data. For total *industry revenue*, we used Disk/Trend's figure of worldwide industry revenue from 1992 to 1998. For the period 1986 to 1992, prior to the publication of Disk/Trend's first report on the market, we estimated industry revenue based on an exponential extrapolation from 1986 up to the exact 1992 industry figure. Our knowledge of the industry gave us a reasonable level of confidence in these early figures.

Stochastic Model and Estimation

Founding/entry estimation. Consistent with standard frameworks for estimating rates of organizational entry/founding (see Carroll and Hannan, 2000), we estimated array producer entry using event-count models in which the array market represented the unit at risk of experiencing an event. For this reason, entry models estimated the effects of population-level and environmental variables but not firm-level covariates. The entry models were based on quarterly counts of array producers entering the array market. Covariates were updated every quarter, the only exceptions being annual measures of industry revenue and venture capital array funding, for which quarterly data were not available.

To estimate array entry rates, we explored both Poisson and negative binomial specifications. Exploratory analyses revealed the presence of overdispersion, in which the variance of the event counts exceeds the mean (see Barron, 1992; Swaminathan, 1995), suggesting the appropriateness of the negative binomial form, which includes a parameter for overdispersion. For the negative binomial model, the relationship between the instantaneous rate of entry, λ_t, and a set of j covariates, Z_{jt}, was specified as:

$$\ln \lambda_t = \alpha + \sum_j \beta_j Z_{jt} + \varepsilon_t,$$

where α is the regression model constant, β_j are effects of covariates, and ε_t is the error term, which follows a gamma distribution. We estimated negative binomial regressions using the software package STATA.

Exit/disbanding estimation. We represented variation in tenure (u) in the disk array market as a piecewise-exponential function with breakpoints for the pieces denoted as $0 \le \tau_1 \le \tau_2 \le \ldots \le \tau_p$. Assuming that $\tau_{p+1} = \infty$, gives P periods: $I_p = \{u \mid \tau_p \le u \le \tau_{p+1}\}$, p = 1,. . .,P. After examining life tables and exploring estimates of a variety of choices of the breakpoints, we decided to break the duration scale (in years) at 2.0 and 4.0. With this choice, the first segment (0, 2.0] included dated events that occurred within the first 24 months in the industry along with cases that entered and exited at unknown times within the same year. The second segment (2.0, 4.0] included dated events that occurred within the second 24 months along with cases that entered at unknown times in one year and exited at unknown times in the next year. The final segment began at four years and was open on the right.

We specified that the instantaneous disbanding/exit rate μ_i for organization i was a function of the following form:

$$\ln\mu_i(u, t) = m_p + \gamma S_{it} + \beta N_{it} + \sum_k \delta_k X_{kit},\ u \ge 0,\ u \in I_p$$

where tenure is denoted by u, m_p denotes a set of tenure-specific effects, S_{it} denotes organizational size for firm i at time t, N_{it} denotes organizational density, and the k other time-varying covariates are summarized in X_{kit}. In basic tests of the hypotheses, we estimated models with this general form with the method of maximum likelihood as implemented with a user-defined routine in STATA (Sørensen, 1999). Estimation of rate models with time-varying covariates required the construction of split-spell data whereby observed durations were artificially broken and censored at periodic points when the values of the covariates were updated. For exit models, we updated values every year because the majority of the independent variables were based on annual, not quarterly, observations. Tables 1 and 2 provide descriptive statistics for the variables used in both the entry and exit analyses. A few variables have different minimum and maximum values for entry and exit due to the different units of time (quarterly versus annual spells, respectively). Appendix tables A.1 and A.2 provide correlations among the key independent variables for entry and exit models.[2]

FINDINGS

Organizational Founding/Entry

Table 3 reports our first set of founding/entry rate models for worldwide array producers. Model 1 represents a baseline model with the main controls and array producer density. Results in model 2 support H1a, as the density of de novo array producers significantly increases entry into the disk array market. Model 3 shows that the percentage of firms in the RAB significantly reduces entry, contrary to predictions based on institutional theory, and that the density of products has nonsignificant effects on entry, contrary to Alt. H1a. Models 4 and 5 demonstrate the robustness of de novo density in increasing firm entry, even controlling for the percentage of firms in the RAB and the density of all products and those for the OEM/PCM market.[3]

2
High correlation among covariates suggests potential problems of estimation due to multicollinearity (see Maddala, 1988; Kennedy, 1992; Greene, 2000). Estimates with collinear data do not violate the standard assumptions of regression and offer unbiased and efficient estimates (Kennedy, 1992; Greene, 2000). Econometrics textbooks suggest that multicollinearity is usually not a problem when statistically significant support is found with collinear data (Maddala, 1988; Kennedy, 1992). Since the effects of many of our key explanatory variables show statistical significance (at the level of $p < .05$), we are fairly confident that with our specifications, issues of multicollinearity do not affect the findings. But because estimates with collinear data can be sensitive to changes in the number of observations in a sample (Maddala, 1988; Kennedy, 1992; Greene, 2000), we re-ran our entry models, which would be most susceptible to multicollinearity, without the last quarterly observation and found little change in our original estimates. In fact, when there was any change, it amplified our hypothesized effects. These estimates are available upon request.

3
De novo density also had substantive effects on firm entry rates. When density of de novo firms reached its mean value of 12 organizations, the entry rates of firms into the disk array market increased by approximately 8 times, suggesting an 800 percent increase in entry rates due to this variable. In contrast, the predicted density of de alio firms was not significant and had hardly any effect on firm entry rates.

Table 1

Descriptive Statistics for Disk Array Producer Entry/Founding Models*

Variable	Mean	S.D.	Min.	Max.
Industry revenue/1000 (t)	4.40	4.92	.003	12.6
Venture capital array funding/1000 (t)	15.5	19.0	0	59.3
Density of all firms (t-1)	79.8	65.0	0	180
Density of de novo firms (t-1)	12.3	9.06	0	27
Density of de alio firms (t-1)	67.5	56.2	0	158
Percentage of firms in RAB (t-1)	.080	.092	0	.217
Density of products (t-1)	187.1	168.7	0	475
Density of products for OEM/PCM market (t-1)	144.2	133.7	0	392
Density of firms outside Boston area (t-1)	71.2	59.5	0	165
Density of Boston area firms (t-1)	8.59	5.79	0	16
Density of firms outside California (t-1)	51.8	43.4	0	117
Density of California firms (t-1)	28.0	21.8	0	63
Density of firms outside Bay Area (t-1)	66.7	56.0	0	153
Density of Bay Area firms (t-1)	13.1	9.21	0	27
Density of Boston area de novo firms (t-1)	.549	.503	0	1
Density of Boston area de alio firms (t-1)	8.04	5.36	0	15
Density of California de novo firms (t-1)	5.43	3.53	0	11
Density of California de alio firms (t-1)	22.5	18.4	0	54
Density of Bay Area de novo firms (t-1)	3.51	1.91	0	6
Density of Bay Area de alio firms (t-1)	9.61	7.42	0	21

* N of firm entries/foundings = 258; N of de novo firm entries = 45; N of de alio firm entries = 213; N of spells = 51 quarters.

Table 2

Descriptive Statistics for Disk Array Producer Disbanding/Exit Split-Spell File*

Variable	Mean	S.D.	Min.	Max.
OEM or PCM firm = 1	.819	.385	0	1
De novo firm = 1	.153	.361	0	1
Size of firm (t)	49.6	274.2	.105	3517.2
Industry revenue/1000 (t)	7.32	4.25	.003	12.6
Density delay all firms (u_0)	74.7	58.7	0	189
Density of all firms (t)	138.5	56.2	0	189
Density of de novo firms (t)	21.8	6.01	0	29
Density of de alio firms (t)	127.7	41.1	1	165
Number of products for firm (t)	3.72	4.29	0	36
Publicly traded firm = 1 (t)	.267	.442	0	1
RAB member = 1 (t)	.162	.368	0	1
Venture capital recipient = 1	.039	.195	0	1
Offers single-use product = 1 (t)	.130	.336	0	1
Offers mainframe product = 1 (t)	.057	.233	0	1
Offers network product = 1 (t)	.879	.327	0	1
Offers high-performance product = 1 (t)	.066	.248	0	1
Venture capital array funding/1000 (t)	15.0	16.2	0	59
Population age at entry (u_0)	6.93	2.30	1	13
Percentage of firms in RAB (t)	.162	.065	0	.217
Density of products (t)	584.9	218.9	1	763
Density of products for OEM/PCM market (t)	214.0	81.9	1	299
Density of firms outside Boston area (t)	135.6	43.1	1	173
Density of Boston area firms (t)	13.9	3.13	0	18
Density of firms outside California (t)	95.9	30.2	1	122
Density of California firms (t)	53.6	15.6	0	68
Density of firms outside Bay Area (t)	124.9	39.7	1	160
Density of Bay Area firms (t)	24.5	6.49	0	31
Density of Boston area de novo firms (t)	1.11	.392	0	2
Density of Boston area de alio firms (t)	12.8	2.86	0	16
Density of California de novo firms (t)	8.97	2.28	0	11
Density of California de alio firms (t)	44.6	13.9	0	58
Density of Bay Area de novo firms (t)	5.67	1.01	0	7
Density of Bay Area de alio firms (t)	18.8	5.91	0	26

* N of all firms = 258; N of de novo firms = 45; N of de alio firms = 213; N of firms' exits = 114 (including acquisitions 128); N of de novo firms' exits = 14(17); N of de alio firms' exits = 100(111); N of firm-years = 1219; N of de novo firm-years = 187; N of de alio firm-years = 1032.

Table 3

ML Estimates of Negative Binomial Models of Founding/Entry Rates of Disk Array Producers, 1986 to 1998*

	Model				
Variable	(1)	(2)	(3)	(4)	(5)
Constant	.365	.123	.342	.146	.092
	(.246)	(.245)	(.246)	(.245)	(.247)
Industry revenue/1000 (t)	–.218•••	–.307•••	–.057	–.183••	–.231•••
	(.041)	(.045)	(.079)	(.079)	(.076)
Venture capital array funding/1000 (t)	.017•••	.008	.015•••	.007	.007
	(.006)	(.006)	(.006)	(.005)	(.006)
Density of all firms (t-1)	.021•••		.013		
	(.003)		(.010)		
Density of de novo firms (t-1)		.198•••		.185•••	.187•••
		(.051)		(.052)	(.055)
Density of de alio firms (t-1)		–.0001		–.013	.002
		(.007)		(.012)	(.013)
Percentage of firms in RAB (t-1)			–10.5•	–7.34	–5.16
			(4.66)	(4.21)	(4.30)
Density of products (t-1)			.004	.005	
			(.004)	(.003)	
Density of products for OEM/PCM market (t-1)					.0007
					(.004)
Dispersion parameter	.272	.171	.219	.144	.158
Log likelihood	–118.6	–113.3	–116.2	–111.1	–112.6
Chi square vs. null (constant rate)	38.7	49.1	43.5	53.6	50.6
D.f.	3	4	5	6	6

• $p < .05$; •• $p < .025$; ••• $p < .01$.
* Standard errors are in parentheses; N of observations = 51.

Table 4 presents the general effects of geographic agglomeration in the Boston area, California, and the San Francisco Bay Area and the role of geographically agglomerated de novo producers in these same areas on all entry rates, without regard to location. Models 6 through 8 show strong support for H2a, as the density of each geographic agglomeration, including Boston, California, and Bay Area firms, significantly increases entry rates.[4] Models 9 through 11 offer some general support for H3a, that geographically agglomerated de novo producers will increase firm entry rates. In models 10 and 11, the density of California and Bay Area de novo producers, respectively, significantly increases entry rates. In model 9, however, the density of de alio firms in Boston, and not de novo Boston firms, significantly increases entry rates.[5]

Figures 2 and 3 plot the predicted significant effects of densities of geographically agglomerated producers (models 6 through 8) and geographically agglomerated de novo and de alio producers (models 9 through 11) on firm entry rates. Figure 2 shows that firm density in the Boston area has the strongest positive effect on all firm entry, followed by the Bay Area density and then California density. For example, when density in the Boston area reaches 10 firms, it increases entry into the disk array market by about 8 times (an 800 percent increase). Figure 3 shows that although the density of de alio firms in the Boston area significantly increases entry rates, this effect is much weaker than the positive effects on entry by either the Bay Area de novo firms or California de novo firms. The density of Bay Area de novo firms shows the most powerful positive effect on entry rates.

4
In these models, the density of firms outside the geographic agglomerations of Boston, California, and the Bay Area reduced entry rates (for non-California firms, this is statistically significant). We believe this is due to the substantial geographic dispersion of disk array producers across the United States and the world, such that 59 percent of all non-Boston array producers were outside of California, and over 88 percent of all non-California and Bay Area firms were outside of Boston. Disk array production occurred in 24 different states and 12 different foreign countries. We found similar results when we ran models combining Boston and California de novo density: the combined de novo variable significantly increased entry, while the density of firms outside of Boston and California reduced entry but was not significant.

5
The nonsignificant effects of Boston de novo firms may be related to their small density (a maximum of one Boston de novo firm in our entry data). The positive effects of Boston de alio density on array producer entry rates may be related to their role in geographic agglomeration: the density of Boston area firms significantly increased array producer entry rates, and Boston de alio firms constituted an overwhelming proportion of Boston area firms (on average, 14 times as many de alio to de novo firms in Boston). The substantive effect of Boston de alio density in increasing array producer entry rates, however, was lower than with all other (non-Boston) de novo density counts.

Table 4

ML Estimates of Negative Binomial Models of Founding/Entry Rates of Disk Array Producers, 1986 to 1998*

	Model					
Variable	(6)	(7)	(8)	(9)	(10)	(11)
Constant	.252	.182	.212	.211	–.115	–.228
	(.240)	(.247)	(.240)	(.247)	(.280)	(.318)
Industry revenue/1000 (t)	–.015	–.188•	–.052	.003	–.310•••	–.070
	(.073)	(.084)	(.070)	(.075)	(.093)	(.066)
Venture capital array funding/1000 (t)	.001	.007	.007	.001	–.001	.001
	(.007)	(.006)	(.006)	(.007)	(.006)	(.006)
Percentage of firms in RAB (t-1)	–7.54	–4.87	–5.62	–8.16	–.079	–3.55
	(4.31)	(4.55)	(4.42)	(4.33)	(4.64)	(4.21)
Density of products (t-1)	.007	.002	.005	.008•	.005	.007•
	(.004)	(.003)	(.003)	(.004)	(.003)	(.003)
Density of Boston area firms (t-1)	.221•••					
	(.083)					
Density of firms outside Boston area (t-1)	–.022			–.025		
	(.017)			(.017)		
Density of Boston area de novo firms (t-1)				–.016		
				(.323)		
Density of Boston area de alio firms (t-1)				.245•••		
				(.088)		
Density of California firms (t-1)		.140•••				
		(.043)				
Density of firms outside California (t-1)		–.039			–.047••	
		(.020)			(.018)	
Density of California de novo firms (t-1)					.446•••	
					(.132)	
Density of California de alio firms (t-1)					.081	
					(.046)	
Density of Bay Area firms (t-1)			.163•••			
			(.047)			
Density of firms outside Bay Area (t-1)			–.021			–.031•
			(.014)			(.014)
Density of Bay Area de novo firms (t-1)						.550•••
						(.170)
Density of Bay Area de alio firms (t-1)						.099
						(.051)
Dispersion parameter	.143	.156	.143	.138	.107	.108
Log likelihood	–113.4	–111.8	–111.3	–113.1	–109.1	–108.6
Chi square vs. null (constant rate)	49.0	52.2	53.21	49.6	57.7	58.6
D.f.	6	6	6	7	7	7

• $p <. 05$; •• $p <. 025$; ••• $p < .01$.
* Standard errors are in parentheses; N of observations = 51.

When Bay Area de novo density reaches six firms, the entry rate increases 30 times (a 3000 percent increase).

Organizational Disbanding/Exit

Table 5 presents the results of our first set of array producer disbanding/exit estimates. Model 12 offers a baseline of the key firm-specific and industry-level factors affecting firm exit. Model 13 shows that the density of array producers had a significant positive effect on firm exit, which supports our earlier speculation that existing theories of organizational form emergence may not fully explain the evolution of organizational forms in the array market. Models 14 through 17 all offer strong support for the focused-identity hypothesis of organizational form development for exit events (H1b), as the density of de novo firms significantly reduces firm exit, controlling for a host of additional firm-specific and industry-level controls. In contrast, across these same models, the density

Figure 2. Effects of densities of geographically agglomerated firms on entry rate of all firms into the disk array market.

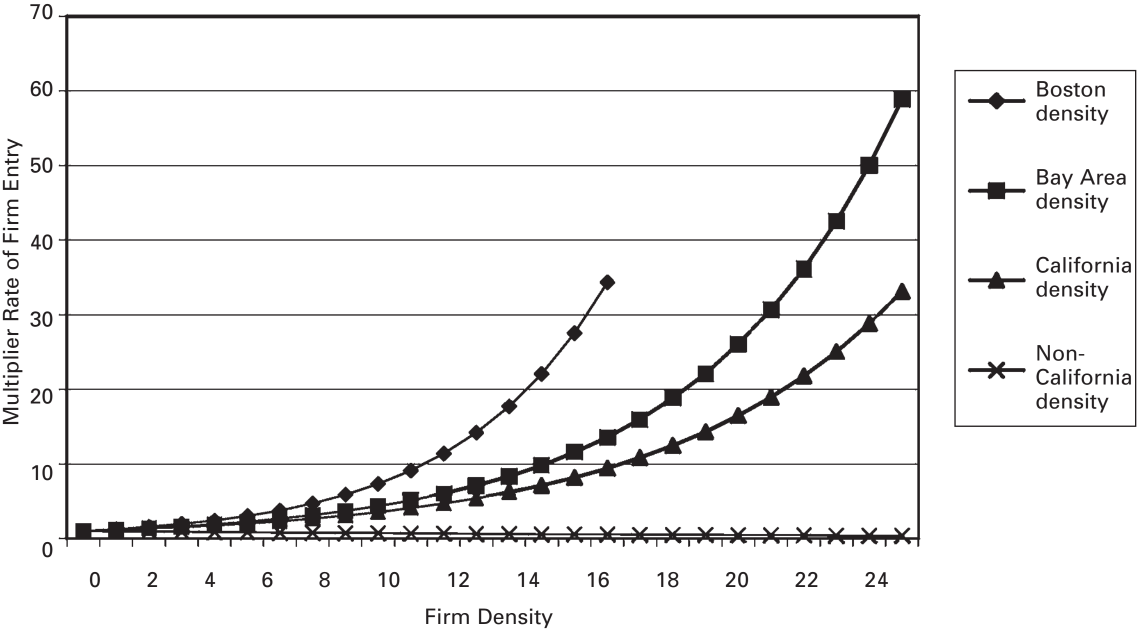
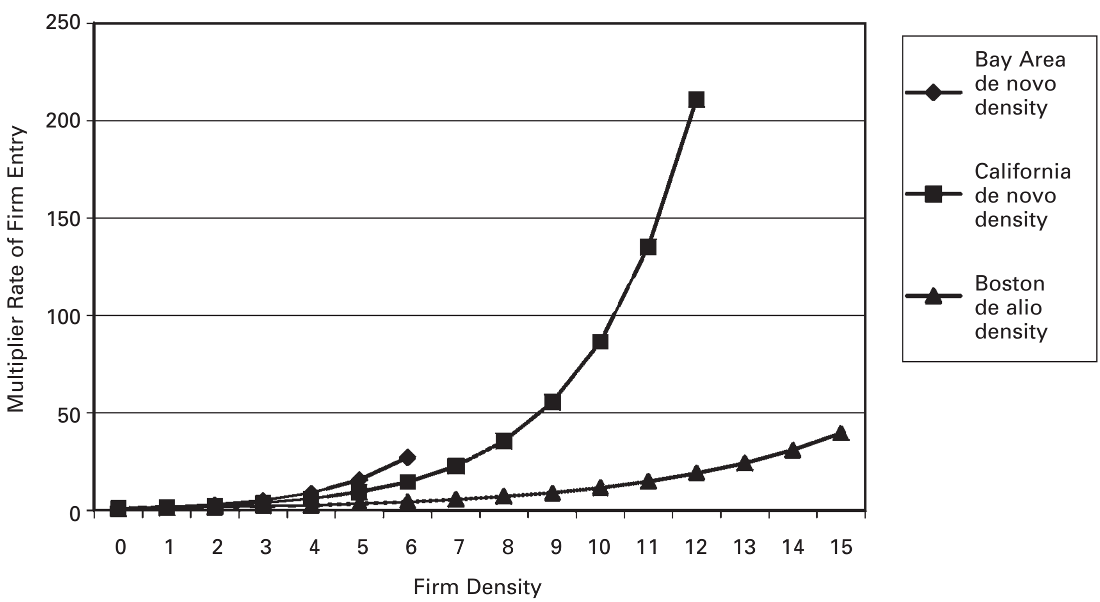


Figure 3. Effects of densities of geographically agglomerated de novo and de alio firms on entry rate of all firms into the disk array market.



of de alio firms significantly increases firm exit. In models 16 and 17, the density of products and products for the OEM/PCM market have nonsignificant (positive) effects on firm exit, which does not support Alt. H1b.

Table 6 examines the general effects on exit rates of geographic agglomeration in the Boston area, California, and the Bay Area and the role of geographically agglomerated de novo producers in these same geographic areas. Models 18 through 20 offer mixed support for H2b, which predicted that

Table 5

ML Estimates of Piecewise Constant Rate Models of Disbanding/Exit of Disk Array Producers*

	Model					
Variable	(12)	(13)	(14)	(15)	(16)	(17)
Tenure: 0 < u <= 2	–1.94•••	–2.87•••	–1.81•••	–1.71	–.093	–.145
	(.408)	(.566)	(.667)	(.967)	(1.00)	(.945)
Tenure: 2 < u <= 4	–1.64•••	–2.49•••	–1.34	–.947	.529	.467
	(.467)	(.603)	(.692)	(.963)	(1.02)	(.951)
Tenure: u > 4	–1.57•••	–2.18•••	–.682	.002	1.19	1.14
	(.547)	(.636)	(.772)	(1.01)	(1.06)	(.996)
OEM or PCM firm = 1	–.681•	–.840•••	–.759••	–.904•••	–.944•••	–.945•••
	(.304)	(.315)	(.308)	(.345)	(.345)	(.344)
De novo firm = 1	–.245	–.137	–.053	–.137	–.087	–.090
	(.280)	(.281)	(.280)	(.299)	(.298)	(.298)
Size of firm (t)	–.239••	–.253••	–.175•	–.123	–.120	–.123
	(.098)	(.106)	(.080)	(.070)	(.068)	(.070)
Industry revenue/1000 (t)	.044	–.083	.131••	.109	.034	.185••
	(.043)	(.059)	(.057)	(.063)	(.106)	(.075)
Density delay all firms (u_0)	.005	.006••	.009•••	.004	.004	.003
	(.003)	(.003)	(.003)	(.004)	(.004)	(.004)
Density all firms (t)		.012•••				
		(.004)				
Density of de novo firms (t)			–.198•••	–.232•••	–.538•••	–.535•••
			(.048)	(.056)	(.111)	(.121)
Density of de alio firms (t)			.022•••	.024•••	.010	.025•••
			(.004)	(.005)	(.020)	(.008)
Number of products for firm (t)				–.177•••	–.172•••	–.173•••
				(.066)	(.066)	(.066)
Public firm = 1 (t)				–.294	–.265	–.264
				(.304)	(.307)	(.307)
RAB member = 1 (t)				–1.86	–1.90	–1.89
				(1.02)	(1.02)	(1.02)
Venture capital recipient = 1				–.565	–.693	–.722
				(1.05)	(1.06)	(1.06)
Single-use product = 1 (t)				.059	.013	.011
				(.370)	(.369)	(.370)
Mainframe product = 1 (t)				–15.6	–16.0	–15.8
				(1232.3)	(1480.6)	(1298.9)
Network product = 1 (t)				–.145	–.185	–.177
				(.421)	(.424)	(.426)
High-performance product = 1 (t)				–1.26	–1.30	–1.28
				(.860)	(.859)	(.861)
Venture capital array funding/1000 (t)				–.001	.006	–.009
				(.010)	(.013)	(.017)
Population age at entry (u_0)				.210	.148	.172
				(.140)	(.140)	(.144)
Percentage of firms in RAB (t)					30.8•••	16.3
					(8.06)	(10.3)
Density of products (t)					.005	
					(.005)	
Density of products for the OEM/PCM market (t)						.010
						(.006)
Log likelihood	–249.6	–244.0	–233.3	–211.4	–202.0	–201.0
Chi square vs. null (constant rate)	72.6	83.8	105.2	149.1	168.0	169.9
D.f.	7	8	9	19	21	21

• $p < .05$; •• $p < .025$; ••• $p < .01$.

* Standard errors are in parentheses. N of observations = 1539; N of firms = 258; N of exit events (does not include acquisitions) = 114.

6
The density of firms outside the geographic agglomerations of Boston, California, and the Bay Area increases exit rates (significant in models 18 and 20). As with our entry analyses, we believe this is based on the geographic dispersion of disk array producers, (*continued,* p. 85)

the density of geographically agglomerated producers would drive form development through reduced exit rates. Only the density of firms in Boston significantly reduces exit rates, while the density of California and Bay Area firms has non-significant (negative) effects on exit rates.[6] In contrast, in models 21 through 23, respectively, the density of Boston,

Table 6

ML Estimates of Piecewise Constant Rate Models of Disbanding/Exit of Disk Array Producers*

Variable	Model (18)	(19)	(20)	(21)	(22)	(23)
Tenure: 0 < u <= 2	–.660	–3.90••	–3.49•	–.705	.755	.230
	(.988)	(1.65)	(1.58)	(.985)	(1.00)	(.964)
Tenure: 2 < u <= 4	–.047	–3.39•	–3.00	–.104	1.39	.852
	(1.01)	(1.64)	(1.58)	(1.01)	(1.04)	(.993)
Tenure: u > 4	.557	–2.96	–2.54	.514	2.08	1.55
	(1.06)	(1.63)	(1.58)	(1.06)	(1.10)	(1.05)
OEM or PCM firm = 1	–.937•••	–.992•••	–.993•••	–.940•••	–.973•••	–.958•••
	(.345)	(.344)	(.343)	(.345)	(.346)	(.345)
De novo firm = 1	–.101	–.147	–.153	–.105	–.111	–.099
	(.298)	(.299)	(.299)	(.298)	(.299)	(.298)
Size of firm (t)	–.134	–.186	–.194	–.137	–.126	–.126
	(.078)	(.105)	(.109)	(.080)	(.072)	(.073)
Industry revenue/1000 (t)	–.032	.089	.032	–.046	–.126	–.312••
	(.100)	(.120)	(.117)	(.101)	(.130)	(.138)
Density delay all firms (u_0)	.004	.005	.005	.004	.003	.003
	(.004)	(.004)	(.004)	(.004)	(.004)	(.004)
Number of products for firm (t)	–.177•••	–.188•••	–.188•••	–.177•••	–.174•••	–.173•••
	(.066)	(.067)	(.067)	(.066)	(.066)	(.066)
Public firm = 1 (t)	–.265	–.280	–.279	–.267	–.288	–.276
	(.306)	(.303)	(.303)	(.306)	(.308)	(.308)
RAB member = 1 (t)	–1.88	–1.82	–1.81	–1.87	–1.88	–1.88
	(1.02)	(1.02)	(1.02)	(1.02)	(1.02)	(1.02)
Venture capital recipient = 1	–.662	–.277	–.284	–.662	–.548	–.738
	(1.07)	(1.05)	(1.05)	(1.07)	(1.05)	(1.07)
Single-use product = 1 (t)	.042	.090	.090	.044	.059	.042
	(.370)	(.373)	(.375)	(.371)	(.373)	(.373)
Mainframe product = 1 (t)	–15.0	–14.4	–14.4	–15.0	–15.7	–15.0
	(910.9)	(725.3)	(722.3)	(909.6)	(1312.1)	(898.8)
Network product = 1 (t)	–.165	–.165	–.164	–.159	–.132	–.131
	(.423)	(.424)	(.426)	(.425)	(.428)	(.429)
High-performance product = 1 (t)	–1.27	–1.28	–1.26	–1.26	–1.21	–1.22
	(.859)	(.868)	(.870)	(.860)	(.859)	(.859)
Venture capital array funding/1000 (t)	–.016	.005	.007	–.016	.119•••	.058••
	(.012)	(.018)	(.014)	(.011)	(.034)	(.026)
Population age at entry (u_0)	.104	–.004	.012	.116	.172	.179
	(.135)	(.121)	(.123)	(.138)	(.144)	(.145)
Percentage of firms in RAB (t)	34.5•••	1.53	6.04	37.4•••	10.9	12.9
	(9.64)	(4.91)	(6.29)	(11.0)	(5.74)	(8.06)
Density of products (t)	–.037•••	–.006	–.008	–.038•••	.023•••	–.015
	(.009)	(.005)	(.004)	(.010)	(.007)	(.008)
Density of Boston area firms (t)	–1.00•••					
	(.236)					
Density of firms outside Boston area (t)	.211•••			.215•••		
	(.049)			(.051)		
Density of Boston area de novo firms (t)				–1.39•		
				(.688)		
Density of Boston area de alio firms (t)				–.978•••		
				(.245)		
Density of California firms (t)		–.004				
		(.109)				
Density of firms outside California (t)		.058			.449•••	
		(.048)			(.113)	
Density of California de novo firms (t)					–2.45•••	
					(.232)	
Density of California de alio firms (t)					–.910•••	
					(.232)	
Density of Bay Area firms (t)			–.074			
			(.095)			
Density of firms outside Bay Area (t)			.061••			.211•••
			(.026)			(.072)
Density of Bay Area de novo firms (t)						–2.01•••
						(.502)
Density of Bay Area de alio firms (t)						–.528•••
						(.181)
Log likelihood	–209.4	–219.8	–219.2	–209.2	–202.0	–201.5
Chi square vs. null (constant rate)	153.2	132.3	133.6	153.5	167.9	168.8
D.f.	21	21	21	22	22	23

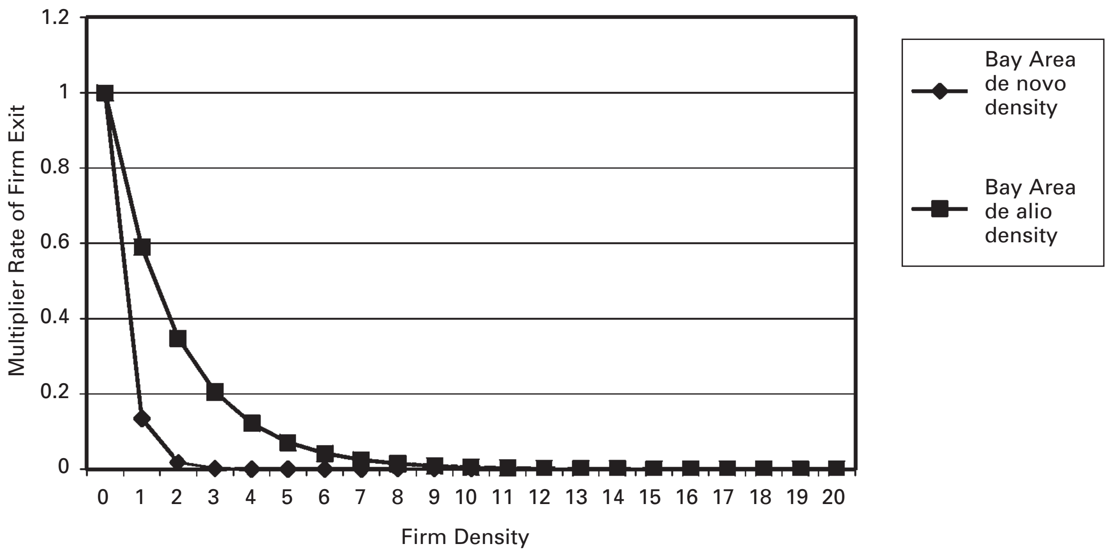
• $p < .05$; •• $p < .025$; ••• $p < .01$.

* Standard errors are in parentheses. N of observations = 1539; N of firms = 258; N of exit events (does not include acquisitions) = 114.

California, and Bay Area de novo firms each significantly reduces firm exit rates, offering strong support for the role of geographically agglomerated de novo producers in reducing exit rates (H3b).

In models 21 through 23, densities of de alio firms in these locales also reduce firm exit. Boston de alio firms may reduce exit rates because of their disproportionate role in geographic agglomeration, as Boston area density significantly reduces exit rates (model 18). The case of California and Bay Area de alio firms may simply implicate more complex competitive dynamics than our present theorizing and modeling have captured, although the magnitude of agglomerated de alio density effects is substantially smaller than that of agglomerated de novo firms. Based on unreported multiplier rate calculations, Boston area de novo firms reduce exit rates 1.4 times more than Boston area de alio firms, California de novo firms reduce exit rates 2.7 times more than California de alio firms, and Bay Area de novo firms reduce exit rates 3.8 times more than Bay Area de alio firms. Figure 4 demonstrates this using firms agglomerated in the Bay Area as an example (based on model 23). It takes three de novo firms operating in the Bay Area to reduce exit rates practically to zero, whereas about 10 de alio firms operating in the Bay Area are required to have the same effect on exit rates.

Figure 4. Effects of densities of Bay Area de novo and Bay Area de alio firms on exit rate of all firms into the disk array market.



DISCUSSION

Disk array production may never become an organizational form, as defined by an external identity code. In fact, the trend in the last year or so has been for market analysts, the trade press, and the companies themselves to treat disk arrays as one element in a storage network, along with software, tape drives, switches, and routers. Although disk arrays underpin these networks, "data storage" may become the external identity that spawns an organizational form. If

which impairs organizational form development. We also found similar results when we ran models combining Boston and California de novo density: the combined de novo variable significantly reduced exit rates, while the density of firms outside of Boston and California increased exit but was not significant.

so, it would invoke a different set of identity rules for firm behavior and appearance; it would also include a much more diverse set of technologies and associated business firms. Notwithstanding this possibility, we think the findings here demonstrate a potentially useful approach for analyzing how and where identity-based organizational forms emerge. We have made two claims about perceptually focused identities that empirical analysis supports: (1) the legitimation of an organizational form emanates from the number of de novo firms in a market, and (2) a large number of de novo firms within a geographic agglomeration possessing a related identity will accelerate identity formation. This amounted to respecifying the density-dependent process currently thought to lead to an organizational form.

The findings for the density of de novo firms in disk array production supported the claim about perceptual focus, since in this market de alio firms came from diverse origins and often retained significant activities in those areas, while de novo firms tended to focus on disk arrays. All other things being equal, an identity is more likely to be perceived and thus to gel into a recognizable form faster—and at lower levels of density—when the constituent organizations possess similar unit identities themselves than when they are heterogeneous. Such a development might be spurred by both intra- and extra-industry processes. Among a set of organizations, a common structure means that firms are likely to rely on common resources of labor, customers, and the like. They are also more likely to identify with each other, recognize common interests, and develop solidarity. Externally, the common features among de novo firms means that outsiders can more readily see the unit character in the grouping of firms and act accordingly.

The findings for agglomeration speak to social science's broad acceptance of the idea that organizational activity tends to be spatially concentrated. Economists, regional scientists, industrial sociologists and economic geographers generally agree that economic benefits accrue to firms that cluster (Becattini, 1990; Porter, 1990; Krugman, 1991; Storper, 1995; Hayter, 1997; Sorenson and Stuart, 2001) and that these benefits—agglomeration effects—increase with the number of firms in the cluster (Arthur, 1986). Agglomerations may enhance innovation, improve operational efficiency and stimulate economic growth through information spillovers, labor market pooling, the availability of specialized suppliers tailored to the industry, and a spirit of rivalry among competing firms that, in turn, enhances learning (Saxenian, 1991, 1994; Jaffe, Trajtenberg, and Henderson, 1993; Feldman, 1994; Head, Ries, and Swenson, 1995; McKendrick, Doner, and Haggard, 2000).

In a narrow sense, our findings agree with these positive evaluations of agglomeration. But they also suggest, as others have argued (Carroll and Wade, 1991; Swaminathan and Wiedenmayer, 1991; Lomi, 1995), that agglomeration might be a more general factor shaping the evolution of organizational populations, in this case, the emergence of an organizational form. Ecologists have long hinted that the level of spatial aggregation implicitly defines population boundaries and that organizations' resource requirements generally have a geographic basis (Hannan and Freeman, 1989). Our findings show that the level of analysis is indeed an important factor in determining how an institutionalized organizational form emerges. Despite possible appearances to the contrary, our findings are also largely consistent with the prior theories about legitimation and geography: whereas Hannan et al.'s (1995) story about legitimation operating on a broader geographic scale applied to the spread of established organizational forms to new populations, the story developed here concerns the initial emergence of a form in any population.

Moreover, in developing the theoretical arguments, we have further modified the specification of the density-dependent process to incorporate particular locations explicitly. If a potential disk array form does get perceived and coheres, it may result not only from the number of de novo producers in a market but also from the number of de novo producers that are also geographically clustered in a place with a related identity. The core idea is that the propinquity of de novo firms in a place with a related social identity may engender awareness of the potential form and make it more visible and salient to external evaluators. Additionally, the perception that organizations derive public cognitive recognition from clustering can even override to some extent the diffuse identity of de alio firms to create a sense of homogeneity and generate solidarity. Although, consistent with our theory, de novo firms had a considerably stronger effect than de alio firms on lowering exit rates, our findings suggested that form emergence may be even more strongly related to geographic clustering than we theorized initially. Indeed, a market composed of geographically dispersed organizations may make it difficult for diverse actors to recognize and act on their commonalities; it may also make it harder for outsiders to see and identify the form, especially if they are engaged only in captive production. Moreover, the initial steps of identity generation may be highly localized, but the process spreads quite rapidly across geographic boundaries. In disk arrays, an increase in the number of agglomerated firms in the Bay Area and Boston region reduced the exit rates for all firms in the market; disk array firms in Taiwan and Europe benefited from the legitimation process in the U.S.

In terms of future research, the findings suggest several avenues. One emerges from a limitation of our study noted by one of the reviewers, namely, that we do not examine the actions of external agents. Although we used what financial analysts and market participants wrote and said about the market to develop our theory, we did not systematically study them. Obviously, attending more carefully to how outsiders classify organizations can bear fruit (Zuckerman 1999, 2000; Zuckerman and Kim, 2003), as the salient bases of identity are likely to be quite different for different external audiences (Philips and Zuckerman, 2001). If codes are enforced differently from place to place, researchers might need to tailor their typologies of organizational form to the specific locale and social context under study. Baron (2002) speculated that different kinds of informants are likely to classify organizations along dimensions that do not correspond to product markets. More systematic analysis of relevant outsiders could contribute to a better understanding of form emergence. Human resource officers or recruiters or even potential employees, for example, give greater importance than other evaluators to an organization's labor market identity (Baron, 2002). Hsu and Podolny (2002) used content analysis of movie reviews to determine how films and genres can be classified, an approach that could be used to classify firms and their identities. There is certainly room for more research on how external agents perceive organizational identities.

A second area could focus on the ecological consequences of delineating identities based on labor market versus product market considerations (Baron, 2002). In fact, Baron and Hannan (2001) found evidence that organizations that established a labor market identity prior to a product market identity were less likely to alter their labor market model over time than were organizations that were product-driven.

A final point regarding the role played by geography in the development of organizational forms seems important to consider in future research. Those who study organizations and geography appear to characterize agglomeration, at least implicitly, in two ways. One approach treats agglomerations in largely functional terms, as places where close proximity in input-output relations confers economic benefits, such as economies of scale, innovation, and economizing on transaction costs. A second more sociological view characterizes agglomerations as places with social identities of their own, independent of any single market cluster. Are the transactional qualities of agglomerations or the social identities of place more relevant to form emergence? We cannot answer for certain, as we found evidence that suggests both processes operate in the disk array market. In support of the view that an agglomeration's functional attributes may contribute to form emergence, for example, was the difference in the magnitude of positive effects on entry rates that appear to reflect the physical proximity of geographical clustering: the Boston area, with the largest effect, is more compact than the Bay Area, and the Bay Area is a subset of California. But we also found it intriguing that our findings were associated with two locations with strong identities of place, Route 128 and Silicon Valley. Both places have related identities recognized by market participants and external agents. Compared with other locations, they likely have denser direct and indirect interaction patterns with their resident organizations, thereby providing more focus to outsiders' perceptions. But we leave this as speculation and encourage researchers to address each possibility.

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APPENDIX: Correlations of Variables

Table A.1

Correlations of Variables Used in Founding/Entry Analyses

Variable	1	2	3	4	5	6	7	8	9
1. Industry revenue/1000 (t)									
2. Venture capital array funding/1000 (t)	−.11								
3. Density all firms (t-1)	.86	−.08							
4. Density de novo firms (t-1)	.91	.01	.97						
5. Density de alio firms (t-1)	.85	−.10	.99	.96					
6. Percentage of firms in RAB (t-1)	.96	−.16	.91	.92	.90				
7. Density of products (t-1)	.81	−.11	.98	.92	.98	.88			
8. Density of products by OEM/PCM producers (t-1)	.83	−.14	.98	.92	.98	.89	.99		
9. Density of firms outside Boston area (t-1)	.87	−.10	.99	.97	.99	.91	.98	.98	
10. Density of Boston area firms (t-1)	.75	.15	.95	.92	.95	.78	.92	.91	.94
11. Density of firms outside California (t-1)	.86	−.11	.99	.96	.99	.90	.98	.98	.99
12. Density of California firms (t-1)	.88	−.03	.99	.98	.99	.91	.97	.97	.99
13. Density of firms outside Bay Area (t-1)	.87	−.10	.99	.97	.99	.91	.98	.98	.99
14. Density of Bay Area firms (t-1)	.80	.05	.98	.96	.97	.83	.95	.94	.97
15. Density of Boston area de novo firms (t-1)	.66	.19	.81	.80	.80	.67	.81	.80	.80
16. Density of Boston area de alio firms (t-1)	.74	.14	.95	.92	.95	.77	.92	.91	.94
17. Density of California de novo firms (t-1)	.89	.12	.94	.97	.93	.86	.88	.88	.94
18. Density of California de alio firms (t-1)	.87	−.06	.99	.97	.99	.91	.98	.98	.99
19. Density of Bay Area de novo firms (t-1)	.74	.21	.91	.92	.90	.75	.86	.85	.90
20. Density of Bay Area de alio firms (t-1)	.80	.00	.98	.95	.98	.84	.96	.94	.97

Variable	10	11	12	13	14	15	16	17	18
11. Density of firms outside California (t-1)	.95								
12. Density of California firms (t-1)	.95	.99							
13. Density of firms outside Bay Area (t-1)	.94	.99	.99						
14. Density of Bay Area firms (t-1)	.97	.97	.98	.97					
15. Density of Boston area de novo firms (t-1)	.86	.80	.81	.80	.82				
16. Density of Boston area de alio firms (t-1)	.99	.95	.95	.94	.97	.84			
17. Density of California de novo firms (t-1)	.94	.93	.96	.94	.94	.80	.94		
18. Density of California de alio firms (t-1)	.94	.99	.99	.99	.98	.80	.94	.94	
19. Density of Bay Area de novo firms (t-1)	.96	.89	.93	.90	.95	.79	.96	.95	.91
20. Density of Bay Area de alio firms (t-1)	.96	.97	.98	.97	.99	.81	.96	.93	.98

Variable	19
20. Density of Bay Area de alio firms (t-1)	.92

Table A.2

Correlations of Variables Used in Exit Analyses

Variable	1	2	3	4	5	6	7	8	9
1. OEM or PCM firm = 1									
2. De novo firm = 1	.08								
3. Size of firm (t)	–.23	–.06							
4. Industry revenue/1000 (t)	.13	.01	.10						
5. Density delay all firms (u_0)	.29	–.00	–.15	.44					
6. Density of all firms (t)	.16	–.03	.07	.86	.45				
7. Density de novo firms (t)	.16	–.02	.08	.84	.45	.87			
8. Density de alio firms (t)	.17	–.07	.02	.46	.34	.81	.73		
9. Number of products for firm (t)	–.16	–.07	.61	.19	–.18	.19	.20	.14	
10. Publicly traded firm = 1 (t)	–.43	–.14	.13	.02	–.18	.01	.03	.01	.12
11. RAB member = 1 (t)	–.04	–.03	.27	.14	–.08	.15	.17	.14	.54
12. Venture capital recipient = 1	–.05	.48	–.02	–.01	–.07	–.04	–.04	–.07	–.04
13. Offers single-use product = 1 (t)	.11	.10	–.07	.04	.12	.03	.02	.01	.05
14. Offers mainframe product = 1 (t)	–.21	–.11	.33	.04	–.10	.01	.02	–.03	.23
15. Offers network product = 1 (t)	.16	–.02	.06	.06	.06	.09	.11	.12	.14
16. Offers high-performance product = 1 (t)	–.28	–.00	.04	–.10	–.23	–.11	–.12	–.11	.09
17. Venture capital array funding/1000 (t)	–.11	.04	–.01	–.33	–.20	–.56	–.38	–.61	–.08
18. Population age at entry (u_0)	.23	.03	–.14	.45	.89	.46	.52	.39	–.17
19. Percentage of firms in RAB (t)	.17	–.03	.07	.80	.44	.87	.94	.80	.19
20. Density of products (t)	.18	–.04	.06	.76	.44	.96	.90	.91	.19
21. Density of products for OEM/PCM market (t)	.17	–.05	.04	.57	.38	.78	.82	.85	.16
22. Density of firms outside Boston area (t)	.17	–.07	.03	.55	.38	.86	.80	.99	.15
23. Density of Boston area firms (t)	.13	–.08	–.01	.09	.19	.47	.51	.85	.07
24. Density of firms outside California (t)	.17	–.07	.03	.53	.37	.86	.78	.99	.15
25. Density of California firms (t)	.17	–.07	.03	.51	.37	.83	.79	.99	.15
26. Density of firms outside Bay Area (t)	.17	–.07	.03	.56	.38	.87	.80	.99	.15
27. Density of Bay Area firms (t)	.15	–.08	.01	.27	.28	.62	.66	.94	.11
28. Density of Boston area de novo firms (t)	.05	–.04	–.02	–.19	.01	–.04	.19	.35	.01
29. Density of Boston area de alio firms (t)	.13	–.08	–.01	.13	.21	.52	.53	.88	.08
30. Density of California de novo firms (t)	.15	–.02	.08	.87	.45	.93	.94	.70	.19
31. Density of California de alio firms (t)	.17	–.07	.02	.42	.34	.77	.73	.99	.14
32. Density of Bay Area de novo firms (t)	.10	–.04	.02	.31	.25	.59	.62	.66	.11
33. Density of Bay Area de alio firms (t)	.15	–.08	.00	.25	.26	.58	.62	.92	.11

Variable	10	11	12	13	14	15	16	17	18
11. RAB member = 1 (t)	.18								
12. Venture capital recipient = 1	.03	.06							
13. Offers single-use product = 1 (t)	–.16	–.09	–.03						
14. Offers mainframe product = 1 (t)	.15	.22	–.05	–.10					
15. Offers network product = 1 (t)	.03	.14	.06	–.37	–.17				
16. Offers high-performance product = 1 (t)	.13	.00	–.05	–.10	.05	–.44			
17. Venture capital array funding/1000 (t)	.03	–.10	.04	–.04	.03	–.05	.06		
18. Population age at entry (u_0)	–.12	–.06	–.06	.10	–.06	.07	–.25	–.15	
19. Percentage of firms in RAB (t)	.01	.18	–.05	.02	.01	.11	–.12	–.57	.49
20. Density of products (t)	.01	.16	–.05	.03	–.00	.11	–.12	–.58	.47
21. Density of products for OEM/PCM market (t)	.00	.16	–.05	.01	–.01	.11	–.11	–.44	.42
22. Density of firms outside Boston area (t)	.01	.15	–.07	.01	–.02	.12	–.11	–.60	.42
23. Density of Boston area firms (t)	.03	.10	–.08	–.03	–.03	.12	–.09	–.45	.28
24. Density of firms outside California (t)	.01	.15	–.07	.01	–.02	.12	–.11	–.62	.41
25. Density of California firms (t)	.01	.15	–.07	.01	–.02	.12	–.11	–.55	.42
26. Density of firms outside Bay Area (t)	.01	.15	–.07	.01	–.02	.12	–.11	–.61	.42
27. Density of Bay Area firms (t)	.02	.13	–.08	–.01	–.03	.13	–.10	–.48	.36
28. Density of Boston area de novo firms (t)	.03	.05	–.04	–.05	–.02	.07	–.04	–.22	.11
29. Density of Boston area de alio firms (t)	.03	.11	–.08	–.03	–.03	.12	–.09	–.47	.29
30. Density of California de novo firms (t)	.03	.15	–.04	.02	.02	.09	–.11	–.31	.50
31. Density of California de alio firms (t)	.01	.14	–.07	.00	–.03	.12	–.11	–.57	.39
32. Density of Bay Area de novo firms (t)	.04	.08	–.05	–.01	–.01	.08	–.08	–.04	.34
33. Density of Bay Area de alio firms (t)	.01	.13	–.07	–.01	–.03	.13	–.10	–.52	.34

Variable	19	20	21	22	23	24	25	26	27
20. Density of products (t)	.91								
21. Density of products for OEM/PCM market (t)	.90	.87							
22. Density of firms outside Boston area (t)	.85	.95	.95						
23. Density of Boston area firms (t)	.59	.61	.60	.81					
24. Density of firms outside California (t)	.84	.94	.94	.99	.83				

(continued on page 93)

Table A.2 *(Continued)*

Variable	19	20	21	22	23	24	25	26	27
25. Density of California firms (t)	.83	.93	.93	.99	.83	.99			
26. Density of firms outside Bay Area (t)	.85	.95	.95	.99	.80	.99	.99		
27. Density of Bay Area firms (t)	.73	.78	.77	.92	.94	.93	.95	.91	
28. Density of Boston area de novo firms (t)	.29	.13	.10	.31	.72	.34	.36	.30	.60
29. Density of Boston area de alio firms (t)	.61	.65	.64	.84	.99	.86	.86	.84	.95
30. Density of California de novo firms (t)	.84	.89	.88	.77	.42	.76	.75	.78	.56
31. Density of California de alio firms (t)	.79	.90	.90	.99	.86	.99	.99	.98	.97
32. Density of Bay Area de novo firms (t)	.43	.63	.63	.67	.58	.66	.69	.67	.63
33. Density of Bay Area de alio firms (t)	.73	.75	.74	.90	.94	.90	.92	.89	.99

Variable	28	29	30	31	32
29. Density of Boston area de alio firms (t)	.65				
30. Density of California de novo firms (t)	–.06	.47			
31. Density of California de alio firms (t)	.41	.88	.68		
32. Density of Bay Area de novo firms (t)	.07	.63	.72	.65	
33. Density of Bay Area de alio firms (t)	.65	.94	.49	.95	.52