Liquidity Events and the Geographic Distribution of Entrepreneurial Activity

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In this paper, we examine the ecological consequences of initial public offerings (IPOs) and acquisitions, specifically how the spatial distribution of these events influences the location-specific founding rates of new companies. We explore whether relatively small spatial units (metropolitan statistical areas) in close geographic proximity to firms that recently have been acquired or experienced an IPO exhibit high new venture creation rates and whether the magnitudes of these effects depend on regional differences in statutes governing the freedom of employees to move between employers. Count models of biotechnology firm foundings establish three findings: (1) IPOs of organizations located contiguous to or within an MSA accelerate the founding rate within that MSA, (2) acquisitions of biotech firms situated near to or within an MSA accelerate the founding rate within the MSA, but only when the acquirer enters from outside of the biotech industry, and (3) the enforceability of post-employment non-compete covenants, which is determined at the state level, strongly moderates these effects.●

Transformational events—those that hasten major changes in organizational culture, systems, routines, and leadership—occasionally punctuate the organizational life course. Two such events that often engender change in core features of organizations, acquisitions and initial public offerings (IPOs), have become particularly salient in recent years because of their prevalence and financial significance. Although researchers from different disciplinary perspectives have offered insight into the causes and consequences of these events, few have considered how the internal organizational changes they precipitate affect the ecology of competing organizations. Because acquisitions and IPOs (hereafter, liquidity events) shift the quantity and distribution of resources within and between types of organizations, however, they can produce a number of changes in population-level variables. The rate of new venture formation, in particular, may vary with the social structural changes that liquidity events produce.

Liquidity events alter the incentive and opportunity structures confronting senior executives and technologists at the companies experiencing them. For instance, an IPO results in a company's equity trading on a public stock market, which enables high-level employees to sell their equity holdings; ownership stakes become liquid assets following the transition to public status. This is relevant to the entrepreneurial process because the individuals best equipped to launch new ventures in a particular field are high-level employees at established companies in that area (Brittain and Freeman, 1986; Aldrich, 1999; Sorenson and Audia, 2000; Klepper and Sleeper, 2000; Burton, Sørensen, and Beckman, 2002; Klepper, 2002). These individuals have the organizing know-how, relevant technical expertise, and professional contacts necessary to mobilize the financial and human resources to create new firms. Thus, one reason why liquidity events may trigger entrepreneurial activity is that they weaken the financial bonds linking senior executives and technologists to their current employers, which removes an important hurdle to the

pursuit of latent entrepreneurial aspirations among those most capable of creating new ventures.

Based in part on this premise, in this article we pose the question, When organizations in an industry are acquired or go public, how and why do these events influence the entry rate of new organizations of the kind experiencing these changes? In pursuing an answer, we make use of a well-established fact in work on the origins of new firms: individuals typically start businesses in close proximity to their current places of residence (Mitton, 1990; Haug, 1995; Klepper, 2002; Stuart and Sorenson, 2003; Thornton and Flynn, 2003). Multiple factors could account for this regularity. For example, there is increasing evidence that nascent entrepreneurs' professional networks are geographically localized (Sorenson and Stuart, 2001; Stuart and Sorenson, 2003), which may impose constraints on the ability of company founders to relocate. Regardless of the particular source of geographic inertia, the fact that it exists allows us to exploit geographic proximity as a means of identifying the relationship between liquidity events and the entrepreneurial activities they promote.

The empirical analyses in this article are location-specific founding rate models estimated in the U.S. biotechnology sector. Using data describing all founding events and liquidity events in this population, we explore how initial public offerings of the shares of private biotechnology firms, and changes in the corporate control of existing biotech firms, influence the founding rates of new companies.

LIQUIDITY EVENTS AND FOUNDING RATES

We situate our analysis in two literatures—organizational demography and the sociologically informed literature on entrepreneurship. This work relates the creation of new organizations to the prevailing opportunity structure facing those people at risk of transitioning to become founders (Stinchcombe, 1965; see overviews in Romanelli, 1989; Aldrich, 1999; Thornton, 1999; Carroll and Hannan, 2000). Ecological studies typically cast the opportunity structure for new venture formation as a function of the density of organizations of a particular type. The best established finding in this area is that entry and exit rates of organizations depend on levels of population density, but recent work has further elaborated the mechanisms underlying population vital rates. For example, corporate demographers have become interested in the spatial boundaries of competition and the geographic diffusion of organizational forms (Carroll and Wade, 1991; Baum and Mezias, 1992; Lomi, 1995; Hannan et al., 1995; Baum and Haveman, 1997; Sorenson and Audia, 2000), institution building and collective action among the members of organizational populations (Ingram and Inman, 1996), the career-related consequences of organizational foundings, growth, and decline (Haveman and Cohen, 1994; Phillips, 2001), and closely related to our purpose here, the dynamics of organizational spin-offs (Brittain and Freeman, 1986; Phillips, 2002).

Likewise, a central research objective in entrepreneurship is to understand the social structural and economic conditions that promote new venture formation (Low and MacMillan,

1988; Shane and Venkataraman, 2000). Researchers in this area have examined the role of incubator organizations in generating spin-off companies and, more generally, the career trajectories most likely to result in a transition to entrepreneurship (Cooper, 1970; Cooper and Dunkelberg, 1987; Mitton, 1990; Dobrev and Barnett, 1999). In a related vein, scholars of economic geography have extensively studied the conditions giving rise to regional differences in rates of entrepreneurial activity, with a particularly active stream of work examining the antecedents to the formation of technology-based industrial clusters (Saxenian, 1994).

We add to the literature in these two fields by considering liquidity events as catalysts in the new venture creation process, exploring in particular the probable influence of liquidity events on the formation of spin-off companies. An important type of founding event, spin-offs represent the dominant mode of entry in many organizational populations (for semiconductor firms, see Freeman, 1983, Brittain and Freeman, 1986, Boeker, 1989, and Eisenhardt and Schoonhoven, 1990; for Detroit-area automobile producers, see Klepper, 2002; for Silicon Valley law firms, see Phillips, 2002; and for technology-based industries in general, see Cooper and Dunkelberg, 1987). The extent to which spin-offs take place likely hinges on a number of interrelated considerations. Two of these are the ability of nascent entrepreneurs to access the resources to launch a company and the incentive of these individuals to depart from their current employment relationship. Liquidity events thus act on each of these factors, influencing the incidence of new firm formation.

Because new ventures represent risky organizational propositions, convincing others to invest in one's proposed enterprise can prove daunting (Stinchcombe, 1965). Issues such as the difficulty of assessing the quality of new ventures and their management teams (Stuart, Hoang, and Hybels, 1999), as well as the information asymmetries between entrepreneurs and potential investors, lead the majority of entrepreneurs to rely on their personal financial resources to fund the early stages of their fledgling firms (Reynolds and White, 1997). Despite popular perception to the contrary, this holds true even in technology-based industries; for example, a survey of all biotechnology startups in the state of Washington revealed that founders' personal funds accounted for nearly half of the initial financing of these companies, the single most important source of capital (Haug, 1995). More generally, Evans and Jovanovic (1989), having analyzed data from the National Longitudinal Survey, found that personal wealth sped the transition to self-employment. These authors concluded that, more than any other factor, financial constraints limit new venture formation.

Liquidity events may lessen or remove the financial constraints that hinder senior-level employees' attempts to found new ventures. In a typical new venture, an IPO or acquisition offers the first opportunity for insiders to extract significant financial resources from their participation in the company. Moreover, because high-technology firms have increasingly used stock options to attract and retain employees in recent years, the financial gains from these events have extended to

a larger group of insiders. Heavy equity participation of top managers and technologists implies that a liquidity event sharply attenuates the financial constraints of many high-potential entrepreneurs. The resources these individuals obtain by selling their equity positions when their employer has recently experienced an IPO or acquisition might subsidize the creation of a new venture. Alternatively, the liquidated equity stake may provide the financial security to permit entrepreneurs to enter a spell of unemployment (or unpaid employment) while raising capital and other resources for a new firm or for them to join a team already in the process of developing a business plan to exploit a risky new opportunity.

In addition to the effect of liquidity events on the personal wealth of senior-level employees, IPOs and acquisitions have a second set of consequences as well: they result in many qualitative changes in the affected organizations, potentially altering numerous dimensions of work role requirements. These changes in turn affect another central variable related to the incidence of spin-offs: the job satisfaction of senior-level employees.

Changes Associated with Initial Public Offerings

The literature on organizational change documents the difficulty of altering the core features of an organization and describes the internal upheaval that inevitably results from such change efforts. Though typologies distinguishing core organizational dimensions from those that are more pliable vary somewhat, most observers consider an organization's structure and strategy to be elements of its nucleus. Hannan and Freeman (1984), for example, listed stated goals, forms of authority, core technology, and marketing strategy as the most inert attributes of organizations. Abundant evidence demonstrates that attempts to change core features destabilize organizations (Hannan and Freeman, 1984; Haveman, 1992; Amburgey, Kelly, and Barnett, 1993). Recent work on the development of high-technology firms, for example, has found that organizations experience turnover when they attempt to change the employment systems that company founders had originally put in place (Baron, Hannan, and Burton, 2001).

The change literature is relevant to our discussion of liquidity events because, in addition to altering the financial relationship between an organization and its senior leaders, IPOs may result in significant changes to an organization's core features. After the IPO, the finance and treasury functions of organizations typically gain prominence, as the public company functions, such as Securities and Exchange Commission (SEC) reporting and managing the firm's relationship with Wall Street, require a new set of tasks, people, and routines. This change alters a core dimension of the organization: it shifts the power distribution within the firm (Tushman and Romanelli, 1985).

Turnover in the membership of the board of directors also typically follows an IPO, and the size of the board usually increases (Baker and Gompers, 2003), potentially affecting relationships between executives and the board. The demands for accountability to new stakeholders, the busi-

ness press's scrutiny of financial performance and the progress of product development, a new class of institutional shareholders, and pressures to conform to standard organizational blueprints (Meyer and Rowan, 1977) may alter the priorities and decision-making processes of the firm. Among early-stage technology companies, the transition to public ownership exposes the organization to pressure for short-term financial performance, as investors seek assurances of the firm's ability to turn a profit. The external demand for near-term profitability often becomes a mandate that filters internal resource allocation decisions, encouraging a relative shift from research to development in the dispensation of R&D funds and, more generally, a reapportionment of funds across the different functions of the corporation. Thus, in addition to redistributing intraorganizational power, IPOs may necessitate a shift in a second core dimension, the organization's strategy.

IPOs can also have another effect inside the firm: they usually raise the level of formalization and bureaucracy. Some of the capital that firms obtain in the sale of equity may be deployed to finance staff expansions. To maintain control as the complexity of the organization increases, firm leaders must narrow the scope of job roles, introduce administrative procedures and authority structures to standardize many tasks and step up the frequency of monitoring by superiors to redress agency problems (Holmström, 1989; Rotemberg and Saloner, 1994). Thus, bureaucracy, as a remedy to incentive and coordination problems arising in large organizations, likely intensifies as a consequence of an IPO, resulting in changes in a third core feature, organizational structure.

These changes have perhaps the greatest significance when they occur in early-stage, high-technology firms. The members of these organizations may perceive the routinization brought about by the introduction of bureaucratic controls to be antithetical to innovation. The freedom to experiment, liberal tolerance for mistakes, the allocation of status and influence based on expertise rather than rank, and the lack of formal planning and constant oversight are cherished features of the work life in young companies that may fade following liquidity events. Moreover, the mere increase in organization size, which makes information about performance less reliable and more diffuse, requires the introduction of incentive systems that reward verifiable, codifiable performance (Holmström, 1989; Baker and Hall, 1998). Such incentive systems often fail to recognize and reward exceptional individual accomplishments, thus compromising innovation incentives—and perhaps explaining why young and small firms are thought to create a disproportionate share of important innovations (e.g., Scherer, 1984; Sørensen and Stuart, 2001). If some members of young and small technology companies gravitate to these organizations in the expectation of a tight link between individual effort, firm performance, and rewards, then liquidity events may disrupt the match between their career interests and their employment contexts.

Thus, IPOs may provoke adjustments in a number of core organizational features, including formal structure, the distrib-

ution of power, strategy, and incentive systems. Simultaneously, the high visibility of these transactions also enhances the opportunities available to members of the management teams that shepherd early-stage ventures to these transitions. Having led a new venture to a successful liquidity event sends a compelling signal of a manager's abilities in the uncertain world of technology-based entrepreneurship. Resource holders, including venture investors, feel more comfortable sponsoring individuals with a track record of success (Shane and Cable, 2002). Serial entrepreneurs returning to a startup after bringing a private venture to a successful IPO or acquisition understand the steps involved in developing a new venture for a liquidity event. In addition to gaining credibility, they also have established relationships with potential customers, suppliers, strategic partners, venture investors, and workers. Thus, the likelihood that an entrepreneur can attract the resources to build a company increases once he or she has previously led an organization to a liquidity event. As the resource mobilization capacity of a potential entrepreneur increases, so too does the incentive for this individual to make the transition.

Liquidity events thus cause the equity positions of senior technologists and managers to become liquid at the very time that the patterns of interaction, authority relations, and levels of autonomy in decision making within their organizations change dramatically and when a salient mark of prior success, leading a new venture to a liquidity event, boosts and propagates the reputations of senior staff members at affected organizations. These forces combine to push senior members of organizations transformed by liquidity events toward many different career destinations. One such destination may be the formation of a new venture, most likely in the same industrial domain as the predecessor company.

Our focus thus far has been on the potential internal organizational changes resulting from IPOs and how these alterations may disrupt the job match between executives and technologists and their employers. In addition, IPOs may influence the entrepreneurial aspirations of individuals external to the affected firm: they may stimulate organizational foundings because they signal the availability of resources for a particular type of company at a given time and place (Ritter, 1984). If a successful IPO triggers investors' enthusiasm for a company's sector, then one organization's public stock offering may open the equity markets to IPOs of other, related firms' securities. Moreover, initial public offerings provide salient signals of the viability of particular business models and organizational forms, thus contributing to the taken-for-granted status of a particular type of enterprise (Meyer and Rowan, 1977). Friends, acquaintances, and professional contacts of the entrepreneurs associated with an IPO may sense the implied opportunity with particular acuity. These individuals witness firsthand the wealth generated in a successful liquidity event and may themselves be well equipped to initiate a venture of the type experiencing an IPO. These considerations lead us to predict:

Hypothesis 1: IPOs of firms in technology-based industries increase the founding rate of similar organizations.

Potential Changes Associated with Acquisitions

When an established firm acquires an early-stage venture, changes similar to those resulting from an IPO may ensue. In a typical acquisition, for example, a larger organization subsumes a smaller one; thus, from the perspective of the acquired company, corporate combinations produce a substantial increase in firm size. Therefore, the structural differentiation of the organization swells following an acquisition (Blau and Schoenherr, 1971), resulting in changes to the incentive system and level of bureaucratization.

In addition to these size-related changes, scholars have noted the possibility that acquisitions jolt another core organizational feature, corporate culture (Cartwright and Cooper, 1992). Although the risk of cultural mismatch exists in all mergers, it is particularly salient when a sizeable, mature organization from a different industry acquires an early-stage technology firm. Stinchcombe's (1965) imprinting hypothesis posited that the time, place, and industry in which an organization is created shape many of the standard operating procedures, core values, and assumptions adopted by the newborn firm. Imprinting implies that organizations born in different eras and industries will conduct and structure themselves in fundamentally different ways. When an acquirer differs demographically from its takeover target, acquirer and acquired share few common features: they likely operate under different norms, values, customs, cultures, human resource and compensation policies, levels of hierarchy and centralization, and so on. In these situations, the acquirer's efforts to impose its structure, systems, culture, values, or routines on the acquired organization will almost certainly give rise to resistance. Therefore, mergers between dissimilar organizations can bring about conflict at the acquired organization. Such disruption leads to the turnover of senior-level personnel at the acquired company, with some of these individuals possibly choosing to start new companies.

Existing evidence supports the view that mergers induce turnover, particularly when the entities to be combined are dissimilar. Hambrick and Cannella (1993) found that post-acquisition executive turnover at acquired companies peaked when the acquirer and target operated at substantially different scales and when the two participated in different lines of business. More generally, Birch (1987) observed that mergers result in the exit of numerous employees from the affected entities (see also Haveman, 1995). Even when the merged enterprise retains the approximate size of the two combined entities, there is evidence of substantial turnover among senior-level personnel following acquisitions (Cartwright and Cooper, 1992). For example, in 1986, the 110-year-old pharmaceutical company Eli Lilly acquired a then seven-year-old, San Diego-based biotechnology firm, Hybritech. Shortly after the Lilly acquisition, the chief executive officer and chief financial officer of Hybritech left the newly combined firm. According to Mitton (1990: p. 347), "The culture of a large corporation descending on Hybritech did not suit their managerial style." These two individuals then established a venture capital firm, which in short order provided financing for a number of spin-off companies from the former Hybritech. All

told, Hybritech directly or indirectly spawned 13 biotech companies in the San Diego area after it was acquired by Eli Lilly (Mitton, 1990). Rather than being a unique occurrence, the response of Hybritech's senior staff to the Lilly acquisition is likely to be typical of large-company–small-company, interindustry acquisitions.

The Hybritech experience dovetails with the findings of two empirical studies reporting evidence that mergers routinely spur the departure of employees to launch spin-off companies. Brittain and Freeman (1986) found that recently acquired semiconductor producers spawned spin-off companies at a higher than expected rate; Klepper and Sleeper (2000) replicated this result, concluding that recently acquired firms in the laser industry parented more spin-off companies. These studies report specific instances of a general finding in the entrepreneurship literature: push factors, prominent among them a nascent entrepreneur's frustration with his or her current work context, often accelerate the transition to a founding event (e.g., Cooper, 1970). These arguments lead us to predict:

Hypothesis 2: Acquisitions of early-stage technology companies by demographically dissimilar firms increase the founding rate in the industry of the acquired entities.

The Moderating Role of Non-compete Covenants

Although liquidity may change individuals' proclivity to depart from their current employers to start new ventures, thereby connecting these organizational transformations to rates of new firm formation, the likelihood that individuals will leave to start new entrepreneurial enterprises may depend on a host of spatially and temporally variable institutional factors. One relevant external factor is the legal code regulating workers and organizations (Edelman, 1990).

Our focus on the link between changes at established firms and new venture creation brings to the foreground a particular aspect of the corporate legal environment: the enforceability of post-employment non-compete covenants. These agreements, typically signed when an employee joins a firm in a high-ranking technical or managerial position, specify a post-employment period of time during which the employee is restricted from enlisting with a rival employer. Similar provisions preclude former employees of an organization from soliciting that firm's customers and still-current employees in new business opportunities. In the U.S., state-level statutes and case law determine the extent to which employers may enforce post-employment non-compete covenants, and there is state-to-state variance in enforcement regimes. For instance, statute 16600 of the California legal code restricts employers' ability to enforce non-compete covenants to all but a narrow range of circumstances (Gilson, 1999; Wood, 2000). The prevalence of non-compete covenants in employment contracts remains unknown, but available data suggest that they may be nearly ubiquitous in employment contracts in high technology businesses. Kaplan and Strömberg (2000), for example, found that venture capital firms required 90 percent of the founders of the companies they financed to sign

non-compete agreements. In a broader survey, Leonard (2001) reported that 88 percent of companies with less than $50 million in sales require employees to sign non-compete covenants.

Post-employment non-compete covenants may deter prospective entrepreneurs from leaving their employers to establish competing firms (Richey and Malsberger, 1996). Even in cases in which nascent entrepreneurs' proposed ventures would not compete directly with their employer, individuals bound by these covenants may still find themselves under threat of legal action if their employer chooses to test the applicability of the covenant to deter other employees from leaving the firm to start new companies. Moreover, when in place, these covenants might discourage potential customers from patronizing the new firm or dissuade providers of venture capital from investing in the organization. Thus, non-compete agreements deter potential entrepreneurs from leaving their existing employers to found new ventures.

Enforceable non-compete and non-solicitation covenants also may indirectly hamper new venture creation by depressing the life chances of early-stage companies. Saxenian (1994), for instance, contended that the high rate of mobility between firms was a central contributing factor to the pro-entrepreneurship culture that has developed in Silicon Valley. These fluid labor market conditions ease the task of recruiting employees to new ventures for two reasons. First, high mobility among the firms in a region engenders extensive social networks, enabling would-be entrepreneurs to draw on their connections to recruit experienced individuals to their fledgling firms. Second, prospective recruits will more willingly enter an employment spell at a venture with uncertain survival prospects when they believe that they can easily find a new job should the new firm fail. In regions in which non-compete covenants can be enforced, however, these conditions may not exist. Therefore, Gilson (1999) argued that non-compete covenants operate to put "a sharp brake" on employee mobility.

Further extending this logic, Gilson (1999) hypothesized that the unique cultural features of Silicon Valley identified in Saxenian's (1994) landmark study of the region owe their origin to a critical institutional feature: the state of California does not enforce non-compete agreements in employment contracts. Saxenian (1994) compared the history and institutions of Silicon Valley with those of Boston's Route 128 in an effort to explain why Silicon Valley emerged as the major technopolis of the late twentieth century. She ascribed much of Silicon Valley's success and its ultimate ascendancy, even though initial conditions may have favored Route 128, to the region's unique culture. Because Massachusetts enforces non-compete covenants and California does not, however, Gilson (1999) posited that this institutional feature may account for the different evolutionary trajectories of the two regions. Although the influence of this institutional feature on the level of entrepreneurial activity remains untested beyond a few case studies (Wood, 2000), we hypothesize:

Hypothesis 3: The positive effects of IPOs and demographically dissimilar acquisitions on the rate of new firm formation will be attenuated in states that enforce non-compete covenants.

METHODS

To investigate how liquidity events affect new venture founding rates, we gathered data describing all liquidity and founding events in the U.S. biotechnology industry. This industry offers several attractive characteristics for our purposes: it is heavily populated with entrepreneurial firms, many of which have experienced IPOs, and many acquirers of young biotech firms have come from outside of the population. The mix of inter- and intra-population transactions permits us to consider how the demographic distance between acquirer and target—defined as a difference in the core industries of the merging firms—affects the post-liquidity event rate of entrepreneurial activity.

The arguments we have presented link liquidity events to the departure of senior employees to create new firms. One empirical strategy to examine this relationship would be to treat existing biotechnology establishments as being at risk of spawning spin-off companies, implying a model of the inter-arrival time between spin-offs at the firm level as a function of the occurrence of organizational transformations such as liquidity events. This empirical approach has been employed in several studies (Klepper and Sleeper, 2000; Phillips, 2002; see also Klepper, 2001, for a review of spin-off studies); Brittain and Freeman (1986), for example, estimated the hazard of spin-offs in the population of Silicon Valley microchip producers. We follow a different approach here: we examine how the rate of creation of new biotech firms in relatively small geographic areas (metropolitan statistical areas, or MSAs) varies with the recent occurrence of liquidity events in the industry.[1] Specifically, we estimate the arrival rate of new firms in MSAs as a function of geographically variable liquidity event concentrations, calculated by weighting liquidity events by the spatial proximity of firms experiencing these transformations to each MSA. Thus, the unit of analysis is an MSA-year.

A pragmatic consideration favored adopting this strategy over the alternative, conventional approach: although the residue of most company starts appears in various industry directories (i.e., the researcher can often obtain the name of a firm, its place of business, and its birth date), uncovering the career histories of company founders for most of the private firms in a population typically proves impossible, particularly in a nationwide, non-left-censored population. In the population of dedicated biotechnology firms (DBFs), for example, we cannot reliably trace the corporate lineage of a large fraction of the firms that have existed. As a result, treating established firms as being at risk of yielding spin-offs would result in a dataset with a sizeable number of missing events. Modeling founding events in small geographic regions as we do here does not suffer from this selection bias. Therefore, our analyses investigate location-specific founding rates in the population of DBFs. The validity of this approach, however, hinges on the appropriateness of two assumptions: (1) mem-

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The Office of Management and Budget (OMB) defines MSAs for the purpose of collecting and reporting federal statistics. In creating these units, the OMB seeks to delineate areas that include a large population nucleus, together with adjacent communities that have a high degree of social and economic integration with that core. In practice, the OMB demarcates MSA boundaries by analyzing commuting patterns around population centers.

bers of existing biotech companies actively participate in the creation of new biotech firms (we label this the intraindustry founders assumption), and (2) company founders typically create new organizations in close geographic proximity to their current places of residence (the local founders assumption).

To assess the accuracy of the intraindustry assumption in the biotechnology industry, we collected information on the previous employment spells of individuals who established biotech companies that ultimately filed papers to go public. We succeeded in identifying the backgrounds of founders of 357 companies; of this set, 161 individuals transitioned directly from employment spells at established biotechnology firms. A majority of the members of the senior leadership team of these companies also appear to have been recruited directly from positions at ongoing biotechnology firms. Moreover, the percentage of founders emanating from biotechnology firms increases over time. Consistent with published accounts of the evolution of the industry (Zucker, Darby, and Brewer, 1998), academic scientists launched many of the early entrants into the industry, but by the late 1980s, established firms had begun to contribute many new company founders. Thus, available evidence supports the intraindustry founders assumption.

Regarding the second assumption, that founders usually create new companies in close geographic proximity to their place of residence before the startup, a considerable body of theoretical work and published data also supports this conjecture. The sociology and entrepreneurship literatures provide an explanation for the local bias in new venture formation: entrepreneurs acquire sponsorship and mobilize resources through their established social contacts (e.g., Stinchcombe, 1965; Aldrich, 1999: chap. 4; Thornton, 1999). A variety of studies detail the importance of social networks in resource mobilization. For example, Shane and Stuart (2002) and Shane and Cable (2002) have demonstrated that entrepreneurs who have direct or indirect personal relations with venture capitalists enjoy much higher odds of securing venture capital investments than do otherwise comparable company founders.

The central role of social networks in attaining the resources to parlay an idea into an organization affects the geography of new venture formation. It is well documented that the density of individuals' social networks declines as the geographic expanse between an individual and the members of his or her contact network increases. This thinning of network ties likely arises from the relatively higher cost of maintaining strong relations with distant contacts and the frequency of "intervening opportunities" to develop associations with more proximate actors (Stouffer, 1940; see Kono et al., 1998, and Sorenson and Stuart, 2001, for evidence in organizational contexts). To the extent that the process of building the team and attracting the resources to begin an organization requires the activation of social and professional relationships, would-be entrepreneurs typically must rely on geographically proximate contacts (e.g., see Fernandez and Weinberg, 1997, for the role of networks in recruiting). Given the fundamental

role of social capital in the organization-building process, entrepreneurs likely have difficulty starting new firms outside of the areas that their dense social networks span, beyond the area in which they have recently lived and worked.

Findings reported in the entrepreneurship literature corroborate the local founders assumption. For example, the percentage of new technology companies started with the participation of at least one local founder who previously worked in the same geographical area as the company has been reported to be 98 percent in Palo Alto and 90 percent in Austin, Texas and England (Cooper, 1970; Watkins, 1973). In his study of the turn-of-the-century automobile industry, Klepper (2002) reported that 50 of the 54 spin-off companies located in the Detroit area emerged from parents also headquartered in Detroit.

In the biotechnology industry, two articles shed light on the geographic origins of founders in different regional clusters of firms. Both presented strong evidence that founders start companies in close proximity to their current locations and that the previous employment spells of the majority of founders take place in established organizations related to the life sciences. Haug (1995) surveyed founders of the biotechnology firms in the state of Washington, almost all of whom started their firms in close proximity to their residences at the time of founding. A second study reached a similar conclusion: Mitton (1990), who detailed the origins of 67 biotechnology firms created in the San Diego area between 1976 and 1989, found that only three arose from individuals moving to the region to launch a new company. Moreover, 56 of the remaining 64 firms emerged as spin-offs from local academic institutions, research institutes, or established biotechnology firms. Hence, existing data on the biotechnology industry strongly support both the local founders and intraindustry founders assumptions and thus justify an empirical analysis treating spatial units as being "at risk" of experiencing spin-off companies from nearby firms of like kind.

Data

We developed our database of biotechnology firms using a variety of sources. We retrieved information on venture-capital-financed DBFs from Thompson Financial's Venture Economics database. We used two other databases to augment the sample and identify all of the non-VC-backed companies in the population. First, we compiled information from Recombinant Capital's alliance and valuation history databases. Recombinant Capital also provided most of the data identifying acquisitions of DBFs. Second, we verified founding dates and firm locations and discovered additional firms at Informagen, a biotechnology industry directory. Several additional sources, including the Bioscan directories, the CorpTech directories, SEC filings, the Lexis/Nexis database, and Bioworld, allowed us to fill in missing data on founding dates and company locations. The Bioscan directories also yielded a small number of firms not listed in any of the other datasets. We acquired information on the timing of IPOs and market values from the CRSP database. Finally, we collected

the IPO prospectuses (S-1s or SB-2s) filed by all firms in the industry that attempted to go public.

The biotech industry did not experience its first wave of mergers until the middle 1980s, and although some firms had IPOs in 1983, the 1986–1987 period represented the first interval during which a large number of biotechnology firms underwent public stock offerings. As a result, we examined founding rates during the 1985–1996 period. The first year was used only to establish lagged variables, and we concluded the analysis at the end of 1996 because we lack systematic data on founding events after this year.

Estimation and Control Variables

To analyze the new venture founding process, we estimated the arrival rates of new biotechnology companies in MSAs. The general approach of analyzing event counts follows nearly all studies of founding rates in organizational sociology (Carroll and Hannan, 2000). Our analysis, however, differs from most other ecological studies in that it allows for spatial heterogeneity in founding rates within each period and does so at a very fine-grained level. Although several precedents exist for treating local geographic areas as the units at risk of experiencing foundings (e.g., Carroll and Wade, 1991; Lomi, 1995; Wade, Swaminathan, and Saxon, 1998; Sorenson and Audia, 2000; Barnett and Sorenson, 2002), our approach also differs from most studies of location-specific founding rates in that we calculate continuous measures of the distance between the geographic units at risk of founding events and the theoretically relevant independent variables (see also Stuart and Sorenson, 2003).

An event count, such as the number of organizational births in an MSA-year, tends to generate a skewed error distribution because zero forms the lower bound of the variable's range. In such situations, researchers generally assume that a Poisson process generates the observed data. We do the same but employ the conditional fixed-effects negative binomial estimator proposed by Hausman, Hall, and Griliches (1984). Whereas the standard negative binomial estimator assumes independence among the units experiencing events, our data contain multiple observations on each observational unit (MSAs). By conditioning the estimation on the total count of events in a particular region, the regressions account for the possibility that some unspecified factors may systematically affect founding rates within a location. In the reported regressions, we define fixed effects at the state level because several factors cited as important determinants of entrepreneurial activity, such as corporate tax rates, vary across these geopolitical boundaries. These state-level factors would otherwise result in spatially autocorrelated errors in the regressions.

There are 327 MSAs in the country. Because Hausman, Hall, and Griliches's (1984) conditional fixed effects negative binomial estimates the distribution of events in time conditional on the total number of events observed, it cannot be estimated for groups (in our case, states) that never experience an event. Hence, our results derive only from the 308 MSAs

that are located in states experiencing at least one biotech founding.

Independent Variables

To determine whether location-specific founding rates change in response to geographic proximity to (1) biotechnology companies that have recently experienced an IPO and (2) recently acquired biotechnology companies, we constructed annual, distance-weighted measures of the local density of these two events. We created the *IPO concentration* measure, which captures the local density of DBF IPOs, by weighting the contribution of each firm going public to each point in space according to the inverse distance between the focal point in space and the location of the firm experiencing the event. Summing these weighted contributions across all firms yields a distance-weighted measure of the proximity of each relevant point in space to all firms having an IPO event in a chosen interval of time. For each of the spatial units i in the dataset, the following equation describes the IPO concentration (IPO) at time t:

$$ IPO_{it} = \sum_j \frac{\ln(\text{market capitalization}_j)}{1 + d_{ij},} \tag{1} $$

where i indexes locations (MSAs), j indexes firms going public in time t, d_{ij} denotes the physical distance between location i and firm j, and (market capitalization)$_j$ denotes the constant (1995) dollar value of the equity of the jth firm (computed by multiplying the number of outstanding shares in firm j by its share price at the close of the first day that j traded on the public market).

Two considerations led us to weight the IPO concentration variable by the size of the transaction. First, large IPOs (and acquisitions) naturally afford significant financial resources to the senior management teams of the affected companies. Second, larger deals typically affect a greater number of individuals, assuming a positive correlation between deal and firm size, thus expanding the set of potential entrepreneurs who may consider changing employment status because of enhanced liquidity.[2]

We calculated the geographic distance between a firm and an MSA by assigning each firm to a specific point in space. After identifying the zip codes of all firms in the population, we assigned longitude and latitude coordinates for the center point of every zip code to each firm lying within that zip code. We also identified the center point of each MSA, which allowed us to compute the precise point-to-point distance between the MSA and firm-zip-code centroids. These distances equate to the geographic distance of the observational units in the regression to liquidity events. Over small distances, one could use Euclid's formula to compute the distance between two locations, but the curvature of the earth nontrivially affects these calculations over areas as large as the continental United States. Thus, we calculated

2
In unreported regressions, we found that the results were similar when we used geographic proximity to raw (size-*un*weighted) liquidity event counts, but a Bayesian Information Criterion (BIC) test (Raftery, 1995) favors the use of size-weighted event counts.

the distance between all pairs of points (A and B) using spherical geometry:

$$d_{A,B} = 687.56 \text{ arccos}[\sin(\text{lat}_A)\sin(\text{lat}_B) + \cos(\text{lat}_A)\cos(\text{lat}_B)\cos(|\text{long}_A - \text{long}_B|)], \quad (2)$$

where latitude (lat) and longitude (long) are measured in radians. The constant, 687.56, converts the distance into units of five miles.[3]

We computed the *acquisition concentration* variables similarly. These variables weight the value of the acquired firm's equity according to the inverse distance between the center of each MSA and the location of the acquired firm. The sum of these weighted contributions across all firms produces a geography-specific, size- and distance-weighted measure of the local concentration of acquisition activity. For each point i in space, the following equation describes the acquisition concentration at time t:

$$\text{Acquisition}_{it} = \sum_j \frac{\ln(\text{market value}_j)}{1 + d_{ij}}, \quad (3)$$

where i indexes MSAs, j indexes all firms acquired in time t, market value indicates the acquired firm's market capitalization in constant (1995) dollars based on the price paid by the acquirer, and d_{ij} denotes the physical distance between MSA i and firm j. We calculated this measure including all acquired firms. We also decomposed this quantity into two parts: intraindustry acquisition concentration (i.e., one biotech firm acquires another) and interindustry acquisition concentration (i.e., a biotech firm is acquired by a non-DBF enterprise).

We created annual lags for all of the local concentration variables for each of the three years prior to the current one. We used the lags to assess the temporal relation between spatially proximate liquidity events and changes in local founding rates. The primary reason to consider lags is that lockup periods and vesting provisions may delay the liquidity effects of liquidity events, and thus the timing of new venture creation. In IPOs, the underwriters of the stock placement almost always impose a temporary moratorium on the sale of company shares by employees of the firm, which is known as a lockup period. Lockups usually extend for six months from the date of the IPO (Bradley et al., 2001). A similar mechanism can delay the sale of shares of insiders following an acquisition: in stock transactions, acquirers often impose vesting structures that limit the ability of executives at the acquired company to sell their shares for a period of time. These provisos allow acquirers to retain senior personnel at acquired companies, at least temporarily. Lockup periods and vesting schedules may generate a lag between the time of a liquidity event and the exit of company personnel. It is thus important to allow for the possibility that liquidity events might have a delayed impact on founding rates.

[3]
The constant term we used implies that objects receive a weight of 0.5 when they reside five miles away from a focal point and so on, according to the concentration equation. One could also scale to miles or tens of miles or some other unit basis. In general, changing the units does not affect the results because doing so amounts to a linear rescaling of the local density term (Sorenson and Audia, 2000).

The other geographically variable characteristic of interest is whether the statutes and case law in a particular area support non-compete covenants in employment contracts. We created a weak-legal-regime dummy variable, defined at the state level to accord with jurisdiction over this component of employment law, that takes the value of one if state law precludes or severely limits an employer's ability to enforce non-compete covenants. Table 1 briefly summarizes the positions of all 50 states on the enforcement of non-compete covenants. Ten states, including California, have enacted regulations that prevent employers from enforcing non-compete clauses (see Richey and Malsberger, 1996, for a detailed comparison). As stated in hypothesis 3, we anticipate that spatially proximate liquidity events will have a stronger effect on the founding rate in an MSA if the MSA falls within one of the ten weak-legal-regime states.

Several control variables helped us partial out the effects of other factors that might influence founding rates. First, we included dummy variables for each calendar year. Although the state fixed effects control for factors that remain relatively stable within locations, many time-varying factors may influence the results. For example, scientific advances such as genomics, combinatorial chemistry, and proteomics create

Table 1

Summary of States' Enforcement of Non-compete Covenants*

State	Statute	Standard	State	Statute	Standard
Alabama	§8-1-1	Reasonable	Montana	§28-2-703	Precludes
Alaska	None	Generally precludes	Nebraska	None	
Arizona	None		Nevada	§613.200	Precludes
Arkansas	None		New Hampshire	None	
California	§§16600–16602	Precludes	New Jersey	None	
Colorado	§8-2-113	Limited time	New Mexico	None	
Connecticut	None	Generally precludes	New York	None	
Delaware	None		North Carolina	§75-4	Reasonable
Florida	§542-33	Limited time	North Dakota	§9-08-06	Precludes
Georgia	§13-8-2.1	Limited time	Ohio	§1331.02	Reasonable
Hawaii	§480-4	Limited time & area	Oklahoma	§217	Precludes
Idaho	None		Oregon	§653.295	Limited time
Illinois	None		Pennsylvania	None	
Indiana	None		Rhode Island	None	
Iowa	None		South Carolina	None	
Kansas	None		South Dakota	§53-9-11	Limited time & area
Kentucky	None		Tennessee	§47-25-101	Limited time
Louisiana	§23:921	Limited time & area	Texas	§15.50–15.51	Reasonable
Maine	None		Utah	None	
Maryland	None		Vermont	None	
Massachusetts	None		Virginia	None	
Michigan	§445.774a	Generally precludes	Washington	None	Generally precludes
Minnesota	None	Generally precludes	West Virginia	§47-18-3(a)	Precludes
Mississippi	None		Wisconsin	§103.465	Limited time
Missouri	None		Wyoming	None	

* The table reports the statute number for all states that have a specific law restricting or regulating the enforcement of non-compete covenants. Some states without statutes still limit the scope of enforcement through case law. "Standard" is the degree to which a state restricts non-compete covenants. An empty cell indicates no restrictions. "Reasonable" denotes that the state courts require the terms of the non-compete agreement to be reasonable, which typically reflects an ambiguous and permissive regime. "Limited time" means that the courts will only uphold contracts with a finite duration, 2–5 years in most states. "Limited area" denotes that non-compete covenants must apply to a restricted geographic area to be enforceable. "Generally precludes" means that courts will only enforce non-compete covenants under very specific circumstances, often in cases of the sale of professional practices (e.g., a dental practice). "Precludes" indicates that state law precludes the enforcement of all non-compete agreements. (Source: Richey and Malsberger, 1996)

opportunities for new companies, and temporally variable macroeconomic conditions affect everything from the cost of capital to the availability of venture capital. Studies in entrepreneurial finance do in fact show significant year-to-year variation in the supply of venture capital available to biotech companies (Lerner, 1994). To purge the effects of these time-varying factors, we report within-year estimates of the founding rate.

We also controlled for attributes of MSAs singled out by others as being particularly significant determinants of the level of technology-based entrepreneurship. These include the human population; the number of biotechnology firms (denoted as local firm density), the number of research universities with biotechnology programs, and the number of venture capital firms in the MSA. Clearly, we would expect to observe more founding events in areas that already have a large number of firms; theoretical claims aside, this covariate should capture occurrence-dependence processes net of the time stationary, state-specific fixed effects. Research on entrepreneurship in high-tech industries suggests that the local presence of venture capital firms (Bygrave and Timmons, 1992; Sorenson and Stuart, 2001) and research universities (Florida and Kenney, 1988; Zucker, Darby, and Brewer, 1998) may stimulate entrepreneurial activity by providing resources in the form of financing and skilled labor. Moreover, scholars generally have found that these types of resources exhibit spatial localization. Hence, all models include time-changing counts of the number of both types of organizations in a region. To avoid problems with endogeneity, we lagged these control variables by the same number of periods (one year, two years, or three years) as the other independent variables.

RESULTS

Table 2 provides the means, ranges, and standard deviations for all covariates, with values of the local density of liquidity events variables broken out by the state-level indicator of the enforceability of non-compete covenants.

Table 2

Descriptives for Variables in MSA-level Biotech Firm Founding Regressions

Variable	Mean	S. D.	Min.	Max.
Dependent (No. of BT foundings in MSA-year)	0.42	1.67	0.00	19.00
No. of BT firms in MSA	5.31	17.43	0.00	157.00
Non-compete (NC) regime (0 = strong, 1 = weak)	0.18	0.38	0.00	1.00
Local density, BT IPOs (logged 1995 dollars)	6.97	10.98	0.00	20.48
Strong NC regime (if NC = 0)	6.55	10.36	0.00	20.48
Weak NC regime (if NC = 1)	8.98	13.29	0.00	20.30
Local density, acquired BT firms (logged 1995 dollars)	0.43	5.37	0.00	21.47
Local density, BT firms acquired by other BT firms (logged 1995 dollars)	0.26	2.76	0.00	20.44
Strong NC regime (if NC = 0)	0.14	1.88	0.00	19.39
Weak NC regime (if NC = 1)	0.72	6.28	0.00	20.44
Local density of BT firms acquired by non-BT firms (logged 1995 dollars)	0.16	2.86	0.00	21.47
Strong NC regime (if NC = 0)	0.02	0.57	0.00	20.95
Weak NC regime (if NC = 1)	0.72	12.02	0.00	21.47
Local density biotech departments in universities	0.42	0.91	0.00	6.00
Local density of venture capital firms / 100	0.05	0.16	0.00	1.51

Table 3

Comparison of Key Metrics of the Average Pharmaceutical Acquirer and the Average Publicly Traded Biotechnology Firm

Metric	Pharmaceutical			Dedicated biotech		
	Mean	25th percentile	75th percentile	Mean	25th percentile	75th percentile
Market cap	$7,091M	$1,257M	$9,145M	$570.9M	$80.3M	$333.7M
Sales	$6,350M	$414.7M	$4,979M	$15.1M	$2.3M	$64.6M
Assets/sales	1.58	0.93	2.33	11.70	1.70	12.44
Employees	13,326	1,600	24,900	556	72	529
Sales/employees	$237,732	$132,653	$253,950	$101,529	$32,175	$139,002
R&D/employees	$19,298	$12,157	$28,987	$134,099	$27,474	$152,786

We have argued that many disruptive intraorganizational changes typically follow IPOs and interindustry acquisitions. Although we cannot directly observe the internal changes that follow liquidity events, we can glean enough information to gain a rudimentary understanding of how biotech firms change after liquidity events. Regarding takeovers of biotech firms by non-biotech acquirers, table 3 separately presents means and inter-quartile ranges for several financial statement variables for the non-biotech acquirers in our dataset and a random sample of publicly traded biotech firms. The table reveals vast differences in size between the two types of firms: the typical outside-industry acquirer has a market capitalization more than an order of magnitude greater than the average public biotech firm, sales revenue more than 400 times greater, and a headcount more than 25 times greater. Consistent with our claims about differences in the day-to-day work environments at the two types of organizations, the typical biotech firm focuses far more narrowly on research: per employee, biotechnology firms spend approximately seven times more on R&D than do non-biotech acquirers. This statistic reflects the nearly singular focus on technology development at many early-stage biotech firms, compared with the relatively greater commercialization emphasis and more bureaucratic organization structures at most established pharmaceutical and life sciences firms. Although spending patterns offer only indirect evidence of actual work environments, the sharp differences in size and resource allocation patterns does at least suggest fundamental differences between the two types of firms.[4]

The metrics reported in table 4 address the claim that the nature of the firm typically changes following an IPO. The table reports basic descriptors, for the year of the IPO and the two following fiscal years, for all firms in our dataset that went public. The numbers reveal several changes. First, possibly reflecting a shift in emphasis from basic research toward commercialization, the revenues of the typical firm nearly triple in the two years following an IPO. Second, a significant increase in bureaucracy appears to accompany the transition to public company status, as overhead (SG&A) increases by roughly 40 percent. Finally, the headcount of the typical firm nearly doubles in the two post-IPO years.

4
Table 3 actually understates the scale differences between the biotech takeover targets in our dataset and non-biotech acquirers because many of the biotech firms that are acquired are actually privately held, but the numbers reported in table 3 are based on averages of publicly traded firms (because accounting data are unavailable for private firms), and publicly held firms are on average larger than private firms.

Table 4

Pre- and post-IPO Characteristics of Dedicated Biotech Firms (Means)

	Time of IPO	1 year later	2 years later
Sales	$3,376,000	$5,903,000	$8,320,000
Employees	63	102	128
Overhead (SG&A)	$6,319,000	$8,436,000	$8,377,000

Table 5 reports the founding rate estimates. Unless otherwise noted, we enter the covariates as one-year lags. Model 1 excludes the state-specific effects so that we can produce a meaningful estimate of the relationship between the state-level weak-enforcement-regime dummy variable and the founding rate. Without fixed effects, MSAs in states that do not allow employers to enforce non-compete covenants (weak regimes) appear to experience much higher rates of foundings than do those in states that enforce non-compete covenants. The coefficient on the weak-legal-regime dummy indicates a large differential: states with weak non-compete regimes realize 217 percent higher founding rates than those that enforce non-compete covenants. Furthermore, this

Table 5

Negative Binomial Estimates of the Biotechnology Firm Founding Rate in MSA-years*

Variable	(1)	(2)	(3)	(4)
Number of BT firms in MSA	0.029** (10.79)	0.006** (4.50)	0.011** (7.31)	0.013** (7.99)
Non-compete (NC) regime (1 = weak)	0.778** (8.21)			
Local density of BT IPOs		0.006** (3.75)	0.008** (5.02)	
Local density of BT IPOs (strong NC regime)				0.002 (1.02)
Local density of BT IPOs (weak NC regime)				0.013** (4.47)
Local density of acquired BT firms		0.002 (1.10)		
Local density of BT firms acquired by other BT firms			−0.035** (5.69)	
Local density of BT firms acquired by other BT firms (strong NC regime)				−0.057** (5.62)
Local density of BT firms acquired by other BT firms (weak NC regime)				−0.021 (1.90)
Local density of BT firms acquired by non-BT firms			0.033** (6.74)	
Local density of BT firms acquired by non-BT firms (strong NC regime)				0.012 (1.10)
Local density of BT firms acquired by non-BT firms (weak NC regime)				0.021** (2.57)
MSA population (logged)	0.810** (17.21)	0.594** (11.71)	0.602** (11.85)	0.606** (11.84)
Number of universities with biotech programs in MSA	0.296** (6.32)	0.345** (6.30)	0.342** (6.25)	0.353** (6.40)
Number of venture capital firms in MSA	0.040 (0.09)	0.892** (5.50)	0.783** (4.78)	0.598** (3.58)
Year dummies	Yes	Yes	Yes	Yes
Conditioned on state foundings	No	Yes	Yes	Yes
Constant	−13.16** (21.01)	−9.525** (13.95)	−9.598** (14.00)	−9.645** (14.00)
Observations	5768	5768	5768	5768
Log-likelihood	−2520.8	−2246.5	−2226.0	−2212.9

* $p < .05$; ** $p < .01$.
* The absolute value of z-statistics is in parentheses.

result does not merely capture a California effect: in an unreported regression that excludes all MSAs in the state of California, we still found nearly a twofold increase in the baseline rate for states with weak non-compete regimes. Without the fixed effects, however, we must interpret this result cautiously, as a number of omitted regional factors might correlate with both the weak non-compete enforcement dummy and the level of entrepreneurial activity in the region.

Model 2 introduces the state-level fixed effects and the local density of IPOs and acquisitions. In support of hypothesis 1, the results show that geographic areas spatially proximate to biotech establishments that had recent IPOs experience higher rates of company starts: the local IPO concentration covariate has a strong, positive effect on the hazard of new venture creation. When we do not distinguish between within- and across-industry acquisitions, geographic proximity to acquired companies has no effect on the MSA-level founding rate.

Model 3 presents the results when we permit the two types of acquisitions to have an independent influence on the rate. The findings in this regression suggest that the null result in model 2 belies opposing effects of proximity to intra- and inter-population acquisitions. In support of hypothesis 2, the rate of new firm creation within a region accelerates when non-biotech entities acquire nearby biotech firms. The model 3 results thus support the postulate that the rate of departure of senior executives to form spin-off companies rises when a demographically distant (i.e., non-biotech) acquirer purchases a biotechnology firm.

We had not expected to find that MSAs near to recent intra-population (biotech-biotech) acquisitions experience lower founding rates. Because the conditions we have theorized to promote spin-offs often do not occur in intra-population mergers—the acquirers in many of these transactions have not yet gone public (implying that the target's equity remains illiquid after the transaction), and many of the internal organizational changes expected to surface in cross-industry transactions and IPOs may not occur in these deals—we had anticipated a null effect of biotech-biotech deals on the founding rate.[5] One possible explanation for why proximity to intra-population acquisitions decelerates the founding rate is that intraindustry acquisitions may occur disproportionately among relatively unsuccessful firms (i.e., poor, not superior, performance drives within-industry transactions). If intra-population acquisitions reflect the poor life chances of the acquired entities, and if firms of like kind co-locate spatially, then the local concentration of biotech-biotech acquisitions may be a proxy for interregional differences in the viability of firms with particular specializations.

Model 4 introduces the interaction terms between the local density of liquidity events covariates and a dummy variable indicating whether the focal MSA resides in a state with weak enforcement of non-compete covenants. Including these interaction effects allows the parameter estimates for the variables representing geographic proximity to liquidity events to depend on interstate differences in legal regimes.[6]

5
It is little surprise that the financing of takeovers also differs by acquirer type: 83 percent of the biotech-biotech acquisitions involve stock swaps, but only 27 percent of the non-biotech acquirers finance the purchase exclusively with stock. The other 73 percent involve at least some amount of cash. For this reason too, the liquidity effects in interindustry transactions may be considerably greater.

6
Because the weak-legal-regime dummy does not vary within a state over time, it does not make sense to estimate the main effect of this variable in the fixed-effects models. Although one can produce a coefficient on covariates that do not change within units when using the conditional maximum likelihood estimator, the parameter would simply reflect the mean value of the covariate across the population, rather than providing information on the relationship between it and the dependent variable. The results of models reporting interaction effects with the dummy variable for weak enforcement regime do not change in regressions that include the main effect.

The results demonstrate that the consequences of liquidity events for founding rates do, in fact, differ significantly depending on whether they occur within or near states with weak non-compete enforcement regimes. Geographically proximate IPOs have a statistically significant, positive effect on the local founding rate, but only in states that restrict the enforcement of non-compete covenants. The occurrence of spatially proximate IPOs has no impact on the biotech founding rate in MSAs located within strong non-compete states. The coefficient magnitudes imply that the median IPO ($61 million valuation) occurring in an MSA in a weak enforcement state increases the founding rate in the MSA by 26 percent. Similarly, acquisitions of biotech firms by companies outside the biotech industry have a statistically significant, positive effect on the local founding rate, but again only in MSAs in weak enforcement states. The median acquisition of a biotech firm ($262 million valuation) in an MSA by a non-biotech enterprise generates a 50-percent increase in the founding rate, assuming the transaction occurred in a weak enforcement state. Thus, the findings suggest that the liquidity infusions resulting from IPOs and cross-industry acquisitions stimulate entrepreneurial activity, but only in states that preclude employers from restricting employee mobility between firms. Acquisitions by other DBFs uniformly depress local founding rates.

Table 6 presents the results of models investigating the lag structure of the effects of geographically proximate liquidity events on the local founding rate. Model 5 includes one-, two-, and three-year lags for each of the local concentration variables, with the reported effects broken out according to the dichotomous indicator of the strength of non-compete enforcement. To reduce potential endogeneity issues, we have included the counts of the number of local biotech firms, VC firms, and universities as three-year lags. From the results, it appears that the catalytic effect of IPOs on the founding rate in weak enforcement states attenuates after one year has elapsed since the time of the transaction. The findings also appear to show that the positive effect on the local founding rates induced by cross-industry acquisitions reaches a peak three years after an acquisition. But chi-squared tests revealed that the coefficients on the lags do not differ significantly for any of the local concentration variables: there are no statistical differences in coefficients on the one-, two-, and three-year lags of local densities of interindustry acquisitions in weak enforcement states or between the coefficients on the three lags of the local density of IPOs in weak enforcement states.

The control variables have consistent effects and the expected signs. The local human population, number of biotech firms, number of universities with biotechnology programs, and count of venture capital firms all accelerate the founding rate. These findings correspond with the premise that existing biotech firms and universities provide training grounds both for potential founders and for the employees to staff new biotech ventures. They also suggest that, at least to some extent, professional labor markets still operate at a local level. Similarly, the strong effect of the number of ven-

Table 6

Investigating Lags: Fixed Effects Negative Binomial Estimates of the Biotechnology Firm Founding Rate in MSA-years*

	(5)	
	Coefficient	z-score
Number of BT firms in MSA (3-year lag)	0.011**	5.48
Local density of BT IPOs (strong NC regime)		
1 year lag	0.003	1.74
2 year lag	0.003	1.69
3 year lag	−0.002	−1.20
Local density of BT IPOs (weak NC regime)		
1 year lag	0.012**	2.71
2 year lag	0.005	1.06
3 year lag	0.009*	2.25
Local density of acquisitions by BT firms (strong NC)		
1 year lag	−0.035**	3.88
2 year lag	−0.020*	2.56
3 year lag	−0.028**	3.36
Local density of acquisitions by BT firms (weak NC)		
1 year lag	−0.016	1.24
2 year lag	−0.004	0.31
3 year lag	−0.022	1.63
Local density of acquisitions by non-biotech firms (strong NC regime)		
1 year lag	0.003	0.19
2 year lag	0.002	0.15
3 year lag	−0.018	−1.10
Local density of acquisitions by non-biotech firms (weak NC regime)		
1 year lag	0.019	1.76
2 year lag	0.005**	3.24
3 year lag	0.023*	2.13
Number of universities with biotech programs in MSA	0.992**	25.50
Number of venture capital firms in MSA	0.001	0.41
Year dummies	Yes	Yes
Conditioned on state foundings	Yes	Yes
Constant	−3.108**	24.53
Observations		5055
Log-likelihood		−2126.1

• $p < .05$; •• $p < .01$.
* The absolute value of z-statistics is in parentheses. All models include unreported year dummies.

ture capital firms in a region concurs with the generally held belief that VCs are more likely to invest in new companies that lie in close spatial proximity to their offices.

DISCUSSION

The findings of this study broadly support the contention that liquidity events experienced by established organizations affect the founding rates of new business enterprises. By enabling the liquidation of equity holdings, these events provide the financial resources and credibility that together enable employees to pursue latent entrepreneurial initiatives. Meanwhile, these proceedings invariably modify the routines, rules, and culture of participating firms, often disrupting the match between senior employees' habits and preferences and the practices and milieu of the post-liquidity-event firm. Moreover, successful liquidity events project vivid signals of the viability and wealth-generating potential of a type of business in a given place. Witnessing liquidity events may induce nascent entrepreneurs, particularly those in close proximity to the principals of the affected firms, to begin the resource

mobilization process to form a new venture. Consistent with these suppositions, our analyses indicate that both IPOs and cross-industry acquisitions of biotech firms stimulate new firm formation in the (geographic) neighborhoods contiguous to the organizations experiencing these events.

The paper offers at least four contributions to the literatures on entrepreneurship and organizational demography. Two of these contributions are empirical. First, we report systematic evidence relating IPOs to new venture formation rates in spatially proximate geographic regions. Although this finding may be unsurprising to many, we are unaware of any existing study that has presented industrywide evidence of the link between IPOs and new venture creation. Second, the paper is the first to exploit archival data to test the hypothesis that state-level employment laws significantly influence the geography of entrepreneurial activity. We found strong evidence that interstate variance in the enforceability of non-compete covenants in employment contracts underlies differences in the dynamics of organizational foundings. Notably, urban areas in states that refuse to enforce non-compete covenants appear to experience higher rates of new venture formation in the biotechnology sector than do states that side with employers in the enforcement of these contractual provisos. Our results also show that enforcing non-compete covenants attenuates the link between liquidity events and new venture formation: the positive effect of liquidity events on the local founding rate emerges only in states that do not impede interfirm employee mobility by upholding contractual restrictions on the freedom of individuals to join competitors of their current employers.

The third contribution is the paper's explication of one micro-level process contributing to a macro-level (population) outcome or, conversely, the extension of ecological analysis to the study of intra-population events. Early work in organizational ecology examined basic characteristics of a population, most notably density. Since then, researchers have extended the paradigm to consider the ecological consequences of the distribution of a variety of organizational characteristics, such as the moments of the population age distribution (Barnett and Hansen, 1996; Barnett and Sorenson, 2002). Our work demonstrates not only the potency of the ecological perspective for examining the consequences of events experienced by the members of a population (see also Haveman and Cohen, 1994) but also that intra-population events can alter population-level parameters. In addition to influencing the evolution of the organizations experiencing them, events such as IPOs and acquisitions exert ripple effects manifesting in the rate of new firm founding. As we describe below, these events may also alter other quantities sometimes examined by organizational demographers, such as patterns of interorganizational competition.

The fourth contribution of the paper is its methodological approach, which we believe may be generally employed to study the repercussions of a wide array of events. The assumption that some of the major ecological consequences of intraorganizational transformations will unfold in locations spatially proximate to the affected entities makes it feasible

to examine the corollaries of events such as downsizings, divestitures, CEO turnover, and restructurings on population-level parameters. The method for measuring local event concentration enables examinations of the effects of a wide range of organizational events that might be thought to have spatially variable consequences for established and potential organizations. There is at least one major benefit of adopting this approach: one can study the social structural underpinnings of the organizational origination process without the typically insurmountable data requirement of information on the career histories and circumstances of company founders.

In addition, the results with our measure of distance suggest that researchers should consider the distance metric that most strongly influences their outcomes of interest. In our paper, the measure used to gauge the expanses between liquidity events and geographic areas was distance "as the crow flies." But many other potential metrics exist for specifying the proximity of two geographic regions. For example, suppose one wished to investigate patterns of geographic diffusion of fashion-based industries or businesses, such as gourmet coffee chains. If this were the analyst's objective, spatial propinquity as a measure of similarity may have less explanatory power than other measures of proximity, such as the similarities between two regions in their population sizes, industrial bases, income distributions, or other attributes. Thus, one could create a very general class of measures of "distance"-weighted proximities of spatial units but replace geographic distance weights with others derived from inter-regional structural equivalencies along any number of theoretically interesting dimensions.

Our arguments and results suggest several directions for future research. One of the most promising is to explore the link between spin-offs and the geography of interfirm knowledge spillovers. To the extent that spin-offs, including those sanctioned by the parent firm and those resulting from unwanted employee defections, represent a common new venture gestation process in technology-based populations, then the social connections between parent and progeny may explain why we observe geographically localized spillovers. The fact that the spin-off process appears to be spatially circumscribed, coupled with the high probability that founders of spin-off organizations endow their fledging firms with some of the knowledge base and organizing routines of the enterprises from which they emerged (Klepper, 2001; Phillips, 2002), leads us to postulate that spin-offs may account for a substantial amount of the transmission of knowledge spillovers between geographically proximate firms. This may explain the paradox that geographically localized spillovers still exist in an age of almost costless, geographically unbounded communication. It also may explain why researchers have found that small firms more extensively utilize the innovative outputs of spatially contiguous firms than their larger counterparts (Almeida and Kogut, 1997).

If the spin-offs-spillovers hypothesis is correct, in might entail a number of demographic implications. We highlight two here. First, the spawning of new organizations in this manner would yield a high correlation between geographic proximity

and organization-specific niche overlaps (McPherson, 1983). This follows directly from the high level of transfer of knowledge and routines sure to occur in spin-off-based new venture formation that has been documented to take place even when executives migrate across the boundaries of established firms (e.g., Boeker, 1997). Second, drawing out the implications of our findings on the strength of state-level enforcement of non-compete covenants, an obvious implication is that the geographic localization of spillovers will vary across states according to the state-level legal regime. Such an easily testable prediction seems consistent with a number of perspectives on regional variations in the incidence of geographic spillovers (Almeida and Kogut, 1997).

In conclusion, it is generally known that liquidity events have a first-order effect on wealth creation, and thus regional economic health. Our analysis establishes that liquidity events also have second-order effects: in addition to generating wealth, they indirectly and often positively influence the level of entrepreneurial activity in organizational populations, as well as the spatial distribution of company formation. Because of this, liquidity events merit more attention from scholars interested in the very broad question of how constraint and opportunity combine to determine the incidence and the place of the creation of new organizations.

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