Regional Industrial Identity and Spatial Arrangements in the U.S. Biotherapeutics Industry, 1976-2004*

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Abstract

We explore the influence of regional industrial identity on the decisions of entrepreneurs, diversifying firms and capital investors about where to locate their organizations and investments. Regional industrial identity is defined as a set of shared understandings by audiences that classify a region as a suitable place for a particular industry. Assuming uncertainty about the location of superior resources and bounded rationality on the part of economic actors, we argue that regional industrial identity is a salient and differentiating signal of the suitability of regions for particular kinds of businesses and thus affects the movement and concentration of industry resources. Empirical analyses of the location and relocation of U.S. biotherapeutics firms and venture capital investments over the period, 1976 through 2004, confirm that regional industrial identity significantly increases (1) the number of venture capitalists who invest in a region, and (2) the entry rates of firms in the region that are started by entrepreneurs who migrated from other regions. This research contributes to our understanding of the spatial evolution of industries especially in situations where multiple regions compete, implicitly or explicitly, to become hosts for particular industry clusters.

Introduction

Interest in industry clusters, which we define as groups of similar organizations operating in a relatively small geographic space, has grown in recent years because of beliefs about their abilities to deliver significant economic benefits to the firms that are located in the clusters (Krugman 1991; Jaffee, Trajtenberg & Henderson 1993; Baum & Haveman 1997) as well as to the metropolitan regions in which they reside (Sorenson & Audia 2000). Accordingly, researchers have been interested in why clusters locate in particular regions. Historical studies of cluster development (e.g., Saxenian 1994; Murtha, Lenway & Hart 2001; Chiles, Meyer & Hench 2001) as well as formal analyses of factors such as the location of prior related industries (Porter 1998), concentrations of relevant scientific resources (Zucker, Darby & Brewer 1998), and characteristics of social networks that provide access to information and resources (Saxenian 1994; Stuart & Sorenson 2003a; Sorenson 2003ab) emphasize the importance of pre-existing resources that advantage some regions over others for the likely rise of a particular industry cluster.

Little research, however, has considered the processes by which industries may concentrate (or disperse) over multiple regions at risk of developing a particular cluster. Recent analyses of early geographic arrangements in the semiconductor (Saxenian 1994), automobile (Klepper 2002; 2004), and disk array (McKendrick, Jaffee, Carroll & Khessina 2003) industries have revealed substantial early geographic dispersion in the U.S., though automobiles and semiconductors eventually concentrated into tight clusters in single regions (Silicon Valley and Detroit).

Two explanations can account for regional industry concentration. First, clusters may emerge as a consequence of differences in historically embedded regional resources and social networks (Krugman 1991; Stuart & Sorenson 2003a). According to this view, the location of new industry clusters is more or less determined by historical patterns in regional investment, which are not easy to change in the short term (Porter 1998). Many regions, however, especially at the outset of a new industry, may possess significant important resources (Scott 1992; 2005). It is unlikely that actors such as entrepreneurs and capital investors, being boundedly rational (Simon 1947), have an accurate understanding about the

nature of best resources for organizing or, therefore, their location. Thus, while embedded resources likely constrain the set of regions that are likely to become home to a particular cluster, they cannot explain particular locations. Case histories of cluster development (e.g., Saxenian 1994; Chiles, Meyer & Hench 2004), while they offer rich insights into the processes of cluster formation, nonetheless sample on the dependent variable and cannot therefore specify critical differences in pre-cluster resources or cluster formation processes.

Second, industries may concentrate geographically as a result of entrepreneurs and capital investors coming to believe that one or a few regions offer greater advantages and locating their investments accordingly. Arthur (1990) argued that, given early uncertainty about the nature of best resources for organizing and, thus, their location, even small early leads in cluster growth could signal advantages that might or might not be present, and thus induce the movement of firms into a region. This argument, however, assumes that potential entrepreneurs and other investors are actively and accurately monitoring the number and growth of industry clusters across multiple regions. In the presence of uncertainty, such signals may be both hard to discern and easy to dismiss.

Thus, research is needed to explore factors that affect both the differences in regional characteristics at the outset of a new industry as well as the rates and directions of movement of resources and firms over geographic regions. Building on recent ecological arguments regarding the identities of organizational forms (Zuckerman 1999; Polos, Carroll & Hannan 2002; McKendrick et al 2003), we offer a new explanation for factors that drive differences in the growth of clusters, especially among regions with similar pre-cluster resources. We argue that regions possess industrial identities, defined as a social code, representing shared understandings by residents and external observers that classify the region as a suitable place for a given industrial activity (Romanelli & Khessina 2005). Classification influences both the types and amounts of resources and firms that flow into a region. Regions that have strong industrial identities—for example, motion pictures in Los Angeles, biotechnology in San Diego, financial services in New York City—will attract more firms and investors to the identified industry.

We examine the geographic origins and destinations of entrepreneurs and diversifying firms, as well as the locations of venture capital investments, in the U.S. biotherapeutics industry from its beginnings in 1976 through 2004. We develop hypotheses regarding the effects of regional industrial identity on two forms of investment in regional biotherapeutics in the U.S.: (1) the number of venture capitalists and the amount of capital invested in regional biotherapeutics firms, and (2) the entry rates of biotherapeutics firms into U.S. metropolitan regions. We predict that the location and movement of resources and firms is influenced by regional industrial identities (Romanelli & Khessina 2005). Controlling for several important regional resources, our findings reveal that the number of venture capital investments is significantly and positively influenced by the strength of regional industrial identities for biotherapeutics. While local organizational entries are not significantly influenced by regional industrial identities, non-local entries, especially by *de novo* firms, do respond strongly to regional industrial identities. Thus, regional industrial identity is an important factor in the spatial concentration of industry resources.

BACKGROUND

Organizational scholars have explored the concept of identity as a potent characterization of organizations (Albert & Whetten 1980; Dutton, Dukerich & Harquail 1994) and organizational forms (Pòlos, Hannan & Carroll 2002; Hannan, Pòlos & Carroll 2004) that significantly influences the commitments of employees to an organization as well as the ability of members of an organizational form to attract resources and maintain the boundaries of the form (Zuckerman 1999; Carroll & Swaminathan 2000; McKendrick & Carroll 2001; McKendrick et al 2003; Rao, Monin & Durand 2003; Dobrev, Ozdemir & Teo 2005). According to these arguments, identity obtains not only from the personal identifications of individuals, which affect their perceptions of membership in groups, organizations, or other social entities (Cerulo 1997), but also from the common understandings of audiences, especially external audiences, about key features of the social entities (Hannan et al 2004; Hsu & Hannan 2005).

External audiences are especially important in this construction, because they control access to symbolic and material resources and, through this control, significantly influence the characteristics of

organizations and organizational forms that will be deemed salient. As external audiences interact with members of a group or an organization, they develop common understandings about the key features of the social entity through direct sharing of information or common exposure to organizational exemplars exhibiting particular features. Over time, as common understandings become widely held and institutionalized (Hannan et al 2004), external audiences command conformance with the features as a condition of continued interaction and investment (Hannan & Freeman 1984; Zuckerman 1999). Organizations that violate their identity in significant ways are penalized by the withdrawal of resources. For example, Zuckerman (1999) showed that firms exhibiting features that were outside of categories understood by security analysts were not covered in the analysts' reports and, as a result, were traded at a discount rate on the stock market. McKendrick et al (2003) found that in the disk array industry, the vast proliferation of diversified producers that did not fit well into the category of the disk array organizational form halted legitimation of the whole industry. Thus, Pólos et al (2002) theorized identity as a social code that both parsimoniously describes and effectively proscribes the key features of an organization or organizational form. Social codes simultaneously provide a theoretical basis for characterizing both the rich and diverse features of organizations and organizational forms and for classifying them as members (or not) of a socially constructed cognitive category.

We draw on the identity theory, especially as advanced by organizational ecologists, to develop the concept of regional industrial identity and its effects on cross-regional flow of resources and firms. We argue that metropolitan regions, like organizations and organizational forms, develop industrial identities that are salient in the investment decisions of audiences. Thus, identity holds promise for initiating research into the relative potentials of regions to attract and retain important industrial resources. Below, we develop the concept of regional industrial identity and a set of hypotheses about the effects of identity on flow of resources and firms into regions.

THEORY AND HYPOTHESES

The Concept of Regional Industrial Identity

Metropolitan regions, like other social entities, develop identities that influence the actions of observers. In particular, metropolitan regions develop industrial identities based on common understandings about the types of businesses that are likely to thrive in a region (Romanelli & Khessina 2005). For example, Los Angeles, California is widely understood as the home of motion picture production, Hartford, Connecticut is associated with the insurance business, and Houston, Texas is known as a major center for the oil industry. Even without information about the number of firms that operate in these regional industries, the proportion of the industry that is located in the region, or about the number of similar firms that may reside elsewhere, most people, when asked to name the industry most associated with these regions will name motion pictures, insurance, and oil, respectively.

Metropolitan regions of course vary substantially in the number and heterogeneity of businesses that are located in the region. Moreover, different audiences may attend to a greater degree to the features of a region in which they have an interest. For example, San Diego may be understood primarily as a beach town to surfers and sun lovers, a Navy town to members of the military, and a burgeoning center of biotechnology firms to investors and others with interests in this industry. Regions, like individuals, organizations, and organizational forms, are complex social entities that present different faces to different audiences. Nonetheless, to one extent or another, regions become known for particular kinds of activity and, most important, as one of a category of regions that are homes to an industry. To say, for example, that London is a world financial center simultaneously describes an essential feature of the region's industrial activity and classifies the region as one of a set of regions with similar features, e.g., New York, Tokyo, Zurich, and others. This characterization does no damage to the idea that London is also home to many other important industries, including theatre, education, and biotechnology, to name just a few. Simply, it is important that London has a strong identity as a financial center.

Regional industrial identity is thus a social code that summarizes shared understandings by audiences, including both residents and external observers, that a metropolitan region is a suitable place for particular industries (Romanelli & Khessina 2005). Such understandings arise from a variety of sources, including formal and informal interactions between scientists, managers, and skilled workers in

one region with individuals outside of the region as well as media reports about managers, organizations, and firms that are located in a region. They may be accurate or inaccurate with respect to the actual distribution of organizations across geographic regions. Jaffee (2003), for example, showed that, despite substantially higher failure rates of law firms in the cities of Palo Alto, San Jose, and Santa Clara than in other, less crowded areas of Silicon Valley, they remain known as "good places" for corporate law practices and continue to attract disproportionately greater numbers of new firms. The identity of the region, which reflects shared understandings about its resources and business opportunities, is sufficient to maintain the inflow of new entrants into the region.

Although, in theory, audiences with interests in a particular industry would seek to obtain information about all regions with organizations and resources that are relevant to their interests, in practice, information is often scarce and private (Hayek 1945; Uzzi 1999). Complete information is thus expensive or even impossible to obtain. Audiences may attach greater importance to information received from trusted sources, which may skew their interpretation of information (Uzzi 1996). Thus, because of bounded rationality (Simon 1947), audiences may satisfice based on more readily and cheaply available common understandings about the suitability of a region for the particular industry.

When one or a few regions develop strong identities for a particular kind of industry, audiences with interests in the industry will tend to focus their attention on these regions. More resources will be attracted to the region for investment in the industry. More organizations will tend to be founded in the regional industry. Organizations of a particular kind, especially when they are concentrated in one or a few regions, attract related organizations, e.g., suppliers, distributors, and service providers (Storper & Christopherson 1987). Although organizations that are more densely concentrated in geographic space may face higher failure rates than organizations in less densely concentrated regions, the concentration of resources in the region supports a commensurately higher rate of entrepreneurial activity (Sorenson & Audia 2000). Thus industry clusters and, by extension, regional industrial identities, once established, tend to persist.

Moreover, as the identities of one or a few regions become very strongly associated with a particular industry, firms that locate outside of these regions should find it more difficult to obtain important resources. In a sense, they violate the social code that governs regional industrial identity. Although many theorists have argued that entrepreneurs have greatest opportunities for acquiring resources in their home environments because of social contacts and personal reputations (Aldrich & Zimmer 1986; Romanelli & Schoonhoven 2001; Sorenson 2003), when some regions outside of the home region have developed strong identities for a particular industry, entrepreneurs may face conflicting opportunities. The greater potential for the individual entrepreneur to obtain resources in the home region may be offset by greater amounts of resources elsewhere. Thus, entrepreneurs and investors in regions with weaker industrial identities may choose to forego the benefits of local networks and locate their businesses in regions with stronger industrial identities.

The dynamics of industrial identities in a region can be quite complex, in part because many regions are home to multiple industry clusters that may either reinforce or obscure the regional industrial identity of any one cluster. For example, Houston, Texas's identity as a major center for the oil industry may obscure its identity as a center of medical research. In their theoretical paper, Romanelli & Khessina (2005) argued that configurations of industry clusters in a region, e.g., cluster dominance and cluster interrelatedness, primarily account for a region's industrial identity and, through identity, the type and amount of resources that a region is likely to attract and the type new industry clusters that will likely arise. Thus, they suggested that regional industrial identities affect both short- and long-term regional economic development.

In this paper, we develop one part of their argument regarding primarily the attractive influence of regional industrial identities on the location of entrepreneurial businesses and the investments of venture capitalists and diversifying firms. Our purpose is partly to demonstrate the importance of regional industrial identity as a factor in location decisions. In addition, we seek to show that regional industrial identity at least in part explains a larger industrial phenomenon, i.e., the location of industry clusters.

Regional Identity and Venture Capital Investments

Studies of the location of venture capital firms and venture capital investments show that, while the firms are rather broadly dispersed over geographic regions, their investments are relatively tightly geographically concentrated. Florida & Smith (1993), for example, showed that, while 80.1 percent of U.S. venture capital offices in 1986 were located in 27 metropolitan regions (in 17 states), investments were concentrated in just six regions (San Francisco, New York, Boston, San Jose, Chicago, and Los Angeles). They argued that the investments concentration was the result of two factors: (1) uneven geographic distributions in the location of high-technology ventures, which are the primary sources of demand for venture capital investments (Gompers et al 1998), and (2) co-investments among geographically dispersed venture capitalists who relied on their partners' regional expertise for locating and assessing investment prospects. Similarly, Gompers et al (1998) found that venture capital investments tended to be concentrated in California, Massachusetts, New York, and Texas, with far and away the greatest amount of investment in California. They showed that state-level industrial and academic R&D spending, as well as gross state product per capita, significantly and positively influenced the amount of venture capital investments in states. Thus, regional resources are related to the location of venture investments.

Venture capitalists, however, are limited in their abilities to assess the economic conditions of regions, and no study that we could find suggested that the location of venture capital investments was systematically driven by such assessments. Rather venture capitalists tend to specialize in industries or technology sectors to improve their abilities to discover, evaluate, and monitor their investments (Gompers & Lerner 2001b). To specialize, venture capitalists develop broad networks of industry contacts, including scientists, engineers, and the current and former senior managers of firms in an industry (Bygrave & Timmons 1992). These networks improve the quality of investment opportunities as trusted contacts recommend certain entrepreneurial businesses, help to evaluate the technology and management of other entrepreneurial businesses, and serve directly as a source of managerial talent businesses that receive venture capital investments.

Venture capital networks take time to develop and maintain and are probably dependent on a high amount of face-to-face communication (Storper & Venables 2002) both to develop trust and to maintain intellectual currency in developing new technologies. Physical distance from the source of information exacerbates the challenge (Sorenson & Stuart 2001). Moreover, for purposes of monitoring venture investments, venture capitalists typically prefer to take board positions in their investments. Lerner (1995), in an analysis of venture capitalist board memberships for a sample of 307 privately held biotechnology over the period 1978 and 1989, showed that more than half of the firms had a venture director with an office within 60 miles of their headquarters; 25 percent had a venture director within seven miles. This supports the popular idea that venture capitalists typically invest, or take lead investment positions, which are associated with board memberships, in ventures that are relatively close to their home or branch offices.

As industry specialists, however, venture capitalists also have interest in discovering entrepreneurial opportunities outside their home regions. To facilitate such discovery, and also to diversify their portfolios, venture capitalists syndicate deals with investors in both their home and other regions. Sorenson & Stuart (2001) showed that venture capitalists were more likely to invest in industries that were outside the scope of their normal investments and in regions that were distant from their home regions when they had participated previously in deals with other venture capitalists that were more experienced in the industry or the region.

These patterns suggest that venture capitalists are at least somewhat limited in both the industrial and geographic scope of their investments. Although, in theory, sophisticated investors would seek to be broadly knowledgeable about investment opportunities across all geographic regions, time and geographic constraints on their abilities to establish good information networks likely restrict their focus, at for lead investments, to one or a few regions. Developing new networks may come at the expense of maintaining established networks.

For investments in more distant regions, venture capitalists rely on regional partners to take the lead. Potentially, these local and extended networks among venture capital firms adequately cover the

geographic range of investment possibilities. It seems just as likely, however, that venture capitalists, as they learn about emerging opportunities, go looking for partners in regions that appear likely to generate large numbers of attractive investment prospects. In this regard, venture capitalists, as boundedly rational decision makers, are likely to be influenced by common understandings about the differential suitability of regions for the new industry.

Thus, we argue that capital investors will be significantly influenced by a region's industrial identity for a particular kind of business. Though we acknowledge that venture capitalists, because of the nature of their business and the critical importance of their resources, may be central players in the establishment of regional industrial identities, we also argue that such understandings become self-confirming over time. In whatever ways that venture capitalists come to view a particular region as a 'good place' for a particular industry, their beliefs become institutionalized and, in a self-reinforcing manner, come to govern the location of their investments.

> **Hypothesis 1a**. The stronger a region's identity for a particular type of industry, the greater the number of venture capitalists who will invest in the regional industry.
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> **Hypothesis 1b**. The stronger a region's identity for a particular type of industry, the greater the amount of venture capital that will be invested in the regional industry.

Regional Identity and Organizational Entry

Starting a new firm or opening a new subsidiary requires that prospective entrepreneurs and managers of diversifying firms acquire information about opportunities for a new business and obtain the resources necessary to build the business. Although prospective entrants, like venture capitalists, may obtain information from both local and extended social networks, we think that the search for information about emerging opportunities is both less intentional and subject to greater distortion. Most individuals do not, as a routine part of their activities, scout entrepreneurial opportunities. They learn about new markets, new technologies, and new businesses that others have founded, in both their home and distant regions, through myriad sources that direct their attention to particular events and developments, and not others.

When potential entrants to a new industry obtain information about distant events and developments, such information may lead to consideration or comparison of regions' capacities to support particular kinds of businesses. In particular, information about foundings is a salient type of information (Arthur 1990). Imagine a professional conference where a new venture of some type has been established by a member of the profession and is generating buzz. Perhaps the venture has recently attracted a large amount of venture capital, or had success with a recent IPO. Whatever the nature of the discussions about why the venture has been a success (or not), some attention will be focused on the location of the business. Perhaps our hypothetical professionals will consider why the venture was located in a particular region, but it seems more likely that, to the extent that they consider regions at all, they will focus on the attributes of the particular region to discover its advantages. Such speculation will likely be heightened if other similar new businesses have been located in the same region. Thus, theories, of a sort, about why the region is a good place for this kind of business will begin to emerge.

McKendrick et al (2003) showed the power of even small groups of similar organizations to focus attention on the features of a new organizational form. Here we simply extend their arguments to suggest that attention will also be focused on the characteristics of regions that host the iconic new venture or the group of similar firms. Perceptual focus, on the characteristics of a region in which new firms are located, is neither a discriminating nor a fully rational assessment of potential of other regions. Rather the focus generates attention to the characteristics of the region and to explanations for why these things have occurred. Other regions that might, hypothetically, have been better locations for the particular kind of business are unlikely to be considered. Thus, attention is focused on explaining what occurred, not whether or why it was the best thing to have occurred.

Over time, as individuals discuss events and socially negotiate their explanation, common understandings emerge that are less and less open to dispute (Berger & Luckmann 1966). Simply, it becomes taken for granted that some regions are good places for particular kinds of business activity while others, by not being part of the conversation, are not. Institutionalized understandings about "right and appropriate ways of doing things" (Zucker 1977), or in this case "right and appropriate places," are

the essence of regional industrial identity. Once such understandings emerge, they both reduce attention to other regions as potential good places for a particular kind of activity and influence the flow of resources across regions. Potential entrants in regions with stronger industrial identities for a particular type of business will feel confirmed in their decision to locate in the home region. Entrants in weaker identity regions will face a trade-off between their access to resources in the local environment and a greater pool of resources, though they may have less access to, elsewhere. At least some of the entrants in the regions with weaker industrial identities will decide to locate their firms away from their home regions.

At the same time, the strength of regional industrial identity will influence the amount of resources that individuals can mobilize for starting a new business. Although potential entrants may have greater personal ability to acquire resources in their home regions, a larger pool of resources may be available elsewhere. As above, when venture capitalists and other important resource suppliers have decided that some regions are better places for a particular type of business, they are less likely to invest in businesses founded outside of the strong identity regions.

Thus, we argue that there will be a positive relationship between the strength of a region's identity for a particular type of business and the rate of entry of new firms to the regional industry.

> **Hypothesis 2.** The stronger a region's identity for a particular type of business activity, the greater the entry rate of firms pursuing this activity into the region.

So far we have assumed that all potential entrants are subject to imperfect information to the same extent and that all potential entrants depend equally on audiences for resources. This stylized assumption is convenient for initial arguments, but is not very realistic. We relax the assumption now and take into consideration two facts. First, as suggested above, potential entrants, as audiences, possess different amount of information about the suitability of regions for particular types of businesses. Second, not all potential entrants depend on their audiences for resources. Below, we consider characteristics of prospective entrants that may affect their access to information and resources: (1) the pre-entry location of a firm's founders or parent organizations, and (2) the mode of a firm's entry into an industry.

Regional Identity and Pre-entry Location of Entrants

Prospective entrepreneurs and diversifying firms can enter an industry either in the region where they already reside or in another region. Local entrants are likely to have both more accurate information about business opportunities and greater access to resources in their home region than non-local entrants.

Local entrants obtain more intimate knowledge of their regions than non-local entrants for several reasons. First, the residents of a region attend more acutely to local events and trends because they are more likely to be directly affected by those events than non-residents (Hilgartner & Bosk 1988; Hoffman & Ocasio 2001). Second, local entrants enjoy information benefits derived from participation in both informal and formal social networks (Sorensen 2003a). The emergence and maintenance of social networks, based either on work, friendship, family or community ties, is facilitated by the spatial proximity of actors (Festinger et al 1950; Green 1983; Kono et al 1998; Sorenson & Stuart 2001). Since social networks often serve as conduits for scarce and private information (Granovetter 1974; Burt 1992; Saxenian 1994; Uzzi 1996; Sorenson & Audia 2000; Sorenson 2003a; Stuart & Sorenson 2003a), local entrants acquire information that is both more accurate and more complete than information available to prospective non-resident entrants. As a result, local entrants have less need to look for indirect indictors of regional suitability for a particular kind of business than non-local entrants.

Local entrants can also rely on their network membership based on strong ties to obtain resources. Local entrepreneurs may experience difficulty in attracting necessary resources because the success of their venture is highly uncertain and they yet have to prove their potential and viability (Stinchcombe 1965, Aldrich & Fiol 1994). Having strong family and friendship ties helps founders recruit their first employees by engendering trust (Sorenson 2003b; Ruef et al 2003). Social ties between prospective founders and holders of capital reduce the asymmetry of information and, therefore, increase entrepreneurs' chances of receiving financial resources (Fried & Hisrich 1994; Uzzi 1999; Sorenson & Stuart 2001; Shane & Cable 2002). Strong social ties to individuals that work either at universities or incumbent firms in the region facilitate acquisition of knowledge (Saxenian 1994; Sorenson 2003a; Stuart & Sorenson 2003a).

Established companies that diversify into a new industrial field in the region of their residence can also draw resources from their local social networks. Diversifying firms usually have well established structures of suppliers and distributors developed for their other businesses in the region that they can leverage for their new ventures in this region. Established earlier relationships with local financial institutions allow diversified firms to obtain capital on favorable terms (Mintz & Schwartz 1985). Finally, having connections with local universities and employing talented individuals in their existing local businesses help diversifiers mobilize intellectual capital for their new ventures either by hiring new people or transferring existing employees to a new subsidiary (Saxenian 1994).

Non-local entrepreneurs and diversifying firms, by contrast, must rely on more dispersed and less dedicated social networks both to acquire information about regional capacities for supporting particular kinds of industries and to obtain resources to start a business. Such information, we argue, is both less specific and less rich than information available to local entrants. Thus, they are more likely to rely on social categories that designate some regions rather than others as good places for particular kinds of industries. At the same time, non-local entrants cannot rely on local networks for resource mobilization and have to conform to perceptions and expectations of audiences to persuade them to invest (Stinchcombe 1965). The lack of social connections between non-local entrants and potential investors, make audiences look for alternative ways of evaluation, such as regional identity. Based on expectations that new ventures founded in regions that are known as more suitable for a given industrial activity will be more successful than ventures founded in regions considered less appropriate, audiences will more likely contribute human, financial and knowledge capital to non-local founders and diversifying companies that plan to enter regions with stronger industrial identity.

Thus, driven by need to acquire information and resources from outside audiences, non-local entrants are more likely to attend to regional identity than local entrants. Therefore, we predict the following:

> **Hypothesis 3**: The entry rates of *non-local* firms into a regional industry will increase more with the strength of the region's identity for this activity than the entry rates of *local* firms.

Regional Identity and Entry Mode of Non-local Entrants

Non-local entrants may also vary in the amount of information they are able to collect about regions as well as their degree of dependence on audiences for resources. Non-local entrants can be classified into three categories: (1) *de novo* entrants defined as new firms founded by entrepreneurs (2) *de alio* entrants defined as diversifying firms that enter an industry which is different from their established industry, e.g., traditional pharmaceutical, chemical, or agricultural firms that enter biotechnology, and (3) relocators defined as established organizations within a particular industry that move to a different region. *De alio* firms usually enjoy significant advantages in performance and survival, because at the time of entry they possess more resources and greater experience than *de novo* firms (Bruderl et al 1992; Carroll et al 1996; Hannan et al 1998; Dobrev et al 2001; Klepper & Simons 2000).

We expect that the entry into a region by non-local *de novo* firms will be more affected by the region's industrial identity than the entry by non-local *de alio* firms for several reasons. First, time constraints and lack of resources do not allow entrepreneurs to collect sufficient factual information necessary for cross-regional analysis (Schoonhoven, Eisenhardt & Lyman 1990). By contrast, *de alio* entrants, whether through the formation of a new division, subsidiary, or joint venture, possess resources and experience that they could apply to collect data for cross-regional comparison (Heinsz & Macher 2004).

Second, prospective founders start their businesses from scratch and as a result need to mobilize the majority of resources from outside agents (Stinchcombe 1965). Resource-holding audiences, however, experience significant difficulty in evaluating new ventures that do not possess any track records or established reputations. As discussed earlier, they are more likely to provide resources for non-local founders who confirm their expectations and enter a region with a strong identity in a given business. Additionally, by entering a region with a strong identity in a given industrial activity entrepreneurs likely find more internal audiences with resources relevant to this activity. By contrast, non-local *de alio* entrants can usually obtain resources from their parent companies and are less

dependent on outside resource-holding audiences (Penrose 1958; Mitchell 1994). Even if there is a need for outside resources, established reputations and relationships with suppliers and buyers in the industries of prior activities make the procurement of outside resources easier (Carroll et al 1996; Mitchell 1994). Audiences that have a history of relationships with *de alio* firms need less to rely on signals such as regional identity to make investment decisions and are more forgiving when *de alio* firms violate their expectations about the region of entry (Zuckerman et al 2003).

Finally, de *novo* firms have more freedom in choosing where to locate their businesses. Even when non-local *de alio* firms heed regional identity, they are more constrained in the choice of location because destination of their entry is often driven by the location of an acquisition or merger target, joint venture partner and the like. Based on the above reasoning we suggest that the geographic destinations of non-local *de novo* entrants are more affected by regional identity than non-local *de alio* entrants.

> **Hypothesis 4:** The entry rates of *non-local de novo* firms into a regional industry will increase more with the strength of the region's identity for this activity than entry rates of either *non-local de alio* firms or *relocating* firms.

METHODOLOGY

Research Setting

We test these hypotheses on the population of all biotherapeutics organizations that operated in the U.S. from 1976 through 2004. Biotherapeutics firms are a subset of the more general biotechnology industry (e.g., human diagnostics, agricultural, and industrial biotechnology) based on their active pursuit of the development of human therapeutic drugs using biotechnological techniques. The year 1976 coincides with the founding of Genentech, which was the first organization established to exploit the gene-splicing technology developed by Herbert Cohen and Stanley Boyer in 1973. Although a few other firms, most notably Cetus founded in 1973, had been established to develop commercial applications for biotechnology, many for the oil and distilling industries, Genentech was the first to focus on human drugs, or biotherapeutics. Thus, our study captures most of the industry's history.

There are several reasons why the biotherapeutics industry is an appropriate setting for testing our theory. First, the industry is relatively new, which makes it possible to track the entry dates and locations

of most of the firms that have entered the industry from the outset. Second, the industry has experienced high rates of entry by different types of firms and has been characterized by a substantial geographic dispersion of firms. Thus, the industry is well suited for investigating location differences in entry of new firms and subsidiaries.

Like all single-industry studies, our research focus poses limitations on generalization. Characteristics of an industry may lend to greater or lesser degrees of geographic dispersion. Potentially, our findings may be limited to knowledge-intensive industries, where transportation challenges are minimal.

Data Sources for the Biotherapeutics Firms

Biotherapeutics organizations located in the U.S., which includes the subsidiaries of non-U.S. organizations, were identified first and primarily through listings provided in *BioScan* (1987 through 2004). *BioScan* is an industry trade publication that includes the most comprehensive listing available of biotechnology firms of any type and located throughout the world. We examined many other listings of biotherapeutics to explore the comprehensiveness of the *BioScan* listings, including Ernst & Young, the Office of Technology Assessment. We found very few firms that were not captured by *BioScan*. The only bias in *BioScan* reporting that we could discover lay in a lag of an approximate average of two years between the founding dates of new firms and their appearance in *BioScan*. To check whether *BioScan*'s lag in coverage biases the results, we used different end points to define our observation period, 1976-2002, 1976-2003 and 1976-2004. Since the results were very consistent and similar, in this paper we report only analyses based on the observation period of 1976-2004.

We identified organizations engaged in biotherapeutics, as opposed to human diagnostics, or agricultural, industrial, or environmental applications, through careful examination of products in research, under development, or on the market listed for each organization in *BioScan*.[1] We also conducted a complete Lexis-Nexis scan for every organization marked as a candidate for inclusion based

[1] For these identifications, we relied on the scientific knowledge of Martin Doyle, an MBA student with a Masters degree in microbiology and substantial experience in the biotechnology industry.

on the *BioScan* listings. Finally, we investigated organizational web sites and other Internet-based listings and information to verify the organizations actual work in the development of therapeutics using biotechnology techniques. The result, we believe, is the most accurate database on U.S.-located biotherapeutics organizations possible.

The location of each biotherapeutics organization was determined based on addresses, including zip code, county, and state of location in the United States. This information was used to identify the Metropolitan and Micropolitan Statistical Areas (MSAs) of the firms, using the 2003 classifications. More detail about procedures used to determine MSA location is provided below.

Operationalization of Variables

Regional Boundaries. Regions exist within several levels of geographic location, for example, cities, counties, states, nations, though they are often not perfectly defined by political boundaries. The specification of a region, which may be accurate for analytical purposes at any of these geographic levels, depends on the interests of observers. In this study, we focus on *metropolitan* regions, e.g., greater Boston, as physical locations in geographic space that are embedded in larger social, business, and political environments, but that are also spatially distinct from other metropolitan regions.

We define regions as either Metropolitan or Micropolitan Statistical Areas (MSAs) which are assigned almost annually by the U.S. Census Bureau, a division of the Office of Management and Budget, and which recognize that the economies of most regions are neither contained within nor well-represented by political divisions, such as city, county, or even state boundaries. Metropolitan regional economies, e.g., what we typically refer to as greater Chicago, develop over multiple contiguous counties that are not restricted by the city of Chicago or even Lake county, within which the city of Chicago is located. In some cases, e.g., greater New York, economic units transcend even state boundaries. Based primarily on commuting patterns, which link the cities in which people live with the cities in which people work, the Census Bureau ascribes metropolitan regional status as contiguous counties over which substantial commuting occurs (OMB Bulletin No. 03-04).

As reported in the OMB Bulleting, the 2003 classification includes about 83 percent of the U.S. population. Of 3,142 counties in the United States 1,090 are in the 362 metropolitan statistical areas in the United States. Over the study period, 79 MSAs were home to at least one biotherapeutics firm. Four of the regions in our study were designated as Micropolitan Statistical Areas. Our data also include one case of a U.S. county, Ravalli county in Montana, which has not been designated as part of either a Metropolitan or Micropolitan Statistical Area. Since our theory does not depend on the size of the human population in a region, though, as discussed below, we control for population size, we treated Metropolitan and Micropolitan Statistical Areas and the single county as equivalent for designating the locations of biotherapeutics firms. Thus, we study the location and relocation of resources for 79 U.S. metropolitan regions.

MSAs Included in This Study. We treat a region as a host for a biotherapeutics cluster if the region has at least one biotherapeutics firm.

Starting of the biotherapeutics industry in the region. We define the beginning of the biotherapeutics industry in a region as occurring in the year when the first biotherapeutics firm entered the region. Most dates of firm entry into specific region are given only with precision to the year of entry. To make the analysis tractable, all the information about timing was annualized.

Ending of the biotherapeutics industry in the region. We defined the ending of the biotherapeutics industry in a region as occurring in the year when the last biotherapeutics firm exited the region. We discovered four regions that were home to biotherapeutics firms for several years, became empty for seven or more years, and then again hosted one or more biotherapeutics firms. We treated these regions as having exited the biotherapeutics industry when they first became empty. We coded the secondary entry of these regions into biotherapeutics as a new event. Empirical results from the analyses do not depend on this treatment and are practically identical to those received if the four regions were treated as they never exited the biotherapeutics

From 1976 to 2004, 771 biotherapeutics firms entered into 79 unique U.S. regions located in 38 different states. Approximately 30 percent of them relocated resources, either through the movement of

entrepreneurs to found new businesses, the relocation of a firm established in one MSA to another MSA, or the investment of an established firm in a firm outside their headquarters region. The data include 1,283 MSA-year observations.

Dependent Variables. There are two primary dependent variables in this study. The first variable measures venture capital investments. The second measures firm entry rates into the biotherapeutics industry in regions. All the variables are updated annually, unless noted otherwise.

Venture capital investment. Two variables measure the flow of venture capital to biotechnology firms in the region. The *number of VC investors into biotechnology in an MSA* is the number of venture capital firms that provided capital for biotechnology firms in an MSA in a given year. The *amount of VC investments into biotechnology in an MSA* is the U.S. dollar amount invested by venture capitalists in biotechnology firms in an MSA in a given year. The variable is logged to correct for skewness. The data on venture capital was obtained from the Venture Expert database, collected by the National Venture Capital Association.

Firm entry rates. The second set of dependent variables captures the entry rates of biotherapeutics firms into a region. Firms were identified as having entered biotherapeutics in a region whenever (a) a new firm was founded in a region to develop biotherapeutics products, (b) an established firm diversified into biotherapeutics in an MSA by the creation of a new division or subsidiary, the acquisition of or merger with an existing biotherapeutics firm, or participation in a biotherapeutics joint venture, or (c) an established biotherapeutics firm relocated from one MSA to another.

The *rate of all firm entry* is constructed by counting the number of all biotherapeutics firms that entered a specific MSA in a given year. To avoid double counting for diversifying and relocating firms, we treated the year of an acquisition, merger, or relocation as the last year in which the prior organization or organizations existed and the following year as the date of entry by the new organization.

Tests of hypotheses about effect of regional identity on entry rates of firms with local and non-local origins require knowledge of their pre-entry locations. The pre-entry locations of *de alio* firms were given directly by the addresses of the firms. To establish the geographic origins of *de novo* firms, an

extensive search of the career histories of their founders was undertaken. Information was obtained from many sources, including biographies of managers and boards of directors that are reported on websites and in annual reports, 10-Ks and prospectuses, and newspaper articles. We identified the names of the universities or organizations that employed entrepreneurs immediately prior to the founding of the biotherapeutics firm, then looked up its address and assigned the pre-entry location to an MSA category.

The e*ntry rate of all local firms* was constructed by counting the number of entrants into a region in a given year for which at least one founder or parenting organization was located in the region where the entry into biotherapeutics occurred. The e*ntry rate of all non local firms* was measured by counting the number of entrants into a region in a given year, of which all founders or parenting organizations were located in the region different from the one where the entry into biotherapeutics occurred. Out of 771 entrants into the biotherapeutics industry in different MSAs, 515 firms had local origins, 228 firms had non-local origins, and 28 had unidentifiable origins.

Three additional variables measure the entry rates of different types of non-local firms. The e*ntry rate of non-local de novo firms* was constructed by counting the number of start-ups, defined as firms with no prior business existence of any kind, launched in a region in a given year by founders who resided outside of this region before the founding event occurred. The e*ntry rate of non-local de alio firm*s was measured as the number of firms with prior existence of any kind that entered a region in a given year whose parent organizations were located outside of the region of entry. Finally, the e*ntry rate of relocating firms* was created by counting the number of biotherapeutics firms that moved their headquarters from one metropolitan region to another. During the observation period, out of 228 non-local entrants, 102 were *de novo* firms, 44 were *de alio* entrants, and 82 were firms that relocated from one MSA to another.

Independent Variable. The independent variable in this study is *the strength of a region's biotherapeutics identity* defined as the strength of shared understandings of audiences about suitability of the region for biotherapeutics business. Operationalizing shared understandings presents a significant empirical challenge because it is not feasible to measure them directly. We undertake an indirect

approach. Shared understandings are a part of public discourse, which significantly shape understandings about people and organizations as well as political and economic events and developments. It is quite common in the literature to measure public discourse through analyses of mass media reports (Ruef 2000; Pollock & Rindova 2003; Fiss & Hirsh 2005; Sine, Haveman & Tolbert 2005). According to the communication literature, media reports reflect public knowledge and opinions at the same time as they focus public attention on certain issues (Kosicki 1993; Rogers, Dearing & Bregman 1993). Media does not tell people *what to think,* but rather tells them what to think *about* (Cohen 1963; McCombs, Llaman, Lopz-Escobar & Rey 1998).

For this study, media reports reflect audiences' perceptions about the suitability of a region for biotherapeutics business activity by providing coverage of and thus directing attention to biotechnology activity in the region. Ruef (2000) used media coverage to measure the identity of emerging organizational forms. In similar fashion, we measured the strength of regions' biotherapeutics identities by counting the number of *New York Times*' articles for each year of the study period that either (1) mentioned or discussed a biotherapeutics firm in an MSA, (2) quoted a biotherapeutics firm manager or a scientist located in an MSA, or (3) discussed the growth, decline, or general suitability of a region for biotherapeutics activity. Recurring lists such as scientists accepted into the National Academy of Scientists or the names of firms conducting an IPO (initial public offering) during a period were not included in these counts as they did not reflect any discriminating attention of New York Times' reporters to the region. We also excluded wedding notices and paid obituaries as not indicative of discriminating attention to biotherapeutics activity in the region. This variable is lagged one year to insure exogeneity.

Control Variables. Other factors than regional identity may affect the entry rates of firms into a given region. We constructed a set of variables to control for these influences. Unless otherwise noted, all controls are updated annually. All time variant controls are lagged one year to insure exogeneity.

Density controls. We operationalized organizational and MSA density to capture competition in the U.S. biotherapeutics industry. First, building on the large body of research in organizational ecology that has demonstrated the influence of organizational density on population vital rates (see Carroll &

Hannan 2000 for a review) we measured the *density of firms in an MSA*, as the number of biotherapeutics firms present in an MSA in a given year, and *density of firms in an MSA squared,* to control for these influences. Second, when multiple regions host biotherapeutics firms, potential founders and parent organizations have a choice of where to locate their business. In other words, regions compete for potential entrants. To control for this influence we created variable the *number of MSAs hosting biotherapeutics firms*, which is the number of MSAs that have at least one biotherapeutics firm in a given year.

Controls for MSA resources. To control for resource differences, we collected data on annual venture capital investments in biotechnology firms in an MSA, grants from the National Institutes of Health to organizations in an MSA, and the number of "top quality" universities involved in biotechnology in an MSA. We measured *venture capital investment into biotechnology in an MSA* as the U.S. dollar amount invested by venture capitalists into the biotechnology industry in an MSA in a given year. The variable is logged to correct for skewness. *NIH grants received by an MSA* measures the U.S. dollar amount granted by National Institutes of Health to firms and research organizations in an MSA in a given year. The variable is also logged to correct for skewness. Finally, to control for an MSA's scientific resources, we use a time-invariant measure from Zucker et al (1998), the *number of "top quality" universities in biotech in an MSA*, which are universities with biotechnology relevant programs (biochemistry, cellular/molecular biology, and microbiology) with scholarly quality reputation rankings of 4.0 or higher in 1982 National Research Council Survey.

Other controls. The above measures, while they have been used in other studies to capture the influence of regional resources on industry clustering may not capture all important influences. In particular, in the U.S., state regulations, e.g., the prevalence and enforcement of non-compete agreements, i.e., agreements signed by employees upon joining a firm that prevent them from getting a job with a rival company for a certain period of time after quitting (Stuart & Sorenson 2003b), may influence the rate of entry into a regional organizational population. States may also differ in the extent of institutional entrepreneurship that may influence firm entry rates as well (Sine & Lee 2005). To control for these and

other possible state-level differences, we created a set of *state-specific dummies*. Additionally, in the venture capitals random effects models we control for *non-compete regime* dummy that takes a value of one if the state does not enforce non-compete agreements and zero otherwise. Temporal changes in the macroeconomic conditions of a region may also affect the entry rate of regions into an MSA. We created *dummy variables for each calendar year* to control for unobserved time-varying changes.

We also considered that the size of a region, in terms of human population, might affect the entry rate of biotherapeutics firms to a region. Although we see no theoretical reason for population size to affect the entry rate of any particular industry, larger regions may be perceived as generally more likely to host a particular population. For example, larger regions are more likely to be home to major medical treatment centers and thus, perhaps, to contain a greater number of medical scientists engaged in research. We measured *human population in an MSA* as the number of people residing in the MSA in a given year. The variable is logged to correct for skewness. The data were obtained from the U.S. Census bureau. Since the Census reports and updates human population data every 10 years, we used the most recent figures reflecting historical estimates and linear interpolation to calculate values for the missing years.

Finally, one possible concern with using *New York Times* articles to measure the strength of a region's biotechnology identity is that it may provide greater coverage for the New York region. To address this concern we constructed a dummy variable for the *New York-Newark-Edison MSA* which takes a value of one if the MSA is New York-Newark-Edison, and zero otherwise.

Model Specification

Venture capital models. To test hypotheses predicting that regional identity affects venture capital investments into the region, we use estimators designed to deal with cross-sectional time-series data, specifically, random effects and fixed effects linear regressions. A general form of the models we estimate specifies (1) the number of venture capitalists and (2) the amount of financial investment as a linear function of MSA's regional industrial identity and a vector of covariates:

$$\kappa(i,t) = \beta I_{i(t-1)} + \delta \Sigma X_{ni(t-1)} ,$$

where $I_{i(t-1)}$ measures industrial identity of MSA *i* in year *(t-1),* and $X_{ni(t-1)}$ summarizes all other time-varying covariates. We expect $\beta > 0$ indicating the regions with stronger identities experience greater flows of venture capital both in terms of number of investors and in terms of dollar amount. We use the software package STATA for estimation.

Entry rates models. To test the hypotheses that entry rates of biotherapeutics firms into a region are affected by the region's industrial identity in biotherapeutics, it is necessary to take into account that many regions experience entry by more than one biotherapeutics firm in a given year and that the entries can happen at any time during the year. Since our data is precise only to the year, it is not possible to determine the exact waiting time between all events of firm entry. It is common to analyze event information with this form as event-count data (Carroll and Hannan 2000: 129-31; 146-49). Event-count data is analyzed by assuming that firm entry rates are events governed by stochastic processes. The instantaneous rate of event occurrence (i.e., the rate at which an MSA experiences its next firm entry) is defined as

$$\lambda_n(t) = \lim_{\Delta t \to 0} \frac{Prob[Y(t+\Delta t)-Y(t) \geq 1 \mid Y(t) = n]}{\Delta t} ,$$

where *Y(t)* is a random variable denoting the cumulative number of firms that entered into an MSA by time *t*. The stochastic process of interest, the firm entry rate, is *[Y(t)| t≤0]* with state space equal to *[0,1,2,...]*. The fundamental parameter of such a process is firm entry rate, the rate of arriving at state *n+1* at time *t*. The analysis focuses on year-to-year variations in counts.

The two common estimation models used in event-count analysis are Poisson regression model and negative binomial regression model. The latter is used if the data is overdispersed, meaning that the variance in counts is not equal to the mean. Overdispersion in this data arises from the years when no firms entered a given MSA, i.e., from the years with zero events of firm entry. So, we used a zero-inflated Poisson model designed to deal with excess zeros in the data (Greene 2003: 749-752, 779-780). The model for Y_{it}, the number of firms entered into an MSA *i* at year *t*, is given by two equations: $Y_i=0$ with probability q_i and $Y_i \sim Poisson\ (\lambda_i)$ with probability $1-q_i$. This implies that $prob\ (Y_i = 0) = q_i + [(1-$

$q_i)\ R_i(0)]$, and $prob(Y_i = j > 0) = (1-q_i)\ R_i\ (j)$, where $R_i(y) = exp(-\lambda_i)\lambda_i / y_i!$, the Poisson probability, and the rate of events $\lambda_i = exp(\beta' X_i)$. The state probability q_i is specified as $q_i \sim$ logistic (v_i), where $v_i = \gamma' Z_i$ (Carroll and Swaminathan 2000).

In the zero-inflated Poisson model, X_i is a vector of variables that affects the occurrence of non-zero counts, years when an MSA experienced one or more firm entry, and Z_i is a vector of variables that affects zero counts, years when no new firms entered the MSA. In this study, we expect that the likelihood of zero firm entry increases with industry age, as a result of market saturation. So, we include the variable of industry age into the part of the model that predicts the occurrence of zero events, i.e., into a so-called inflated model.

The Vuong test (Greene 2003: 751-752) shown that a zero-inflated framework is favored over either Poison or negative binomial models. The majority of models (all models except Model 3.1) also show that zero-inflated Poisson is favored over zero-inflated negative binomial models, i.e., event counts are not overdispersed in the zero-inflated Poisson framework.

Since observations within specific MSAs are not necessarily independent, to calculate robust standard errors we use Huber/White/sandwich estimator of variance with cluster option that relaxes the assumption of independence.

A general form of models we estimate specifies firm entry rate into a given MSA $r(i,t)$ as a log-linear function of MSA's regional industrial identity and a vector of covariates $X_{(t-1)}$:

$$\ln r(i,t) = \beta I_{i(t-1)} + \delta \Sigma X_{ni(t-1)} ,$$

where $I_{i(t-1)}$ measures industrial identity of MSA i in year $(t-1)$, and $X_{ni(t-1)}$ summarizes all other time-varying covariates. We expect $\beta > 0$ indicating that regions with the stronger identity in biotherapeutics will experience higher entry rates of biotherapeutics firms.

We estimated zero-inflated Poisson and zero-inflated negative binomial models using the software package STATA. To estimate rate models with time-varying covariates, we constructed split-

spell data breaking observed durations in year-long periods with the values of covariates updated every year.

FINDINGS

Table 1a provides descriptive statistics for the variables used in the analyses. Table 1b shows correlations between the variables. The data file contains multiple spells for each MSA, so the descriptive and correlation tables do not always reflect intuitively the experiences of different regions.

[Tables 1a and 1b about here]

Analyses of venture capital investments. Table 2 shows analyses of venture capital investments into regional biotechnology firms. Models 2.1a and 2.1b are random and fixed effects linear regressions aimed to estimate the *number of venture capitalists* who invested any amount of capital in a region in a year. The models demonstrate a strong positive effect of firm density in the region on the number of investors attracted to the region. The presence of universities with biology related programs of high quality significantly increases the number of venture capitalists investing into biotechnology firms in the region. Supporting Hypothesis 1a, the key effect of regional identity is positive and significant. Thus, regions with stronger biotherapeutics identities attract a greater number of venture capitalist investments than regions with weaker identities.

Models 2.2a and 2.2b are random and fixed effects linear regressions aimed to estimate an effect of a region's biotherapeutics identity on the *amount of venture capital* invested into biotechnology in the region. Both models reveal a strong inverted U-relationship between firm density in the region and the number of investors. The effects of other controls are similar to those in the two previous models. The effect of regional identity, however, is insignificant. Contrary to Hypothesis 1b, regional identity does not affect the amount of money invested by venture capitalists into the region.

[Table 2 about here]

Analyses of firm entry rates. Tables 3 and 4 report estimates of zero-inflated Poisson and negative binomial count models. The significant curvilinear effect of firm density in an MSA shows that entry rates of firms into a given region are subject to the density dependence process. First they increase

with the number of firms already present in a region; then when organizational density reaches 34 firms, the entry rates of firms start to decrease.

The negative effect of MSA density points to competition between regions. The greater the number of regions that were home to at least one biotherapeutics firm in the U.S., the lower the entry rate of biotherapeutics into any given region. This finding makes intuitive sense since greater dispersion of firms in an industry likely obfuscates the regional advantages of particular regions.

Amounts of VC investment and NIH grants into a region increase firm entry into the region but only to an insignificant extent. The region's population does not significantly affect firm entry. The presence of universities with "top quality" biotechnology related programs only insignificantly increases firm entry into the region.

The key explanatory variable in Model 3.1, a region's biotherapeutics identity measured as the number of *New York Times* articles about biotherapeutics in an MSA, shows a positive but insignificant effect on firm entry. Thus, Hypothesis 2 about positive effect of regional identity on entry rates of all firms is not supported. Although this result is somewhat unexpected, given our reasoning that entrepreneurs and managers in established firms should be more likely to invest in their home regions, we argued that the effect of regional biotherapeutics identity would be significantly stronger for non-local rather than local firms. The dominant presence of local founders and managers among entrants into regions may be a reason for the weak effect of regional identity on entry rates of all firms. Findings from Models 3.2 and 3.3 lend support to these arguments.

Models 3.2 and 3.3 explore how regional identity affects the entry rates of local versus non-local firms. Model 3.2 indicates that entry rates by biotherapeutics founders and parent firms local to the region are not affected by the region's biotechnology identity. Model 3.3, however, shows that entry rates of non-local biotherapeutics entrepreneurs and firms into a region are significantly increased by the region's biotherapeutics identity. Regions with stronger industrial identities experience a higher rate of entry by non-local firms. Thus, Hypotheses 3 is supported.

[Table 3 about here]

Models 4.1 through 4.3 investigate whether regional identity affects entry rates of different types of non-local firms differently. They demonstrate that entry rates of all types of non-local firms into a region increase with the strength of biotherapeutics identity of the region. However, as Model 4.1 shows, only the effect of regional identity on entry rates of non-local *de novo* firms is highly significant, indicating that regions with stronger identity experience a greater rate of start-up entry than regions with weaker identity. Model 4.2 reveals that the effect of regional identity on entry rates of non-local *de alio* firms is large substantively but not statistically significant. We hesitate however to conclude that regional identity does not affect the entry rate of non-local *de alio* firms, because statistical insignificance of the effect may be caused by very few number of observations. Finally, Model 4.3 demonstrates that effect of regional identity on entry rate of relocating firms is marginally significant at $p<.07$ level. Very few observations on relocating firms can be a reason for the marginal effect. Overall, Table 4 shows that entry rates of non-local *de novo* firms increase with the strength of the region's biotechnology identity significantly more than entry rates of either non-local *de alio* or relocating firms, thus confirming Hypothesis 4.

[Table 4 about here]

DISCUSSION AND CONCLUSION

Most studies of industry clusters and the factors that explain their existence have emphasized the characteristics of regions that are known, *post hoc*, to have become homes to significant industry clusters. While an impressive body of case historical research has provided good insight into the kinds of resources and the characteristics of social networks that tend to give rise to and sustain particular industry clusters, such studies have failed to confirm that these characteristics, which may also have been present in other regions, systematically account for differences. At the same time, while a few studies (e.g., Sorenson & Audia 2000; Sorenson & Stuart 2003a) have compared the abilities of regions, with different cluster densities, to sustain cluster size and dominance, they have not explored whether and how the presence of multiple regions with similar resources, and even similar early rates of cluster growth, affects the rate of cluster growth in any one region.

Part of the difficulty, we believe, has been a failure to consider that entrepreneurs and capital investors may make location decisions based on understandings or beliefs about the relative attractiveness of regions for particular types of business activity. To some extent, this consideration is implicit in theories positing uneven distributions of resources over geographic space. To the extent that entrepreneurs and investors either know or can learn about differences in regional resources, they make rational location decisions. These arguments also underpinned Arthur's (1991) theoretical analysis of expectations; he posited that, in the presence of uncertainty and with little direct knowledge of regional differences in important resources, prospective entrepreneurs and other investors might ascribe regional attractiveness for particular kinds of businesses base on a simple heuristic of the number of firms that had already located in a region. This argument, however, relies on an assumption of all entrepreneurs having either accurate, or similarly inaccurate, information about the locations and regional densities of firms in a particular industry

In this paper, we have examined the effects of regional industrial identity on entrepreneurial, diversification, and capital investment decisions over the life of the biotherapeutics industry located in the United States, and in the context of multiple regions seeking to attract such investments and entries. We believe that regional industrial identity, while it may be socially informed by information about resources and regional population densities, is a more cognitively available and theoretically compelling influence on the location decisions of prospective entrepreneurs and capital investors, among others, for several reasons. First, the construct does not rely on active and costly monitoring or the acquisition of accurate information about regional advantages. We think that the latter is an unwarranted assumption, especially given difficulties in observing regional resource differences and small early leads in regional population density. Second, while the construct does assume that audiences will develop common understandings about the relative attractiveness of metropolitan regions for particular kinds of resources, it provides an explanation for how audiences might develop the common understandings. Identities, of organizations, organizational populations, and regions, we here suggest, emerge through processes of social exchange and social negotiation of common understandings. As entrepreneurs, investors, and other audiences share

idiosyncratic information about science, industry, and regional attractiveness, there will emerge, we believe, common understandings about which regions are most attractive. It is important to emphasize that such understandings can emerge independent of rational calculations or objective information. Simply, regions, like organizations and organizational forms, develop a taken-for-granted status as better or worse places for particular kinds of activities as audiences socially negotiate these conclusions.

Our findings reveal that regional industrial identity, in the U.S. biotherapeutics industry, significantly influences the location of venture capital investments but not the amount of capital invested into a region. Without additional analysis, it is difficult to speculate too much about the implications of these findings. It appears, however, that new firm location decisions are made independent of capital decisions. It seems reasonable to suppose that amounts of capital investments depend on the characteristics and capital requirements of individual firms. Thus, given that a venture capitalist has decided to invest in a firm in a particular region, which is influenced by regional industrial identity, the amount of investment is determined solely on the attributes of the firm being invested in. Nonetheless, more research into the decision processes and behaviors of venture capitalists is needed.

Our findings also confirm that non-local entrepreneurs, i.e., the founders of non-local *de novo* biotherapeutics firms, are significantly and positively influenced by regional industrial identity. For entrepreneurs who either do not perceive a greater ability to attract important resources in their local environments or who believe that their prospects will be improved by locating in a region with a stronger industrial identity, however, our findings are intriguing. These entrepreneurs, who have less information about the actual resources available in other regions, appear to rely, as predicted, on regional industrial identity for determining the locations of their firms. This is a strong and important result, we believe, in that it suggests a mechanism for industry clustering that takes into account competition among regions for particular clusters. If prospective entrepreneurs monitor regional identities for a particular kind of business, and act on such understandings, then their migration across regions may account for both increases and decreases in the number firms of a particular kind across regions. Regions with stronger biotherapeutics identities are more likely to attract prospective entrepreneurs from other regions, which

implies the loss of these entrepreneurs to these regions. Although additional research is needed to examine the migration patterns, i.e., whether non-local entrepreneurs were more likely to hail from regions with weaker biotherapeutics identities, these findings suggest that establishing a strong regional industrial identity may have lasting influence on regional prospects for sustaining a particular industry cluster. In other words, regions may be successful hosts of particular clusters, not only as a function of superior resources, but also as a consequence of establishing a strong identity for a particular kind of business. Potentially, regions with objectively inferior resources could become home to a significant culture through projecting a clear and salient industrial identity.

The U.S. biotherapeutics is an industry that is still in its becoming. Even after 29 years since the first biotherapeutics firm, Genentech, was founded, 62 regions remain home to at least one biotherapeutics firm, remains large. Although three regions, San Francisco, Boston, and San Diego, have become home to disproportionately large biotherapeutics clusters, other regions, in particular Houston and Durham have shown increases in the sizes of their biotherapeutics clusters while regions that were initially home to proportionately large clusters, e.g., Los Angeles and Washington, D.C., have declined. In other analyses not reported here, we find that the number of relocating entrepreneurs and firms has increased substantially during the later years of the study, and that they are tending to move to strong identity regions. This may suggest that the industry is beginning to converge on a few strong identity regions. Future research into the ongoing evolution of this industry will clarify the already significant influence of regional industrial identity on the spatial evolution of this industry.

Table 1a. Descriptive Statistics for Biotherapeutics Firm Entry, 1976-2004

Variable	Mean	St. Dev.	Min	Max
Number of VC investors into biotech in an MSA (t)	9.83	23.5	0	202
VC investments into biotech [in US$] in an MSA (t)	1.8e+07	5.9+07	0	8.6e+08
Ln [VC investments into biotech in an MSA] (t)	8.10	8.04	0	20.57
Ln [VC investments into biotech in an MSA] (t-1)	8.14	8.01	0	20.57
N of Entries by All Firms into an MSA (t)	.601	1.33	0	11
N of Entries by All Local Firms into an MSA (t)	.401	.962	0	9
N of Entries by All Non-Local Firms into an MSA (t)	.178	.540	0	5
N of Entries by Non-local *De Novo* Firms into an MSA (t)	.080	.342	0	5
N of Entries by Non-local *De Alio* Firms into an MSA (t)	.034	.190	0	2
N of Entries by All Relocating Firms into an MSA (t)	.064	.297	0	3
Number of NYT articles about biotech in an MSA (t-1)	2.65	5.81	0	66
Density of biotherapeutics firms in an MSA (t-1)	5.93	11.3	1	61
N of MSAs hosting biotherapeutics firms (t-1)	52.3	14.3	1	65
Amount of NIH grants [in US$] received by an MSA (t-1)	1.39e+08	2.12e+08	0	2.0e+09
Ln [amount of NIH grants received by an MSA] (t-1)	16.67	4.52	0	21.42
MSA human population (t-1)	2,247,983	3,091,900	23,200	1.86e+07
Ln [MSA human population] (t-1)	13.9	1.32	10.1	16.7
N of universities with 'top quality' bio programs in an MSA	.370	.697	0	3
New York-Newark-Edison MSA dummy =1	.021	.144	0	1
Non-compete regime (1=weak)	.273	.446	0	1
Industry age/ Time trend (t)	17.6	6.8	0	28

N of MSAs = 83 (N of unique MSAs = 79, N of "reborn" MSAs = 4); N of MSA-years = 1283
N of entrants = 771 (local = 515; non-local = 228; unknown = 28; de novo = 457; de alio = 232; relocating = 82)

Table 1b. Correlations of Variables

		1	2	3	4	5	6	7	8	9	10
1	Number of VC investors into biotech in an MSA (t)										
2	Ln [VC investments into biotech in an MSA in US$] (t)	.51									
3	Ln [VC investments into biotech in an MSA in US$] (t-1)	.48	.72								
4	N of Entries by All Firms into an MSA (t)	.59	.40	.37							
5	N of Entries by All Local Firms into an MSA (t)	.52	.37	.33	.93						
6	N of Entries by All Non-Local Firms into an MSA (t)	.51	.31	.31	.76	.48					
7	N of Entries by Non-Local *De Novo* Firms into an MSA (t)	.34	.21	.22	.61	.42	.76				
8	N of Entries by Non-Local *De Alio* Firms into an MSA (t)	.22	.18	.17	.40	.26	.49	.15			
9	N of Entries by All Relocating Firms into an MSA (t)	.41	.21	.21	.43	.23	.66	.14	.08		
10	Number of NYT articles about biotech in an MSA (t-1)	.73	.42	.42	.61	.50	.57	.42	.22	.41	
11	Density of biotherapeutics firms in an MSA (t-1)	.85	.47	.47	.62	.55	.54	.35	.23	.45	.79
12	N of MSAs hosting biotherapeutics firms (t-1)	.09	-.01	.02	-.08	-.10	.02	-.04	-.04	.10	.04
13	Ln [amount of NIH grants received by an MSA in US$] (t-1)	.27	.41	.40	.24	.23	.19	.13	.10	.13	.27
14	Ln [MSA human population] (t-1)	.34	.47	.45	.34	.31	.26	.17	.14	.19	.42
15	N of universities with 'top quality' bio programs in an MSA	.64	.48	.47	.60	.55	.47	.35	.24	.30	.65
16	New York-Newark-Edison MSA dummy =1	.07	.15	.14	.25	.24	.20	.08	.09	.20	.30
17	Non-compete regime (1=weak)	.23	.15	.15	.16	.14	.12	.09	.09	.07	.14
18	Industry age/ Time trend (t)	.12	.05	.07	-.10	-.13	.01	-.08	-.05	.13	.04

		11	12	13	14	15	16	17
11	Density of biotherapeutics firms in an MSA (t-1)							
12	N of MSAs hosting biotherapeutics firms (t-1)	.13						
13	Ln [amount of NIH grants received by an MSA in US$] (t-1)	.30	.01					
14	Ln [MSA human population] (t-1)	.42	-.07	.56				
15	N of universities with 'top quality' bio programs in an MSA	.69	-.18	.34	.49			
16	New York-Newark-Edison MSA dummy =1	.40	-.07	.12	.31	.34		
17	Non-compete regime (1=weak)	.15	-.08	-.15	-.07	.20	-.09	
18	Industry age/ Time trend (t)	.13	.89	.02	-.04	-.14	-.06	-.07

Table 2. Random and Fixed Effects Models:
Effect of Regional Identity on VC Investors and Investments into MSAs
(Standard errors shown in parentheses)

	Model (2.1a)	Model (2.1b)	Model (2.2a)	Model (2.2b)
		Dependent Variable:		
	Number of VC investors into an MSA	**Number** of VC investors into an MSA	ln **Amount** of VC investment into an MSA	ln **Amount** of VC investment into an MSA
Density of biotherapeutics firms in an MSA (t-1)	1.38***	1.42***	.608***	.598***
	(.113)	(.123)	(.069)	(.070)
Density of biotherapeutics firms in an MSA (t-1)^2	.007**	.006**	-.009***	-.008***
	(.002)	(.002)	(.001)	(.001)
N of MSAs hosting biotherapeutics firms (t-1)	-.041	-.033	.038	.040
	(.066)	(.066)	(.037)	(.037)
Ln [amount of NIH grants into an MSA] (t-1)	.068	.205*	.328***	.338
	(.078)	(.089)	(.050)	(.051)
Ln [MSA human population] (t-1)	.136	-1.06*	.362	.159**
	(.293)	(.516)	(.276)	(.294)
N of universities with 'top quality' bio programs in an MSA	3.57***	4.21***	1.02*	1.15*
	(.672)	(.836)	(.466)	(.477)
Non-compete regime (1=weak)	2.57***	*dropped*	1.32	*dropped*
	(.682)		(1.76)	
New York-Newark-Edison MSA dummy =1	-52.8***	-48.6***	-5.33**	-4.90**
	(2.21)	(3.09)	(1.72)	(1.76)
Constant	-1.76	12.6	-8.11***	-4.51
	(5.50)	(7.63)	(4.26)	(4.36)
Year Dummies	*Yes*	*Yes*	*Yes*	*Yes*
State fixed effects	*No*	*Yes*	*No*	*Yes*
Number of NYT articles about biotech in an MSA (t-1)	**.447*** **	**.370*** **	**-.019**	**-.023**
	(.084)	**(.087)**	**(.049)**	**(.050)**
Estimation function	*random effects GLS*	*fixed effects GLS*	*random effects GLS*	*fixed effects GLS*
Number of Observations	1200	1200	1200	1200
Number of Groups (States)	38	38	38	38
R-sq: within	.78	.78	.28	.29
between	.94	.92	.62	.59
overall	.84	.84	.43	.41
Wald statistics	6211.6		479.0	
F statistics		118.2		13.2
Log likelihood				
(d.f.)	(35)	(34)	(35)	(34)

Table 3. Zero-inflated Poisson and Negative Binomial Models:
Effect of Regional Identity on Entry Rates of Firms with Different Pre-entry Location
(Robust standard errors clustered on MSA shown in parentheses)

	Model (3.1)	Model (3.2)	Model (3.3)
	Dependent Variable:		
	Entries by **all** firms into an MSA	Entries by **all local** firms into an MSA	Entries by **all non-local** firms into an MSA
Main Model			
Density of biotherapeutics firms in an MSA (t-1)	.069**	.073**	.043^
	(.021)	(.023)	(.023)
Density^2 of biotherapeutics firms in an MSA (t-1)	-.001***	-.001**	-.001*
	(.000)	(.000)	(.000)
N of MSAs hosting biotherapeutics firms (t-1)	-.103^	-.255**	-.031
	(.055)	(.078)	(.046)
Ln [VC investments into biotech in an MSA in US$] (t-1)	.021	-.006	.037
	(.017)	(.014)	(.022)
Ln [amount of NIH grants received by an MSA in US$] (t-1)	.493	1.18**	.180
	(.316)	(.367)	(.126)
Ln [MSA human population] (t-1)	-.238	-.451**	-.228
	(.154)	(.169)	(.215)
N of universities with 'top quality' bio programs in an MSA	.034	-.164	.180
	(.178)	(.190)	(.221)
New York-Newark-Edison MSA dummy =1	-.056	-.746	.252
	(.576)	(.594)	(.618)
State Dummies	*Yes*	*Yes*	*Yes*
Year Dummies	*Yes*	*Yes*	*Yes*
Number of NYT articles about biotech in an MSA (t-1)	**.015**	**.003**	**.031*** **
	(.027)	**(.013)**	**(.006)**
Inflated Model			
Industry age/ Time trend	.232	.452	-.051
	(.445)	(.282)	(.361)
Constant	-9.92	-13.1	-14.5
	(61.4)	(7.22)	(7.75)
Number of Observations	1200	1200	1200
Number of None-zero Observations	310	247	140
Number of Zero Observations	890	953	1060
Dispersion parameter (alpha)	.073	0	0
Log-likelihood	-759.65	-604.02	-362.26
(d.f.)	(73)	(73)	(73)

p^<.07; p* < .05; p** < .01; p*** < .001

Table 4. Zero-inflated Poisson Models:
Effect of Regional Identity on Entry Rates of Non-local Firms with Different Entry Mode
(Robust standard errors clustered on MSA shown in parentheses)

	Model (4.1)	Model (4.2)	Model (4.3)
	Dependent Variable:		
	Entries by **non-local de novo** firms into an MSA	Entries by **non-local de alio** firms into an MSA	Entries by **relocating** firms into an MSA
Main Model			
Density of biotherapeutics firms in an MSA (t-1)	.107***	-.142*	-.003
	(.029)	(.072)	(.038)
Density^2 of biotherapeutics firms in an MSA (t-1)	-.002***	.001	.000
	(.000)	(.001)	(.001)
N of MSAs hosting biotherapeutics firms (t-1)	-.005	-.673**	-.071
	(.059)	(.201)	(.063)
Ln [VC investments into biotech in an MSA in US$] (t-1)	.032	.035	.036
	(.031)	(.059)	(.039)
Ln [amount of NIH grants received by an MSA in US$] (t-1)	.359*	2.68**	.087
	(.173)	(.846)	(.074)
Ln [MSA human population] (t-1)	-.652*	-.578	.026
	(.259)	(.392)	(.317)
N of universities with 'top quality' bio programs in an MSA	.084	-.699	.092
	(.431)	(.441)	(.252)
New York-Newark-Edison MSA dummy =1	.838	-4.20*	1.30
	(.757)	(1.78)	(.855)
State Dummies	*Yes*	*Yes*	*Yes*
Year Dummies	*Yes*	*Yes*	*Yes*
Number of NYT articles about biotech in an MSA (t-1)	**.041*** **	**.044**	**.014^**
	(.009)	**(.033)**	**(.007)**
Inflated Model			
Industry age/ Time trend	-.158	3.25	-.138
	(.432)	(2.61)	(.115)
Constant	-12.5	-82.1	-9.6***
	(6.08)	(67.4)	(2.03)
Number of Observations	1200	1200	1200
Number of None-zero Observations	72	39	57
Number of Zero Observations	1128	1161	1143
Dispersion parameter (alpha)	0	0	0
Log-likelihood	-193.15	-106.18	-162.68
(d.f.)	(73)	(73)	(73)

p^ < .07; p* < .05; p** < .01; p*** < .001

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