The Entrepreneur's Choice of Location: Evidence from the Life Sciences

Christos Kolympiris
Peter G. Klein
Nicholas Kalaitzandonakes

Department of Agricultural Economics
University of Missouri-Columbia

Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Portland, OR, July 29-August 1, 2007

Corresponding author: Peter G. Klein, Department of Agricultural Economics, 135D Mumford Hall, Columbia, MO 65211, kleinp@missouri.edu.

The Entrepreneur's Choice of Location: Evidence from the Life Sciences

Abstract: Why do biotech firms cluster? New and established firms in biotech clusters are said to capitalize on knowledge spillovers, labor-market pooling, and other externalities. Some have even argued that such spillovers are so strong that the cluster itself, rather than the individual, is the "locus of entrepreneurship." Such arguments, however, do not resolve the mechanism by which clusters might contribute to the establishment of new firms. This paper proposes a conceptual framework for analyzing the locational choices of entrepreneurial firms in the life-sciences industry. Building on both the cluster literature and the literature on entrepreneurship, we develop hypotheses about how cluster characteristics, the entrepreneur's personal characteristics, and characteristics of the business environment affect the entrepreneur's decision to establish a new firm. We argue that a key factor in the location decision is the relative mobility of the appropriate resources. Our main hypothesis is that specialized labor is less mobile than capital and other resources and that it is the base from which entrepreneurs are ultimately created. If so, new firms will emerge in areas characterized by an existing concentration of specialized labor. This labor pool may be "spawned" by universities and incumbent small and larger biotech (or other high-technology) companies. An alternative explanation is that entrepreneurs establish new ventures outside the cluster, then move them to the cluster to take advantage of local knowledge and other resources. Or a potential entrepreneur could conceive a business plan, then relocate to an existing cluster before founding a firm. We explain how survey data can be used to sort through these explanations.

JEL codes: L26, L65, O18, O32

Keywords: entrepreneurship, biotechnology, clusters, knowledge spillovers, agglomeration economies

Much of the entrepreneurship literature over the last two decades focuses on the personal characteristics of those individuals who become entrepreneurs. More recently, however, economists and management scholars have turned their attention to the manner in which entrepreneurship is manifested. Under what circumstances, for example, do entrepreneurs establish firms to realize their entrepreneurial visions? (See, for example, the papers collected in Alvarez and Barney) What critical resources—venture finance, human capital, infrastructure, intellectual property—are necessary for entrepreneurial ventures to succeed? What explains why some communities, regions, and even nations are more "entrepreneurial" than others?

A substantial literature explores the entrepreneur's choice to create a firm (see the review in Shane, chapter 10), and several papers examine the way a new venture should be organized (cites). Less attention has been paid, however, to the entrepreneur's decision *where* to locate a new venture. How important is location to the entrepreneurial firm? Should the entrepreneur locate close to other entrepreneurs or far from them? Which is better, a cluster of same-industry firms or a more diverse environment with a mix of specialties, or a mix of new and established firms? Are some clusters more desirable than others? Which is more important, proximity to venture capitalists or proximity to cheap labor?

It is well known that new firms, particularly in knowledge-intensive, high-technology sectors like software, pharmaceuticals, and biotechnology, tend to emerge in clusters like California's Silicon Valley and Boston's Route 128. However, the dynamics of cluster formation are difficult to analyze. Do entrepreneurs make their location choices independently, with groups of firms subsequently arbitrarily designated as "clusters," or do entrepreneurs chose to locate near groups of existing firms with shared characteristics? What common features are necessary to classify firms as belonging to one cluster or another? Are clusters defined exclusively by geography, or is temporal clustering (or clustering around some other dimension) equally important?

Despite substantial work in economic geography, industrial organization, labor economics, and the management of innovation and technology on clusters, little is known about the location decision from the entrepreneur's point of view. Most of the literature takes the cluster as the unit

of analysis, asking why clusters form in particular locations and how cluster characteristics (size, age, structure, growth rate, degree of similarity, and the like) affect the behavior and performance of cluster firms and the performance of the area or region. Less attention has been paid, however, to the microfoundations of this process—the decisions of individual entrepreneurs to locate in clusters. The entrepreneur's choice of location and the emergence of the cluster itself are endogenous and cannot be treated independently. On the other hand, from the entrepreneur's perspective the behavior of other entrepreneurs, the existence of anchor entities such as universities, research institutes, and established companies, and government policy toward entrepreneurship in a particular region can be taken as given.

This paper suggests a conceptual framework for understanding the locational choices of entrepreneurial firms in the life-sciences industry. Strict regulation, a complex science, and frequently ambiguous intellectual property rights differentiate biotechnology and the other life sciences from most other high-technology sectors and prolong its R&D cycles. Despite lengthy research and product cycles, however, a large share of the R&D work in the biotech sector has historically been performed by entrepreneurial startup firms. According to the National Science Foundation (NSF) out of the total number of firms performing biotechnology R&D 61, 94 and 93 percent of them employed less than 499 employees for the years 2001, 2002 and 2003 respectively. Even though the connection between size and age of firms is not definite, the preceding statistics indicate that small and typically startup firms do perform the majority of R&D in the biotech industry. Moreover, biotech startups tend to cluster. Indeed, a handful of U.S. locations—Boston, Raleigh-Durham, San Diego, San Francisco, Seattle, and St. Louis—account for a large share of the biotech firms established in the 1970s and 1980s and over half the startups that were created in the last decade. For these reasons, the biotechnology sector provides an excellent setting for examining our hypotheses.

Why do biotech firms cluster? New and established firms in biotech clusters are said to capitalize on knowledge spillovers, labor-market pooling, and other externalities. Some have even argued that such spillovers are so strong that the cluster itself, rather than the individual, is the "locus of entrepreneurship." Such arguments, however, do not resolve the mechanism by which

clusters might contribute to the establishment of new firms. In the paper we study at a theoretical level the interactions between biotech entrepreneurs and clusters as well as the relative contribution of such interactions to entrepreneurial activity and success. In particular, our analysis focuses on the following questions: What cluster resources (e.g. research infrastructure, financing, human capital pools, social capital, etc.) are most important in encouraging biotech entrepreneurship? And, how do the structural characteristics of the cluster (e.g. size, scope, composition, existence of anchor firms, etc.) affect the likelihood of entrepreneurial activity?

Our investigation focuses on two related questions. First, why start a new firm? This question has received considerable attention in the entrepreneurship literature. Using primary data (interviews, surveys, and experiments) and, to a lesser extent, secondary sources (such as the Panel Study on Income Dynamics [PSID]), researchers have identified several individual-level characteristics that are positively correlated with new firm formation. Second, given that an entrepreneur is committed to establishing a new venture, what determines the choice of location? Should the entrepreneur locate in a cluster of same-industry firms, or a more diverse environment with a mix of specialties, or a mix of new and established firms? Why choose one cluster over another? Despite substantial work in economic geography and industrial organization on clusters, little is known about this decision from the entrepreneur's point of view. Building on both the cluster literature and the literature on entrepreneurship, we develop hypotheses about how cluster characteristics, the entrepreneur's personal characteristics, and characteristics of the business environment affect the entrepreneur's decision to establish a new firm.

We argue that a key factor in the location decision is the relative mobility of the appropriate resources. Our main hypothesis is that specialized labor is less mobile than capital and other resources and that it is the base from which entrepreneurs are ultimately created. If so, new firms will emerge in areas characterized by an existing concentration of specialized labor. This labor pool may be "spawned" by universities and incumbent small and larger biotech (or other high-technology) companies. An alternative explanation is that entrepreneurs establish new ventures outside the cluster, then move them to the cluster to take advantage of local knowledge and other

resources. Or a potential entrepreneur could conceive a business plan, then relocate to an existing cluster before founding a firm.

The paper proceeds as follows. We begin with a comprehensive review of the theoretical and empirical literature on the entrepreneur's choice of location, including cluster characteristics, the entrepreneur's individual characteristics, and characteristics of the general business environment. Next we develop a set of hypotheses about the relationship between industry, firm, and entrepreneur characteristics and the spatial distribution of entrepreneurial firms. We conclude by discussing strategies for examining these hypotheses empirically.

Effects of Cluster Characteristics on Biotechnology Startups

Recent years have witnessed a resurgence of interest in the economics of location, particularly as applied to economic growth, international trade, and regional development (see Fujita, Krugman, and Venables, 1999, for an overview). Economists have long recognized (at least since von Thünen) that transportation costs play an important role in the firm's location decision and subsequent profitability. The modern literature builds on Marshall's (1890) concept of agglomeration economies, the benefits from locating close to firms producing complementary or substitute products and sharing key resources and markets. Marshall argued that industrial districts emerge because of horizontal knowledge spillovers, specialized labor markets, and links to vertically related firms. Recent contributions to cluster theory, such as Porter (1998), explain cluster formation in terms of factor conditions, demand conditions, strategic considerations, the presence of supporting industries, regulatory and tax incentives, and chance. Much of the recent literature focuses on location-specific intangibles such as knowledge spillovers from horizontally and vertically related firms; access to universities, incubators, and other sources of specialized technical knowledge; and a general climate for innovation.

Agglomeration economies

The literature has identified two sources of agglomeration economies. The first, *localization economies,* describes the gains from locating close to firms with similar characteristics (firms in the same industry, firms sharing a common organizational or financial structure, firms of similar

age and size, or whatever). The second, *urbanization economies,* describes the benefits of variety or heterogeneity—gains from complementary use of shared resources, experimentation with novel strategies and forms of organization, and the like. While most of the recent literature on agglomeration has focused on localization economies, the benefits from urbanization may be equally important.

Localization economies exist when the gains from locating in a particular place are increasing in the number of "similar" or "related" firms already in that place. Theories of localization depend on the definitions of similar and related. As discussed below, these concepts are often difficult to define precisely.

The literature on geographic concentration emphasizes the resource and vertical dimension of the firms and cluster. "[I]ndividual firms, in aiming to minimize their observable spatial transactions costs, have implicitly or explicitly determined that this is best achieved by locating close to other firms within the particular input-output production and consumption hierarchy of which they are part" (Gordon and McCann, 2000). This attraction of firms through vertical relationships is evident in the biotechnology industry. Prevezer (1997) notes that "sophisticated [biotechnology] buyers attract suppliers of product that the buyer needs. This is attraction via demand for new products and is likely to have been a significant force in the creation of new equipment and research tools companies."

Access to an adequate supply of upstream and downstream firms in the local region provides opportunities for several externalities. Local suppliers encourage close contact and opportunities for cooperation and negotiations to reduce costs and ensure quality and reliability in the vertical relationship (Tallman et al., 2004). Unconventional linkages and industries also play a significant role in the biotech and biomedical industry clusters. Prevezer describes this with importance of related firms in close proximity that employ similar core technologies (1997). However, the presence of these features does not ensure the externalities are achieved as Gordon and McCann describe (2000). Thus, the location of firms and industries provide an indicator of the opportunity for supply and demand externalities. Also, these types of connections are believed to decrease costs when they are engaged within the local cluster (Dalpe, 2003).

The most important spillovers, whether horizontal or vertical, may be less easily observed. Indeed, the literature on clusters and regional development (Kogut and Zander, 1992; Jaffe, Trajtenberg, & Henderson 1993; Adams and Jaffee, 1996; Feldman, 2002) increasingly recognizes the importance of specialized, tacit knowledge. Tacit knowledge, whether scientific, assembled, or idiosyncratic (Jensen and Meclking, 1990), is not easily communicated through explicit, formal channels, but instead can only be acquired through direct observation, participation, or shared experience. Such knowledge is useful not only for imitation and learning, but also for performance benchmarking, "It is by watching, discussing, and comparing dissimilar solutions often emerging form the everyday practices that firms along the horizontal dimension of the cluster become increasingly engaged in the process of learning and continuous improvement, on which their survival depends" (Maskell, 2001). Hanson (2000) concludes that productivity gains are realized through the horizontal dimension. Tallman et al. echoes Maskell's and Hanson's thoughts with the idea that clusters can be attributed to these knowledge spillovers and the economic gains that result (2004). Smaller and younger firms are likely to be more vulnerable and dependent on the local environment for survival and thus may attempt to realize these externalities through the horizontal dimension. Therefore, the horizontal dimension may impact the cluster development and spatial configuration of organizations.

Moreover, to the extent that scientific knowledge is costly to transfer, a region's science base is particularly important for the emergence of clusters of high-technology firms (Prevezer, 1997). Universities, research firms, and large corporations with significant research divisions constitute much of the science base, and thus proximity to the science base is influential to innovative activity and resultant spillovers (Audretsch, 2000; Feldman, 2000a and 2000b; Audretsch & Feldman, 1996; Malmberg, Solvell, & Zander, 1996). Audretsch and Feldman (1996) cite empirical evidence that the concentration of innovative activity is associated more strongly with the presence and role of knowledge spillovers as compared to simply concentration of production activities. It is the need for steady interaction, the uncertain nature of tacit knowledge, innovations, and the process by which both are developed that become significant factors for communication and knowledge flows, which several authors suggest as the leading factor for proximity or "face-

to-face contact" (Malmberg, Solvell, & Zander, 1996). Thus, knowledge spillovers and increased innovation can come about through formal linkages and informal mechanisms. Proximity is influential to realize these opportunities (Gordon & McCann, 2000).

Another strand of literature emphasizes the gains from heterogeneity, or economics of urbanization (Jacobs, 1969; Feldman, 2000). These gains arise from shared infrastructure (including vertical agglomeration economies, on both the supply and demand sides), use of each others' by-products, the availability of complementary resource providers, and gains from experimentation (Desrochers and Sautet, 2004).

As identified in Cortright, the pioneer advocates of urbanization economies were Jacobs and to a lesser degree Chinitz. Jacobs described the beneficial effects that the interactions of diversified economic entities have on economic growth in cities while Chinitz formed a theoretical framework which suggested that urbanization rather than localization economies foster economic growth. Harrison, Kelley and Gant empirically tested the importance of urbanization and localization economies in promoting cluster innovativeness. By using data from the metalworking sector the authors found that urbanization economies were conductive to the adoption of a new technology, which was the measure for innovativeness. Glaeser et. al also found positive effects of urbanization economies: the concentration of firms from diverse industries in a city, boosted the employment growth. The study used a comprehensive data set containing information in 22 industries in every U.S. county. Additionally, Staber (2001) using a hazard model of failure rate and historical data from the knitwear industry in a German region found that the presence of firms from the same industry increased the failure rate, while the positioning of firms in diversified clusters of complementary industries reduced failure rates.

Other studies did not explicitly study the effects of urbanization economies but part of their results provided support against localization economies. Prevezer empirically showed that as the employment in a certain biotechnology sector increased (as a result of more own-sector companies located in the cluster), the attraction of own sector new companies to be located in the cluster decreased. The explanation given by the author was the negative effect of prospective competition, but one can alternatively interpret this as an indication of non-existent localization econo-

mies. Alecke et. al used data providing information on plant level employment across counties for Germany's 116 manufacturing industries. They found no statistically significant relationship between agglomeration and high-tech firms among German manufacturing industries, and they interpreted these findings as evidence against localization economies from knowledge spillovers. Therefore the empirical studies introduced previously focused on pecuniary externalities, used different performance indicators (innovation, employment growth and failure rate) and pulled data from diverse industries but they all concluded that urbanization economies enhanced the economic performance of firms. The studies by Harrison, Kelley and Gant, Glaeser et al. and Staber did not disentangle the ways in which these pecuniary externalities were achieved (i.e. Marshallian externalities or Porter's competitive forces).

The mixed evidence on the relative importance of localization versus urbanization economies appears to derive from differences in theoretical frameworks, the operationalization of key variables. Studies using employment growth to measure entrepreneurial activity have supported both urbanization and localization economics (Prevezer; Glaeser et al.; Henderson 1997; Beaudry). In studies that use innovation as the performance measure there is a more uniform consensus that localization effects outweigh urbanization effects (Beaudry and Breschi; Beaudry; Acs, FitzRoy and Smith; Harrison, Kelley and Gant). Other studies also presenting mixed results have used performance measures beyond employment and innovation. Staber measured the cluster failure rate and the effects that urbanization and localization economies have on it. His research yielded results in line with urbanization economies. Staber's study is the only one that used a hazard model and thus it is not directly comparable with any other. Nevertheless, it raises the question of whether the empirical technique plays a role in reaching conclusions. Put it differently, if the study had the same data but another econometric estimation, would the pro-urbanization results still hold? Henderson (2003) used productivity as a measure of economic performance and he found evidence of localization economies. As we have already discussed, the important role of the choice of the variable representing performance is apparent in this case too.

Product Differentiation

Other structural factors interact with agglomeration economics to affect locational choice. Belleflamme, Picard and Thisse argume that once firms co-locate due to the cost reductions derived from localization economies the threat of severe price competition can be overcome by product differentiation. Firms avoid the classical zero economic profit outcome of Bertrand competition by differentiating their products and consequently softening the price rivalry. The authors develop their theory by assuming that localization economies result to a marginal cost reduction and the choice of location comes down to a. the comparison of the magnitude between the transportation costs and this cost reduction, and b. the nature of the firm competition (price competition or not).

When products are differentiated, i.e. non-price competition, firms are expected to cluster since they are able to obtain some economic profit. If for example the nature of the rivalry is that of Cournot competition, firm reaction curves slope downwards allowing competing firms to make profit (Varian). It is then straightforward to anticipate location choice to be positively related to clusters where products are differentiated.

Aldrich's theory of firm foundation is one of the few that examines the conditions affecting the rate at which organizations are added to an existing population, like a cluster. He examines three processes affecting the foundation rate: those occurring within populations (prior deaths, prior births, density dependence etc), those occurring between populations (type of competition, sources of capital), and those occurring in the institutional environment (political factors, culture etc). The theory focuses on the time-dependent nature of organizational foundings—"knowing when something occurs is as important as knowing why it occurred." The theory does not account for the type of firms founded, but it deals with the aggregate addition rate.

One of the intra-population processes discussed in the theory is density dependence. Density is simply defined as the number of organizations in a cluster. Aldrich discussed both the positive and the negative consequences of density dependence. The former included rising legitimacy and institutionalization of an organizational form, spreading availability of knowledge and skills

and possibility of collective action while the latter included diminishing returns and smaller potential gains as competitors become more numerous and the cluster approaches its carrying capacity. The intuition of the positive and negative effects is that if the cluster is already dense, the chances of a newly founded firm being dominant are rather slim. Therefore, the propensity of firms to be located in dense clusters is positive unless the cluster approaches its carrying capacity.

Most of the literature described above focuses on the benefits of clusters more generally, not the benefits of clusters for startups specifically. A few studies describe the effects of cluster characteristics on entrepreneurial activity more explicitly.

Cooper and Folta explored the relationship between clusters and high-technology start-up companies. It is a fairly comprehensive literature review on the research that has taken place on clusters. Using descriptive statistics and findings from prior studies the authors concluded that start-ups (measure of entrepreneurship) mainly occur in clusters because within them there is specialized labor and inputs, access to capital, knowledge spillovers, proximity to customers and psychological support.

Blasio and Addario used Italian data from several industries and regressed the probability of being entrepreneur and the probability of becoming entrepreneur if already employed, on the location in a cluster and several other controls. Entrepreneurship was defined as the pursue of an entrepreneurial activity. The empirical results showed that clusters were aligned with higher chances of being entrepreneur either by immediately starting a new business or by creating a new venture after being previously employed elsewhere in the clusters. Rocha and Sternberg also had similar results to Blasio and Addario. In their empirical article using data from Germany, entrepreneurship was defined as the creation of new business and it was measured by the number of nascent and new firms. The authors distinguished between clusters and industrial agglomerations by defining the latter as a special case of clusters in which the only interactions between firms is via price signals. Industrial agglomerations were defined as clusters without networks, especially social. The results showed that clusters had an impact on entrepreneurial activity, while industrial agglomerations did not.

Sternberg and Litzenberger empirically tested the hypothesis that the existence of one or several industrial clusters in a region has a positive impact on the number of start-ups and attitudes in the same region. The start-ups were aligned with the notion of entrepreneurship. Using t-tests among clustered and non-clustered sectors of the manufacturing and services industries the authors observed that clustered regions were stronger in terms of entrepreneurial activity.

Feldman mentions that the literature has formed a conventional wisdom on the connection between entrepreneurship and clusters while Cortright's brief literature review concludes that the studies analyzing the issue have a consensus on the positive relationship. Additionally, Rocha's more comprehensive literature review presented the evolution of studies in cluster economics, the different schools of thought, the different definitions of cluster and entrepreneur and finally the theoretical and empirical approaches on the role of clusters on entrepreneurship. On the latter, the author concluded that in general the literature has argued in favor of the relationship between clusters and entrepreneurship. He noted several factors fostering entrepreneurship within clusters: more available information about opportunities; lowering of entry and exit barriers; low degree of vertical integration leading to more niches of specialization; competition forces; providing role models of successful firms; knowledge spillovers; providing access to physical, financial and commercial infrastructure and finally providing a culture where new business formation is natural and failure does nor constitute a social stigma.

A few additional articles have shown that clusters are conductive to innovation but they have not made the explicit connection of innovation and entrepreneurship. Feldman's literature review concluded that geographic proximity does matter in the creation of innovations while Bonte constructed a lifetime growth model pooling data from a survey of CEO's rating the relevance of several agglomeration forces (knowledge flows, demanding customers and firm rivalry) on innovation. He did find a positive impact of geographic proximity on innovation but only the effects of demanding customers were cluster specific. Beaudry and Breschi also empirically found that even though clustering per se does not enhance innovation, firms located in clusters possessing certain characteristics are more innovative that firms located outside. Measuring innovation by number of patents, the authors found that if a firm is located in a cluster containing other innova-

tive firms, then its performance in terms of producing more patents is enhanced. Furthermore, Bell's empirical study verified the notion of cluster firms being more innovative than outside cluster firms. The results indicated that enhanced innovation was attributed to managers' social ties while formal ties among firms had no effect on innovativeness. The article differed from the majority of articles dealing with cluster economics in that it was one of the few that used data for a non-high technology industry: mutual funds. Baptista and Swann using data on UK innovations from 248 manufacturing firms from during the 1975 to 1982 period found that cluster firms are more likely to innovate than outside firms if the own-sector employment in the locale is strong.

Baptista (2000) built a duration model where the dependent variable was the time that firms from the engineering and metalworking industries adopt a new innovation. The results indicated that if early adopters are located in the clusters, then innovations do diffuse faster. The theoretical explanation given for that observation was the significance of learning effects. As in Bonte, Beaudry and Breschi, and Baptista innovation was not connected to entrepreneurship neither explicitly not –we believe- implicitly.

On the other hand, Khan and Ghani made the connection between entrepreneurship and innovation. Using a case study the authors proposed that technological innovation is a potent characteristic of clusters and it is a central aspect of entrepreneurial activity. Rocha in his literature review, also identifies other authors that have defined entrepreneurship as the pursuit of innovation (for a review see Wennekers and Thurik, Davidsson et al) just like Breschi and Malerba did in their paper. The non-connection of innovation and entrepreneurship seems peculiar since, as identified in both reviews by Baptista (1999) and Rocha, one of the first studies related to the issue carried on by Schumpeter in 1934 explicitly made the connection. One can validly argue though that the focus of the studies that did not make the connection was different and this is why entrepreneurship was not explicitly discussed.

Characteristics of the Individual Entrepreneur

A substantial literature in the economics of entrepreneurship—drawing primarily on labor economics, but also applied psychology, network theory, and sociology—examines the charac-

teristics of individuals who become entrepreneurs (i.e., who found new companies). The most important of these characteristics are experience, education, age, wealth, parental background, social status, and social ties.

Experience

The most important determinant of an individual's proclivity to create a new business venture is work experience, both as an entrepreneur and as an employee. Employees of established firms may become entrepreneurs to exploit knowledge and experiences acquired during their tenure with their employers—i.e., by becoming part of an entrepreneurial network "spawned" from a knowledge-intensive parent. The birth of Silicon Valley as a network of firms founded by former employees of Fairchild Semiconductor, fits this profile (Saxenian). Alternatively, employees may become self-employed because they are frustrated with the firm's bureaucratic environment, which stymies their innovative ideas (Gompers, Lerner, and Scharfstein call this the Xerox model), or because they are fired (cite).

Gompers et al. (2006) show that entrepreneurs who successfully brought at least one project to fruition (i.e., started a company that subsequently went public) are nearly twice as likely to succeed in their next venture as a first-time entrepreneur. (They also find—contrary to some conventional wisdom among practitioners—that entrepreneurs who failed in their last project are not much more likely to succeed in their next one as someone who has never tried.) Other papers examining "serial entrepreneurs" include Eesley and Roberts and Bengtsson (20005, 2006).

Education, age, wealth, parental background, and social status

A number of studies find a positive correlation between self-employment and education, age, wealth, and parental background. Consider age, for example. The decision to start a company depends, on the margin, on outside opportunities. For this reason, the relationship between entrepreneurial activity and age is curvilinear. As individuals get older, their increased experience, skills, and knowledge expand their entrepreneurial opportunities. On the other hand, their oppor-

tunity wages also increase. Early in the professional life-cycle, the former effect appears to dominate the latter, with the relationship becoming reversed later in the life cycle.

Several studies have also found that the children of entrepreneurs are more likely to become entrepreneurs than the children of non-entrepreneurs, suggesting a role for tacit learning about the entrepreneurial process. (see Shane, pp. 87-88). Membership in a dense social network is also positively correlated with the decision to start an entrepreneurial venture. (Begley and Tan)..

Linking the entrepreneur to the cluster

Audretsch developed the Knowledge Spillover Theory of Entrepreneurship (KSTE), which posits that new entrepreneur firms emanate from knowledge investments from public research and incumbent firms, which are not fully appropriated or commercialized. If an employee (or a group of employees) of an established firm feels that he will not appropriate the expected value of an idea or innovation generated internally, then if the benefits outweigh the costs the employee will start his own firm. Audretsch and Lehmann tested whether KSTE holds for regions where there is abundance of knowledge stock such as areas surrounding universities. The empirical estimation included the number of firms located closest to a university as the dependent variable verified the propositions of KSTE.

The Role of the Business Environment

Besides the cluster and individual characteristics mentioned above, the decision to locate a new venture in one place or another depends on a series of background, or business environment, features.

Clusters of firms may emerge simply because each firm benefits from access to key resources such as physical resources and infrastructure, specialized labor markets, or “anchor” entities such as universities, research facilities, or established firms. In other words, groups of similar firms may locate nearby even in the absence of agglomeration economies; co-location is an incidental byproduct of entrepreneurs’ individual decisions, rather than an objective in itself.

Krugman (1991) emphasizes the importance of natural endowments and advantages. Local endowments include natural resources that are key supply factors for an industry or natural geographic features such as ports. If transportation costs are sufficiently high, or inputs or products are highly perishable, firms will tend to cluster near these local endowments. Basic infrastructure such as roads and rail lines, utilities, airports, warehouses, and the like can also provide local advantages (Gordon & McCann, 2000; Walcott, 1999). Cetindamar and Laage-Hellman (2003) emphasize the importance of infrastructure for biomedical and biotechnology firms in Ohio and Sweden; Dalpe (2003) also highlights the importance of infrastructure for small biotech firms (2003).

As mentioned above, a specialized labor force is one of Marshall's three determinants of regional concentration (Fingleton, Igliori and Moore, 2003). Complementary industries may often rely on the same core workforce, and consequently co-locate to take advantage of this shared resource. Krugman (1991) argues that risk and increasing returns create a labor-market network effect; the larger the labor market and the network of firms using it, the greater the benefits for the individual employer. Labor pooling externalities may include reduced search costs for firms and individuals, diffusion of technical knowledge among organizations with the rearrangement of employees among organizations (Glaeser, 2000), a rich supply of skilled labor (Glaeser, 2000; Krugman, 1991), productivity gains, and the like.

Besides physical resources and infrastructure, labor markets, and other inputs, the presence of particular firms or organizations, known as "anchors," can also affect the entrepreneur's location choice. Feldman (2002) argues that "existing firms may serve as anchors that establish skilled labor pools, specialized intermediate industries and provide knowledge spillovers for new technology intensive firms in the region" (see also Audretsch and Feldman, 1996). Universities, nonprofit research institutions and foundations, or incubators can also serve as anchors (cites). Incubators are particularly important for new life-sciences firms (Cetindamar and Laage-Hellman, 2003).

Several papers also examine the relationship between the legal, regulatory, and political climate and general levels of entrepreneurial activity. Kreft and Sobel, for example, use state-level

data on startups, venture capital, and the Fraser Institute Index of Economic Freedom to show that states with lower tax burdens, modest and transparent regulatory regimes, and protection for property rights attract more venture capital which, in turn, spurs entrepreneurial activity. Comprehensive data on these aspects of the business environment are difficult to obtain at the city or county level, but could be assessed from survey data on respondents' subjective perceptions of legal, regulatory, and political constraints.

Hypotheses and Strategies for Empirical Analysis

The foregoing discussion suggests several testable hypotheses about the location of entrepreneurial firms in the life sciences industry. Our reading of the literature suggests the following general model of location:

> p (entrepreneur *i* starts a firm in cluster *j*) = f(**C**, **E**, **X**), where **C** is a vector of cluster characteristics, **E** a vector of entrepreneur characteristics, and **X** a vector of business environment characteristics and control variables).

The vector **C** includes measures of urbanization economies (+), localization economies (+), product differentiation (+), and the entrepreneur's expected position in cluster. The vector **E** includes prior entrepreneurial experience (in any sector) (+), prior life-sciences employment experience) (+), education (+), age (U-shaped), wealth (+), self-employed parent (+), social status (+), and social ties (+). The vector **X** includes access to specialized resource (+), transportation costs (−), the availability of venture capital (+), and measures of institutional characteristics such as economic freedom (+).

One strategy for empirical implementation of this model is to collect data from founding entrepreneurs about their ventures, where their ventures were founded, and their perceptions about the strength of various cluster, entrepreneur, and business environment characteristics in the decision to establish a new venture. Our analysis suggests the following potential hypotheses:

> Proposition 1: Entrepreneurs are more likely to start firms in the presence of previously existing agglomeration economies (economies of urbanization or localization)

The importance of agglomeration economies is one of the best established results in the existing literature. The problem is the direction of causality; do agglomeration economies, once established, attract additional firms, or do firms come into existence in particular locations for other reasons, leading to agglomeration economies ex post? By measuring the founding entrepreneur's perception of the role of agglomeration economies before choosing to locate in the cluster (by founding a new firm in the cluster or moving an existing firm to the cluster) we can avoid the endogeneity problems that plague studies based on secondary data.

Both economies of localization and economies of urbanization are viewed in the literature as important. The relationship between the relative strength of these factors and industry age is not established clearly, so we cannot say, a priori, which effect is likely to dominate in an emerging industry like biotechnology. Because nascent industries like biotech are unable to draw on localized pools of highly specialized labor, but must rely on more heterogeneous pools of workers with general skills, we conjecture that the urbanization effect outweighs the localization effect, suggesting Proposition 2:

> Proposition 2: Urbanization economies will have a greater impact than localization economies in the firm founding decision in biotechnology.

The literature on market structure discussed above suggests that firms prefer to avoid intense price competition, leading to Proposition 3:

> Proposition 3: Price competition in the target market lowers the probability of starting a new venture in that market.

Entrepreneurs pay attention not only to the existence of clusters, but the cluster density, structure and the entrepreneur's expected position within the cluster. The discussion above suggests a nonlinear relationship between cluster density and attractiveness to new firms. From this we derive an additional proposition:

> Proposition 4: The effect of cluster density on the probability an entrepreneur will locate in a particular cluster is increasing up to a threshold level and decreasing afterwards.

To examine these propositions, we are designing a survey of founding entrepreneurs in life-sciences companies, both inside and outside the major clusters located throughout the U.S. The main variable of interest is the role of locational factors in the entrepreneur's start-up decision. We will ask our sample entrepreneurs if they started their firms where they already lived and worked, if they started firms elsewhere before moving to their current location, or if they moved to their current location specifically to start a new life-sciences firm. We will also ask about the entrepreneur's personal characteristics (age, education, wealth, prior entrepreneurial experience, prior employment experience) and the entrepreneur's perception of the business environment factors that have contributed to their entrepreneurial success (ease of access to specialized physical, labor, and financial resources; access to relevant personal/social networks, etc.). We will combine the survey data with secondary data on firm and regional characteristics to provide comprehensive cross-section of the nascent life-sciences industry.

References

Acs, Z. J., F.R. FitzRoy and I. Smith "High – Technology Employment and R&D in Cities: Heterogeneity vs. Specialization." *Annals of Regional Science* 36 (2002): 373-386

Aldrich**,** Howard E. "Using an Ecological Perspective to Study Organizational Founding Rates." *Entrepreneurship: Theory & Practice* 14.3 (1990): 7-24.

Alecke, B., C. Alsleben, F. Scharr and G. Untiedt. "Are There Really High-Tech Clusters? The Geographic Concentration of German Manufacturing Industries and its Determinants." *Annals of Regional Science* 40 (2006):19-42

Almeida, P., and B. Kogut, "The Exploration of Technological Diversity and the Geographic Localization of Innovation." *Small Business Economics* 9 (1997):21-31.

Alsleben, C. "The Downside of Knowledge Spillovers: An Explanation for the Dispersion of High-tech Industries." *Journal of Economics* 84.3 (2005):217-248.

Alvarez, S.A., and J.B. Barney. "Special Issue on the Entrepreneurial Firm." *Journal of Management Studies,* forthcoming.

Amit R., l. Glosten and E. Muller., "Entrepreneurial Ability, Venture Investments and Risk Sharing" *Management Science* 36.10 (1990): 1232-1245.

Appold, S.J. "Agglomeration, Interorganizational Networks, and Competitive Performance in the U.S. Metalworking Sector." *Economic Geography* 71.1 (January 1995): 27-54.

Audretsch, B.D. and E.E. Lehmann. "Does the Knowledge Spillover Theory of Entrepreneurship Hold for Regions?" *Research Policy* 34 (2005): 1191-1202.

Baptista, R., "The Diffusion of Process Innovations: A Selective Review." *International Journal of the Economics of Business* 6.1 (1999): 107-129.

Baptista, R., "Do Innovations Diffuse Faster Within Geographical Clusters?" *International Journal of Industrial Organization* 18 (2000): 515-535.

Barnes S. and V. Menzies, "Investment into Venture Capital Funds in Europe: An Exploratory Study." *Venure Capital* 7.3 (2005): 209-226.

Baum, A.C.J and B.S. Silverman, "Picking Winners of Building them? Alliance, Intellectual and Human Capital as Selection Criteria in Venture Financing and Performance of Biotechnology Startups." *Journal of Business Venturing* 19 (2004): 411-436.

Beal, D.B. "Geographic Agglomeration, Knowledge Spillovers, and Competitive Evolution." PhD Dissertation. Texas A&M University, 2001.

Beal D.B. and J. Gimeno. "Geographic Agglomeration, Knowledge Spillovers, and Competitive Evolution." *Academy of Management Proceedings* 2001.

Beaudry, C., "Entry, Growth and Patenting in Industrial Clusters: A Study of the Aerospace Industry in the UK." *International Journal of the Economics of Business* 8.3(2001):405-436.

Beaudry, B., and S. Breschi. "Are Firms in Clusters Really More Innovative?" *Economics of Innovation & New Technology* 12.4: 325-342.

Begley, T.M., and W.L. Tan. "The Socio-Cultural Environment for Entrepreneurship: A Comparison Between East Asian and Anglo-Saxon Countries." *Journal of International Business Studies* 32 (2001): 537-533.

Bell, G.G., "Research Notes and Commentaries Clusters, Networks, and Firm Innovativeness." *Strategic Management Journal* 26 (2005): 287-295.

Belleflamme, P., P. Picard and J.F. Thisse. "An Economic Theory of Regional Clusters." *Journal of Urban Economics* 48.1 (July 2000): 158-184.

Berk, R.A., "An Introduction to Sample Selection Bias in Sociological Data." *American Sociological Review* 48.3 (June 1983): 386-398.

Bianchi, P., L.M. Miller, and S.Bertini, "The Italian SME Experience and Possible Lessons for Emerging Countries." Discussion Paper 1997.

Blasio, G. and S. Addario. "Do Workers Benefit From Industrial Agglomeration?" *Journal of Regional Science* 45.4 (2005): 797-827.

Bonte, W. “Innovation and Employment Growth in Industrial Clusters: Evidence from Aeronautical Firms in Germany.” *International Journal of the Economics and Business* 11.3 (November 2004): 259-278.

Breschi, S., and F. Lissoni. “Localised Knowledge Spillovers vs. Innovative Milieux: Knowledge “tacitness” Reconsidered.” *Papers in Regional Science* 80 (2001): 255-273.

Breschi, S., and F. Malerba, “The Geography of Innovation and Economic Clustering: Some Introductory Notes.” *Industrial and Corporate Change* 10.4 (2001): 817-833.

Bresnahan, T., A. Gambardella and A. Saxenian, “Old Economy Inputs for New Economy Outcomes: Cluster Formation in the New Silicon Valleys.” *Industrial and Corporate Change* 10.4 (2000): 835-860.

Caniels, M.C.J., and H.A. Romijn, “What Drives Innovativeness in Industrial Clusters? Transcending the Debate.” *Cambridge Journal of Economics* 29 (2005): 497-515.

Carlton, W.D., “The Location Choice and Employment Choices of New Firms: An Econometrc Model with Discrete and Continuous Endogenous Variables.” *Review of Economics and Statistics* 65 (1983): 440-449.

Chinitz, B. “Contrasts in Agglomeration: New York and Pittsburg.” *American Economic Review* 51: 279-289.

Combes, P.P. and G. Duranton. “Labor Pooling, Labor poaching and Spatial Clustering.” *Regional Science and Urban Economics* 36 (2006): 1-28.

Cooper, A. C. and Folta, T. (2000) Entrepreneurship and high technology clusters, in: D. L. SEXTON and H. LANDSTRO¨M (Eds) *The Blackwell Handbook of Entrepreneurship*, pp. 348–367. Oxford: Blackwell.

Cortright, J. “Making Sense of Clusters: Regional Competitiveness and Economic Development.” Discussion Paper. March 2006

Dean**,** T.J.; Meyer, G. D.; DeCastro, Julio. “Determinants of New-Firm Formations in Manufacturing Industries: Industry Dynamics, Entry Barriers, and Organizational Inertia.” *Entrepreneurship: Theory & Practice* 17.2 (Winter 1993): 49-60.

Feldman, P.M., “The New Economics of Innovation, Spillovers and Agglomeration: A Review of Empirical Studies.” *Economics of Innovation & New Technology* 8 (1999): 5-25.

Feldman, P.M., “The Entrepreneurial Event Revisited: Firm Formation in a Regional Context.” *Industrial and Corporate Change* 10.4 (2001): 861-891.

Feldman, P.M., J. Francis and J. Bercovitz. “Creating a Cluster While Building a Firm: Entrepreneurs and the Formation of Industrial Clusters” *Regional Studies* 39.1 (February 2005): 129-141.

Folta, B.T., A.C. Cooper and Y. Baik., "Geographic Cluster Size and Firm Performance." *Journal of Business Venturing* 21 (2006): 217-242.

Gartner**,** W. B. "A Conceptual Framework for Describing the Phenomenon of New Venture Creation." *Academy of Management Review* 10.4 (1985): 696-706.

Glaeser L. E., et al. "Growth in Cities" *Journal of Political Economy* 100.6 (1992): 1126–1152.

Hakanson, L., "Epistemic Communities and Cluster Dynamics: On the Role of Knowledge in Industrial Districts." *Industry and Innovation* 12.4 (2005): 433-463.

Hakanson, L., "Epistemic Communities and Cluster Dynamics: On the Role of Knowledge in Industrial Districts." Academy of Management Proceedings; 2004.

Harrison, T.R., S.Y. Cooper and C.M. Mason. "Entrepreneurial Activity and the Dynamics of Technology-based Cluster Development: The Case of Ottawa." *Urban Studies* 41.6 (May 2004): 1045-1070.

Harrison, B., M.R. Kelley and J. Gant., "Innovative Firm Behavior and Local Milieu: Exploring the Intersection of Agglomeration, Firm Effects and Technological Change." *Economic Geography* 72.3 (July 1996): 233-258.

Head, K., J. Ries and D. Swenson., "Agglomeration Benefits and Location Choice: Evidence from Japanese Manufacturing Investments in the United States." *Journal of International Economics* 38 (1995): 223-247.

Hellmann, T. and M. Puri., "Venture Capital and the Professionalization of Start-Up Firms: Empirical Evidence" *The Journal of Finance* 57 (2002): 169-197.

Henderson, V., "Externalities and Industrial Development." *Journal of Urban Economics* 42 (1997): 449-479.

Henderson, V., "Marshall's Scale Economies." *Journal of Urban Economics* 53.1 (2003): 1-28.

Jacobs, J. *The Economy of Cities* London: Penguin Books.

Khan, H.J., and J.A. Ghani., "Clusters and Entrepreneurship: Implications for Innovation in a Developing Economy." *Journal of Developmental Entrepreneurship* 9.3 (December 2004): 221-237.

Klepper, S., "Employee Startups in High-Tech Industries." *Industrial and Corporate Change* 10.3 (2001): 639-673.

Kortum, S., and J. Lerner. "Assessing the Contribution of Venture Capital to Innovation." *RAND Journal of Economics* 31.4 (2000): 674-692.

Kreft, S., and R. Sobel. "Public Policy, Entrepreneurship, and Economic Freedom." *Cato Journal* 25.3 (2005): 595-616.

Krugman, P. *Geography and Trade.* Cambridge, Mass.: MIT Press

Marshall, A. *Principles of Economics* London: McMillan

Maskell, P., "Towards a Knowledge-based Theory of the Geographical Cluster." *Industrial and Corporate Change* 10.4 (2001): 921-943.

Malmberg A. and D. Power. "(How) Do (Firms in) Clusters Create Knowledge?" *Industry and Innovation* 12.4 (December 2005): 409-431.

Porter, M.E. *The Competitive Advantage of Nations.* Free Press

Pouder, R., and C.H.St. John., "Hot Spots and Blind Spots: Geographical Clusters of Firms and Innovation." *Academy of Management Review* 21.4 (1996): 1192-1225.

Power, D. and M. Lundmark. "Working through Knowledge Pools: Labor Market Dynamics, the Transference of Knowledge and Ideas, and Industrial Clusters." *Urban Studies* 41.6 (May 2004): 1025-1044.

Prevezer, M., "The Dynamics of Industrial Clustering in Biotechnology." *Small Business Economics* 9 (1997): 255-271.

Rocha, O.H., "Entrepreneurship and Development: The Role of Clusters." *Small Business Economics* 23 (December 2004): 363-400.

Rocha, H. and R. Sternberg. "Entrepreneurship: The Role of Clusters Theoretical Perspectives and Empirical Evidence from Germany." *Small Business Economics* 24 (2005): 267-292.

Shane, S. *A General Theory of Entrepreneurship: The Individual-Opportunity Nexus.* Cheltenham, UK: Edward Elgar, 2003.

Shaver, J.M. and F. Flyer. "Agglomeration Economies, Firm Heterogeneity, and Foreign Direct Investment in the United States." *Strategic Management Journal* 21 (2000): 1175-1193.

Shepherd A.D. and A. Zacharakis, "The Venture Capitalist-Entrepreneur Relationship" Control, Trust and Confidence in Co-operative Behaviour" *Venture Capital* 3.2 (2001): 129-149.

Staber, U. "Inter-firm Co-operation and Competition in Industrial Districts." *Organization Studies* 19.4 (1998): 701-724.

Staber, U. "Spatial Proximity and Firm Survival in a Declining Industrial District: The Case of Knitwear Firms in Baden-Württemberg." *Regional Studies* 35.4 (2001): 329-341.

Sternberg, R. and T. Litzenberger. "Regional Clusters in Germany-their Geography and their Relevance for Entrepreneurial Activities" *European Planning Studies* 12.6 (September 2004): 768-791.

Tyebjee T.T. and A.V. Bruno., "A Model of Venture Capitalist Investment Activity" *Management Science* 30.9 (1984): 1051-1066.

Varian, H.R. *Microeconomic Analysis* New York: W.W. Norton & Company, 1992.

Williams R.D., W.J. Duncan and P.M. Ginter., "Structuring Deals and Governance after the IPO: Entrepreneurs and Venture Capitalists in High-Tech Start-ups." *Business Horizons* 49 (2006): 303-311.