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# Homegrown Solutions: Fostering Cluster Formation

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*The 1980s ushered in a new era in technology and economic development policy as a result of increasing competitive pressure. Start-up companies built around commercializing new technologies developed in public or private labs were seen as a means to reinvigorate economies and renew industrial competitiveness in high-technology fields. This article considers the perspective of the small innovative firm and the question of what small technology-intensive firms want from state economic development programs. Drawing on a review of the literature and a series of case studies of cluster development, this article presents a set of stylized facts and policy recommendations.*

**Keywords:** *industry clusters; entrepreneurship; high-tech industrial development; regional growth*

In 1995, the states of Maryland and Ohio engaged in a bidding war over the football franchise that changed the Cleveland Browns into the Baltimore Ravens. This bidding war, waged with escalating incentives and tax breaks, captured media and public attention. After all, hosting an NFL franchise signals that a city has arrived or reached major metropolitan status. This type of bidding war is a well-known feature of the old economy. At the same time, Maryland and Ohio were waging another battle using the same economic tools. At stake was the future location of the burgeoning biotech firm MedImmune. The number of jobs, fewer than 200, was small by economic development standards. This battle was really over capturing the future economic benefits of a knowledge-based, entrepreneurial industry, sparking regional transformation by transplanting a cutting-edge firm. To the extent that these industries are perceived to be the next wave of economic development, locations without them are perceived to be losers (MacRae, 2002). Empirical evidence demonstrates that tax incentives and relocation subsidies did not induce the desired results in traditional manufacturing industries (Bartik, 1991; Papke, 1991). Such incentives have even less economic justification in early-stage, innovative industries characterized by long gestation periods, where tax subsidies are irrelevant because the firms are not yet profitable. In contrast to the tradition of offering incentives to recruit companies, an understanding of agglomeration externalities and cluster formation reveals that different factors are important in developing high-tech industries.

Certain places are associated with particular industrial activities, such as computers and semiconductors in Silicon Valley, movies in Hollywood, automobiles in Detroit, biotechnology in Boston, or medical devices in Minneapolis. This clustering reflects dynamic agglomeration economies—the economies of scale generated by locating in the same geographically bounded

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space as other firms working on similar technologies or products. Alfred Marshall's (1949) well-known quote that "the secrets of the industry are in the air" (pp. 152-153) implies that certain locations enhance firm productivity through externalities that are beyond the capability of markets to price but that represent positive economic value. Some of these "secrets" today are recognized to be such factors as improved communication among suppliers and competing firms, simplified exchange of ideas, and proximity to service providers. There is no evidence that industrial incentives were a driving force to these locations. Rather, these clusters developed endogenously using their ability to leverage location-specific assets to induce new investment and create new value; no incentive program can be identified a priori (Feldman & Francis, 2002).

Entrepreneurs play a special role in cluster formation. Entrepreneurs start firms that capitalize on technological opportunities, adapting scientific breakthroughs and generic technologies to create new product markets and reorganize economic activity. Through their individual decisions in creating and developing new companies, entrepreneurs may collectively also spark regional industrial transformation. Cluster formation is a complex and self-organizing process that occurs in developmental stages. Agglomeration economies emerge over time from the activities of individual entrepreneurs and the institutions that coevolve to support them. The attributes observed in a mature and fully functioning cluster are artifacts of the formation process and reflect attributes and relationships formed as the cluster developed, rather than preconditions for cluster development. Understanding the process of cluster formation may be expedited by considering the motives and constraints of entrepreneurs as they form and grow their innovative small firms.

This leads to the question, from the perspective of economic development policy, what do small firms want? Also, what can state governments do to promote entrepreneurship and firm growth and, thus, capture the benefits of the new knowledge-based economy? Most evaluations of state economic development focus on the outcomes of specific programs, often highlighting successes or generating report cards against some normative standard. This article proposes to shift the unit of analysis to small start-up firms and their entrepreneurs and to consider cluster formation from the perspective of the resources small firms use in growing a business, the barriers they encounter, and possible solutions.

We begin by offering some context for knowledge-based economic development strategies. Characteristics of knowledge-based industries, such as increasing returns, positive externalities, the importance of high-skilled labor and communications networks, and the differences among technological trajectories imply the need for new strategies. This article provides a set of stylized facts about technology-based economic development and a discussion of current concepts that potentially limit both firm and cluster development. We conclude with suggestions for additional research.

### NEW STRATEGIES TO PROMOTE ECONOMIC GROWTH

**The emphasis has shifted in economic development policy to the current view that clusters of firms and supporting institutions are the key to creating and sustaining global competitive advantage.**

As the barriers to trade and costs of transportation have decreased and the speed of communication has increased, paradoxically, geographically defined clusters of related firms have become fundamental cornerstones of regional economic growth and national competitiveness. The emphasis has shifted in economic development policy to the current view that clusters of firms and supporting institutions are the key to creating and sustaining global competitive advantage (Porter, 1990). The evidence begins with Italy's Emilia-Romagna region (Piore & Sable, 1984) and continues with what may only be regarded as an infatuation with California's Silicon Valley and its economic success.

The old strategy of providing economic incentives is based on the neoclassical view that firms' decisions are responsive to small differences in input prices. According to microeconomic theory, firms should prefer locations that offer lower factor prices, and, therefore, state programs that reduce costs should influence locational choices. In equilibrium, firms choose locations that offer the lowest cost of production. However, for high-technology firms in particular, skilled labor services and proximity to sources of knowledge and expertise are much more important than factor cost reductions. Indeed, innovative start-ups are frequently creating new markets where no compe-

tion exists and demand is not sensitive to product costs. The small firms' competitive advantage lies in being first to market or offering a higher quality product. Small firms, lacking the resources of their larger counterparts, are more dependent on resources in their local environments. Indeed, many times, small firms become the mechanism by which a new technology is commercialized. Therefore, the success of the firm and the success of the region are interrelated or endogenous, in the terminology of economics.

The cases where governments have established a cluster by fiat, such as Science Park in Taiwan or the Bio-Regio clusters in Germany, do not always generate mature, innovative, and profitable clusters. In many cases, the attempt to artificially establish a cluster where none existed previously has resulted in failure or has spawned a completely different type of cluster from what was initially envisioned. A good example of the latter is New Jersey's attempt to create a Silicon Valley high-tech sector along the turnpike, which eventually resulted in a limited research consortium (Leslie & Kargon, 1997). Cortright and Mayer (2001) concluded that no general set of conditions generated particular industrial clusters in the United States; instead, unique factors appeared to be associated with each. An alternative view is that cluster formation is a process predicated on the actions of entrepreneurs and their symbiotic relationships with their local environments. The cluster and its characteristics therefore emerge over time from the individual activities of the entrepreneurs and the organizations and institutions that evolve to support them.

New economic development strategies may be informed by recognizing the endogenous nature of regional industrial development. A literature is developing that considers the formation of clusters and the processes by which local economies are able to garner the rewards of investments made in resources that support innovation according to Markusen's (1996) typology to make the transition from slippery to sticky.

### THREE STAGES OF CLUSTER FORMATION

Case studies of the formation of industrial clusters suggest that a complex, self-organizing process is at work (Chiles, Meyer, & Hensch, 2002; Feldman, 2000; Feldman & Francis, 2001). The typical formation of an entrepreneurial environment appears to be characterized by three general stages. In the initial stage, the region is inert: Few, if any, entrepreneurial start-up companies exist within the industry of interest. The region may have assets in terms of universities, government labs, and large companies, but it does not have significant entrepreneurial activity.

The movement from latent to active entrepreneurship appears to be in response to some exogenous shock. For some regions, the exogenous shock may be corporate mergers and acquisitions, such as occurred with the New Jersey electronics industry (Leslie & Kargon, 1994). In Washington, D.C., government downsizing and budgetary stringency made self-employment a viable and attractive option. Firms began with government procurement contracts and then recognized or created commercial markets for their products. These exogenous and unanticipated factors lowered the opportunity cost of entrepreneurship. Other factors, such as reductions in capital gains taxes, may positively influence the decision to become an entrepreneur. Potential entrepreneurs may be particularly sensitive to changes in capital gains tax rates because the majority of their future income will come from capital appreciation on their company equity (Gompers & Lerner, 1999; Poterba, 1989).

In this simple model, the second stage is the formation of the cluster. At this stage, learning and adapting to new events and responding to changes in the policy environment are important in the development of the cluster. The second phase of cluster development is characterized by increased entrepreneurial activity and the beginnings of interaction between entrepreneurs and their environment. Having the experience and example of the initial start-ups, new start-ups are created and spin-offs occur. The industry may become self-sustaining if entrepreneurs are able to build resources by attracting physical and human capital to the area and creating networks to support and facilitate their ventures. During this stage, entrepreneurs define resources to promote and protect their interests. In this way, the independent actions of entrepreneurs are catalytic components of a self-organizing system. Furthermore, the cluster organizes around the entrepreneurial activities in

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an unpredictable fashion. Entrepreneurial activity is inherently creative and pioneering; therefore, the specific needs of entrepreneurs cannot be predicted a priori. The types of institutional capabilities that will promote and sustain technology-based entrepreneurship develop over time as firms and products are created. Thus, the organization of the cluster and the entrepreneurial ventures evolve simultaneously and even symbiotically. Maskell and Malmberg (1999) conceived of industrial clusters as ecologies of mutually dependent firms and institutions. Entrepreneurs, as active agents, may motivate the industrial cluster by creating institutions that stimulate further innovation and promote localized learning. It is the creative feedback response of the entrepreneurs to their environment that determines the nature and stability of the cluster. Looking at clusters such as Silicon Valley, the Texas conurbation, Research Triangle Park, and the Maryland-Virginia-U.S. Capital region, we see that entrepreneurship responded to each unique environment differently, creating clusters with their own signature characteristics as well as different abilities to withstand external shocks (Engelking, 1999; Feldman, 2001; Leslie & Kargon, 1994; Link, 1995; Saxenian, 1994). Most critically, if the area is able to develop relevant infrastructure through public and private initiatives to support the industrial activity, then it may become the place associated with this industrial activity, further enhancing its ability to attract venture capital and sustain large investment projects.

The ultimate result is a fully functioning entrepreneurial environment within an innovative and adaptable industrial cluster. The success of the initial start-ups and the synergy among them generates new possibilities for further start-ups and new spin-offs. Networks of entrepreneurs, policy makers, and secondary industry contractors spring up; universities, colleges, and technical centers recognize the need for high-tech personnel and offer training programs to satisfy that demand. The success and experience of the initial activity further generates local recognition of the emerging industry. Local recognition, a reduction in risk, and more opportunities created by the initial companies contribute to more start-up activities. The final stage of cluster development is the establishment of a critical mass of resources. At this point, the location has established a reputation as the place to be for a particular technology. Consider the case of Cambridge, Massachusetts, where massive amounts of new investment from large pharmaceutical companies have been attracted to the biotech cluster. Other hallmarks of mature firms include the ability to be self-sustaining. When a cluster can withstand exogenous shocks, such as preference shifts, resource price shocks, and recessions, as well as have the ability to remake and renew itself, it can be considered fully mature (Saxenian, 1988).

The critical mass of start-up activity spawned the necessary infrastructure to sustain it, which in turn attracted more activity to the region. We see that as soon as a minimum efficiency level of activity is in place, venture capital is attracted from other parts of the nation, and the industry begins to mature. Government policy creates further incentives for investment, incubators and other technology partnerships are created to promote growth of the industry, and mergers and acquisitions begin to thin out the companies. Successful entrepreneurs also move from their initial start-ups to form other companies. The maturing industry spurs policy changes as government seeks to attract and provide a flourishing environment for even more high-tech development.

#### **STYLIZED FACTS ABOUT CLUSTER FORMATION AND KNOWLEDGE-BASED ECONOMIC DEVELOPMENT**

The process of cluster development is neither linear nor fully predictable; as the cluster develops, it self-organizes, or creates itself, in a manner that cannot be determined at the outset. Even the set of resources required for success develops endogenously along with the firms (Feldman & Francis, 2001). Although more research is needed to quantify the stages of cluster development and detail transition points, some stylized facts about innovation, entrepreneurship, and technological change may be useful to consider in crafting economic development policy. The first point to note is that innovation, entrepreneurship, and technological change are distinct concepts that are interlinked in such a way that providing the conditions for one component does not guarantee the

development of the others. Innovation without entrepreneurship cannot result in regional development. Regions may develop sophisticated innovations, but without entrepreneurs to develop and market them, the profit of the innovation will be reaped by entrepreneurs in other locations. Entrepreneurship without innovation cannot result in technological change. Previous development policy was predicated on promoting the development of technology without concern for who the purveyor of that technology was. Today, it is recognized that entrepreneurship plays a pivotal role in regional development and the promulgation of new technology.

### **Innovation Is a Complex Process Predicated on the Actions of Individuals**

Classical work on entrepreneurial activity, such as Schumpeter (1939), Knight (1921), and Kirzner (1973), suggested that entrepreneurs have a greater ability to perceive opportunity, accept challenges, and organize resources. Blanchflower, Oswald, and Stutzer (2001), drawing on this tradition, theorized that the differential ability to perceive opportunities and subsequently act on them is the most significant factor affecting the decision to become an entrepreneur and is a good predictor of the success of the venture. Any geographic region can have latent entrepreneurship, that is, individuals who prefer to be self-employed or individuals who desire to become entrepreneurs but who do not act for a variety of reasons, which may include risk aversion, insufficient start-up capital, lack of opportunity, lack of innovative ideas to develop, and barriers to new firm creation, among others. Furthermore, entrepreneurial ability (or the entrepreneur's marginal product) is unevenly distributed across individuals, and, more important, particular skills are unequally developed. To be a biotech entrepreneur, for example, a background in bioscience is typically required; moreover, most of the current biotech entrepreneurs also took innovations or licensed innovations from their own labs to create their companies. Clearly, these skills are not evenly distributed across the country. The policy question is, therefore, how to translate latent entrepreneurship into active entrepreneurs and how to provide potential entrepreneurs with the skills they need to become high-tech entrepreneurs. Schumpeter (1976), in his emphasis on the evolutionary nature of capitalism, proposed that a shock to the system of production is required for technological change to occur and that it is this crisis or opportunity to which individuals respond (pp. 82-83). The destruction of the old means of production through the creation of a new means of production was an important part of Schumpeter's innovation (capitalist) cycle. Bygrave and Hofer (1991) suggested, "The essence of the entrepreneurial process is a fundamental discontinuity in the industry involved" (p. 19). However, just as Schmookler's (1966) scissors metaphor posited that innovation is simultaneously the product of supply and demand, entrepreneurship may similarly require the convergence of technological opportunities and a perceived reduction in the risk or opportunity cost of starting a new venture. Carroll (2002) and Hurst and Lusardi (2002) found that the entrepreneurial decision is correlated with the receipt of an inheritance or some economic windfall.<sup>1</sup> Feldman (2001) found that entrepreneurship might also be motivated by a decrease in job security or career advancement possibilities. In the regional context, factors such as corporate downsizing or layoffs may also promote the formation of new firms, although layoffs clearly are not an ideal means of promoting self-employment.

Our conceptualization posits that some initial change—whether a crisis, a discontinuity in an industry, or a technological opportunity—creates the impetus for latent entrepreneurs to become active and engage in starting companies. If the entrepreneurial decision is sufficiently sensitive to exogenous factors rather than merely a function of preferences, then it can be influenced by government policy. Government policy may either facilitate this transference or inhibit its realization. The ability of a region to adapt to exogenous shocks may depend on the alignment of incentives and environmental resources that promote the transfer from latent to active entrepreneurship. The local environment, in terms of the types and quality of resources and the networks and institutions that provide support and further business interests, ultimately affects the sustainability of the startups, although not necessarily their initial establishment.

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**The policy question is, therefore, how to translate latent entrepreneurship into active entrepreneurs and how to provide potential entrepreneurs with the skills they need to become high-tech entrepreneurs.**

**For a region attempting to create a cluster, understanding what factors inhibit potential entrepreneurs from starting companies may suggest policy venues to address.**

### **Entrepreneurship Is Local**

Entrepreneurship is inherently a local phenomenon; individuals start companies in the location where they have formed business networks and have access to resources (Delaney, 1993; Feldman, 2001; Romanelli & Feldman, 2003; Stuart & Sorenson, 2003). Individuals start companies based on their prior experience and interests, typically fulfilling some niche that a larger corporation may judge too small, exploiting a new opportunity that may have a risk profile unsuited to a larger corporation, or using a unique set of skills and knowledge to develop applications from licensed patents. These actions may involve entrepreneurs starting a company part time in their homes while they remain employed elsewhere or starting a company after being laid off. In building their companies, entrepreneurs rely on their local contacts, connections, and knowledge of the business environment. Many individuals have location inertia because of such reasons as family mobility constraints, location preferences, familiarity with the environment, costs associated with changing residence, or the cost of establishing a new company in a thickly populated environment, where office and housing costs tend to be higher. As one interviewee rhetorically asked, "If you are changing your job, would you also want to complicate your life by changing your residence?" Those few who do relocate tend to move to a location of some prior attachment, such as where they went to school or received training or where they have family or some other social connection. This contrasts with entrepreneurial enterprises attracted to a region where they have neither the connections nor the attendant loyalty that roots them in the local community. For a region attempting to create a cluster, understanding what factors inhibit potential entrepreneurs from starting companies may suggest policy venues to address. For example, Germany recognized that its bankruptcy laws created a barrier to the formation of new companies; this recognition could potentially be far more important for developing entrepreneurial ventures than could tax incentives.

### **The Attributes of Fully Functioning Clusters Are not Responsible for Their Development**

Many government policies aim to replicate the conditions that exist in mature clusters in the belief that these factors are responsible for new firm formation and the attendant economic growth. However, much of this conventional wisdom is based on a snapshot of the advanced stage of Silicon Valley's development or on a fully functioning innovative system. Looking at a successful region in its full maturity, however, may not provide prescriptive information about the process of how such regions develop. That is to say, the conditions we associate with an entrepreneurial environment are the result of a functioning entrepreneurship and do not illuminate the early efforts by which such entrepreneurship took hold and a cluster initially developed. The characteristics of mature clusters, similar to the characteristics of a mature firm, reveal little about the development process. The conditions that the literature typically associates with a cluster are found to lag rather than lead cluster formation (Feldman, 2001). The list of necessary conditions, such as the availability of supportive social capital, venture capital, entrepreneurial support services, and actively engaged research universities, appears to reflect the successful establishment of an entrepreneurial culture rather than the conditions and context associated with the genesis of entrepreneurship. Analyzing a mature cluster reveals neither the reasons it began nor the process through which it developed.

### **Technological Change Is Path Dependent**

One striking fact that emerges is that the history of each cluster is unique, suggesting that cluster development is path dependent or heavily influenced by chance historical events (Kenney & von Burg, 1999). Although technological innovation is radical and disruptive, the earliest automobile manufacturers adapted techniques from carriage makers and served the same functions and markets. Similarly, both Silicon Valley and Route 128 built on their prior expertise in electronics. Historical events matter in determining the success of future industries in particular locations.

Technological progress involves adapting general-purpose breakthroughs to serve existing markets and consumer needs. General-purpose technologies are adapted to commercialization by those who have experience with current product markets. This process of co-invention is highly localized because of the nature of knowledge creation and its initial application. As soon as a technology reaches a stage that it can be codified, it easily transfers across geographic space. However, at its earliest stages, before it is capable of codification, locating near the center of innovative activity provides critical competitive business advantage. This is one of the reasons innovations cluster geographically.

Many economic development programs are limited in their perspective on new technology. For example, many programs interpret biotechnology to be limited to human therapeutics. Certainly, human therapeutic products face lucrative markets, as demonstrated by such well-known names in biotech as Genetech and MedImmune. Nevertheless, this focus ignores potential applications in environmental remediation, agriculture, and advanced materials that may build on local expertise. Although not all locations can develop glamorous high-tech clusters, each location has a unique industrial heritage that provides some expertise and resources that might constitute the basis for innovation, technological advance, and sustainable competitive advantage.

Evidence on the location of the biotech industry highlights the importance of the location of the chemical and pharmaceutical industries, especially their headquarters and research and development laboratories (Gray & Parker, 1998; Orsenigo, 2001; Zeller, 2001). Orsenigo (2001) suggested, "The pre-existence of a strong pharmaceutical national industry, with some large internationalized companies, may have been a fundamental prerequisite for the rapid adoption of molecular biology" (p. 86). He also noted,

The strength of the local science base is important but may not be the only factor in accounting for the development of the biotech industry. The biotech industry in Italy developed in Milan, which did not have the top-rated academic research while Naples, an important academic center, did not develop a biotech industry. (p. 83)

By the time a technology is known to the economic development community, it is probably too late for state governments to begin investing with the intent of pulling companies out of an established cluster to relocate in their jurisdiction: The established centers have an advantage (Cortright & Mayer, 2001). To the extent that society values the overall impact on development of an industry, state and local incentives may actually impede economic growth by creating bidding wars. Moreover, to the extent that these incentives redistribute resources from those locations where they would be most productive, the overall innovation system is compromised.

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### **Cluster Formation Is the Sum of Many Small Events**

One critical concern in studying industrial clusters is the choice of the initial conditions or the situation prior to the emergence of a cluster. For example, Kargon, Leslie, and Schoenberger (1992) emphasized the early input of Frederick Terman as the founder of Silicon Valley: He orchestrated the creation of a world-class research institute with strong ties to the business community and an environment that encouraged students to become entrepreneurs or at least be actively involved in corporate research programs. Recent work, moreover, documents a strong preexisting tradition of university-industry interaction and a leveraging of government contract work (Sturgeon, 2000).

Economic development efforts appear to give priority to large-scale projects, even if an equivalent or larger impact might be achieved with smaller, more modest efforts. After all, the local news is not typically interested in covering stories about single companies or modest successes. The tyranny of big events skews public investment toward high-visibility projects. Using a baseball analogy, the emphasis is on home runs at the expense of singles and good fieldwork. Although a home run generates excitement, a string of singles and good pitching will win a game.

There is an inherent information asymmetry between state officials and small-firm entrepreneurs, making it necessary for economic development officials to cultivate client lists of small



firms and learn their concerns. However, one common complaint among small-firm entrepreneurs is that state economic development officials do not talk with them; instead, they focus their attention on attractive relocating firms, offering one-off special deals and incentives, rather than understanding the needs of existing firms and providing solutions. Providing incentives for firms to relocate does not anchor them to a region, whereas providing incentives and shared resources for small local firms strengthens their attachment. This systemic bias toward relocation takes away resources that address the needs of existing taxpayers.

Daniel Patrick Moynihan (1927-2003) is credited with saying that no one without 40 years to spare should get involved in urban renewal; this insight may be extended to considerations of regional economic transformations. For example, Link (1995, 2002) found that the genesis of Research Triangle Park was predicated on some 70 years of patient government investment. In the U.S. Capital region, changes in government policy toward employment and outsourcing created a frenzy of start-up activity that began rather humbly with systems integrators and biological services firms. Over 30 years, entrepreneurs reinvested in the region and created conditions that drew resources to the cluster (Feldman, 2001). Even in Silicon Valley, for example, a small group of people with a vision for the development of the region championed the aeronautical and electronics industries, and the region was poised to benefit from technological advance in computers (Sturgeon, 2000).

### **Firm Development Is Adaptive: The Fallacy of Business Plans and Industrial Targeting**

Technology changes rapidly, and entrepreneurs must constantly reevaluate their efforts against their competition and adapt to market changes. Company interviews typically lead off with “Tell me about your technology,” and the description offered typically deviates from previously published information. Indeed, the younger the company, the more likely this deviation is. The reason appears to be that the technology is evolving rapidly and the company is constantly reinventing itself to keep pace. This healthy but seemingly chaotic state of affairs makes it difficult to attract government funding.

When a company develops a business plan, it will abstract a so-called elevator talk—a 3-minute description of what they are about. This is crafted just in case an entrepreneur is lucky enough to ride in an elevator with a venture capitalist. It is perhaps more marketing than reality. Indeed, to the extent that the business plan is written in stone or that any funding or program participation is tied to executing the business plan, the company will not have the ability to adapt to change.

Venture capitalists say that they bet on the person and not the technology, with the idea that a skilled entrepreneur can make a business work. In contrast, public sector investment tends to focus on evaluation of business plans and, therefore, locks entrepreneurs into situations that limit their adaptability.

Targeted programs seem to be preferred by politicians because they clearly delineate goals, but they may be limited in success because industries are fluid. Innovative firms often defy classification in standard schemes as they create an industry or industry segment by responding to market opportunities, typically operating in niches that are not profitable for larger or more established firms. Many of the fast-growing companies in the economy operate in emerging technologies, such as bioinformatics, nanotechnology, and genomics, among others. These industries are rapidly evolving and difficult to track with the tools that economic developers typically use. Perhaps one means to identify new industries is to consider the founding of a dedicated trade journal. For example, *Small Times*, the journal of nanotechnology, was launched in 2000 to distinguish the industry and promote firms’ common interests. Rapid change contrasts with the often slow bureaucratic practices of state development programs and their inability to catch a trend on the upswing.

### **Failure Is an Important Learning Mechanism**

Economists recognize many different ways that firms acquire knowledge, notably learning by doing, through collaboration, or by acquisition. Learning through failure may be just as important

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a tool because failure, when examined, reveals pitfalls, dead ends, or ineffective strategies to avoid in the future. Most important, failure points to what might have been done differently or what additional resource or effort may have made the difference.

In a regional context, failure may provide a learning mechanism that facilitates the next round of entrepreneurship. Failed businesses provide learning devices for new entrepreneurs, as well as for development policy makers. Each region deals with failure in a different manner. When failure occurs because of recessions or unexpected industrial downturns, the solution is not as clear. However, when failure occurs because of poor execution of a business plan or inability to obtain a patent or regulatory approval for a product, the next attempt begins by correcting the old failure. In some cases, entrepreneurs who fail are perceived as experiencing a rite of passage (Feldman, 2000).

In addition to learning from previous failures, the next set of entrepreneurs can benefit from the liquidation of failed firms and the reorganization of resources. Part of the capitalist process is redirecting resources to their most productive ends so that failures become important in establishing strong companies. Artificially sustained companies that would have otherwise failed prevent resources from being released to more productive ends and may require large amounts of subsidies and other government help to sustain themselves before failing at some point in the future. Moreover, the first unsuccessful attempts at creating firms in a new industry automatically lower the barriers to entry for firms that come after them. Liquidating the assets of firms that fail reduces costs for the next generation of start-ups. The beneficial aspects of failures point to a perverse incentive associated with government-sponsored incubators that may inhibit the redistribution of resources from firms that are not as productive at using them. If the price per square foot is set and not allowed to fluctuate to reflect changing market conditions—that is, no fire sale occurs—the next round of firm formation may not be facilitated.

### REFLECTIVE CONCLUSIONS

Today, jurisdictions from Azerbaijan to the state of Wisconsin have recognized the importance of entrepreneurs in generating economic growth and increasing international competitiveness. Instead of relying on the zero-sum game of attracting successful firms from other regions through financial incentives, the new strategies attempt to create an environment that favors entrepreneurship and the creation of new firms.

This self-organizing system of cluster formation suggests that existing economic development policy may have limited effects because of its reliance on old-economy strategies and its tendency to preserve firms that ought to be allowed to fail. Building on the stylized facts outlined, this suggests reorienting the role of economic development policy toward fostering entrepreneurship, listening to what small firms need, and recognizing the difference between a firm that needs help to achieve stronger growth and a firm that is beginning to decline.

Certainly, there is a role for government to play in facilitating entrepreneurship, cluster formation, and economic growth. Government has a role in providing infrastructure and other goods that markets fail to provide. The potentially long time horizons of development policy, as opposed to the short horizons of the stock market, can provide an environment conducive to entrepreneurship and local innovations, as well as the redevelopment and redeployment of existing resources. Also, states are more able to recognize and encourage small humble beginnings of a new industry, which venture capitalists and large-scale investors would not notice. Rather than targeting specific industries or technologies, effective state policy might focus on creating conditions that would allow firms to grow and prosper. One key component of the new regional development strategies is the recognition of the importance of entrepreneurship and the potential in homegrown industries. Instead of relying on attracting successful firms from other regions through financial incentives, the new strategies focus on providing a hospitable environment for entrepreneurs to create new firms.

Unfortunately, government programs that offer business assistance are frequently evaluated using private sector metrics, such as rate of return on investment. Of course, government should be accountable, but there is a need to develop new metrics that consider the nature of the inherent mar-

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ket failure that prompted government involvement in the first place. Although the number of new jobs created is important politically, it is an imperfect measure of the total benefit from government investment. New metrics need to be developed to consider the synergies that government investment creates in a region and the additional activities that would not have been undertaken in its absence.

Under any cost-benefit criteria, more downstream programs will appear to have greater impact when, in truth, firm development is incremental and cumulative. An early-stage program may have made a pivotal difference with no direct traceability. A menu of state programs and incentives addressing various funding gaps and providing external resources that augment firm capabilities or smooth transitions may be required. Tax dollars invested in economic development are diverted from other state programs. More than just an academic exercise, state investments affect a locale's quality of life and growth potential. The cumulative and reinforcing creative environment that anchors an industry appears to depend on encouraging entrepreneurship and innovation. The strategy for long-term growth relies less on bidding wars and high-profile investments than on creating conditions for firm development and cluster formation.

## NOTE

1. It is unclear whether liquidity constraints are a barrier to new firm creation. Hurst and Lusardi (2002) determined that they are not. On average, they found that individuals who wish to begin a business were not constrained financially in their attempt to do so. Other studies (Evans & Jovanovic, 1989; Evans & Leighton, 1989) suggested that liquidity constraints do matter and that wealthier individuals have a higher propensity to begin a business.

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