Chapter 5
Clusters/Science Parks/Knowledge Business Incubators

Benjamin B. Boroughs

5.1 Introduction

As information and communications technology (ICT) grew more advanced during the 1990s, some observers predicted that geographic location would cease to be a determining factor in economic development. In the old economy, factories had to be near raw materials like coal or iron ore. In the new economy, business would be global, with workers across the globe engaging with one another via mobile devices and the Internet. Instead, the last 20 years have shown that location still matters. While some services like call centers have been outsourced, they have been outsourced to particular places, like Bangalore in India, where many companies compete for business within a geographically restricted space. With this realization, economic development is now focused on creating local and regional agglomerations with a special focus, often aimed at the high-technology sector which is perceived to have high growth and export potential. This chapter focuses on these agglomerations, called clusters, and two policy options for encouraging high-tech growth, Science Parks and Knowledge Business Incubators. Despite the fact that many parks and incubators remain limited in scope, policy makers sometimes view such subsidized initiatives as the first seeds or stages of an economic continuum leading ultimately to the emergence of a vibrant high-tech cluster with many profitable private firms.

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B. B. Boroughs (✉)
Center for International Science and Technology Policy, The George Washington University, Washington, D.C., USA
e-mail: benboroughs@gmail.com

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5.2 Clusters

In the second quarter of 2011, the Silicon Valley Region of the US State of California captured 39% of the roughly $7.5 Billion in US venture capital funding in that quarter. In a nation as vast as the United States, how did one relatively small geographic region, far from the financial and political centers of the US East Coast come to play such an important role in technology and innovation? The answer is that Silicon Valley is a phenomenally successful high-tech industrial cluster. Promoting cluster formation remains a common yet frequently elusive goal among technology and industrial policy makers across the world.

5.2.1 What is a Cluster and Why are they Desirable?

Just as moving people from a dispersed rural setting, to a dense urban one increases interaction and economic efficiency, so does concentrating businesses and specialists in one region increase their productivity and innovation. Michael Porter (1998) offers this succinct definition of clusters:

> Geographical concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, associated institutions (for example universities, standards agencies, and trade associations) in particular fields that compete but also cooperate.

More generally, clusters are agglomerations of people, firms, institutions, and other economic actors working in a similar field who interact in a relatively small region. While this Chapter focuses on high-tech clusters, such as in the fields of biotechnology and information and communication technology, low-tech clusters can also be extremely important economic drivers.

Indeed economic dynamism and innovation are precisely the qualities that attract policy makers to aid cluster-formation. High paying jobs, high economic growth, market dominant companies with export potential, and the prestige of being an international technological leader, are just some of the reasons high-tech clusters are so valued. A cluster can become a global center for the activity performed there, drawing investment from across a nation and the world. Examples of such dominant clusters range from financial services (Manhattan, City of London); shipping (Athens, Singapore); fashion (Milan, Paris); film and entertainment (Hollywood, Mumbai). High-tech clusters include electronics and software like Silicon Valley or biotechnology like Route 128 in Boston. Often high-tech clusters draw on the talent of top universities in the previous examples, Stanford and UC Berkeley and MIT and Harvard respectively.

Clusters are often described geographically, but it is not merely the proximity of related firms and institutions which makes them successful. It is the social interaction between economic actors which helps to drive innovation. A university may

contain a brilliant scientist, a firm may retain a skillful lawyer or engineer, and a banker may possess access to great sums of capital, but if they never meet and discuss the ways that each may help the other a new innovative company is unlikely to be formed. In successful clusters, such collaboration and entrepreneurialism is profitably fostered.

Does an Innovative Cluster Need to be High Tech?

For the vast majority of developing countries it would be foolhardy to literally try creating "The Next Silicon Valley". It is not necessary to go after a leading edge high tech field such as software, biotechnology, or advanced materials to be innovative. Applying new technologies to older industries and encouraging an environment of collaboration, competition, entrepreneurship while extremely difficult, can boost the competitiveness of a region. One example is the Sinos Valley region of Brazil, which has grown from a regional center of shoe production into a major global exporter of shoes. Firms there have developed strong ties between firms, suppliers, and international retailers; this has dramatically increased the efficiency and scope of production (Nadvi 1995).

5.2.2 Why Do Industries Cluster?

When many businesses of the same type gather in one region, information sharing between firms, competition, and specialization spur development. A virtuous cycle develops where people seeking to be at the forefront of their field choose to live in the leading cluster and large talent pools in turn attracts more businesses. Workers then are even more likely to move to such an area because they are confident of finding employment and so on. Specialized financial institutions, tailored to a particular industry emerge, making business transactions easier. Increasing rates of return and positive externalities are key features of clusters. (Breschi and Malerba 2005).

Clustering also occurs because of the characteristics of four different kinds of knowledge relative to spatial proximity. These knowledge types are sometimes simplified as "Know-what", "Know-why", "Know-how", "Know-who". The first, "Know-what", refers to an up to date understanding of the state of the field. Both with regard to technology and changing business conditions; a firm grasp of formal and informal business and science news and facts. Know-what is needed to understand what direction companies should be moving in and is critical for strategic planning.

Analytical or scientific knowledge makes up "Know-why" which can be thought of as explanation of the works of nature. Both "Know-what" and "Know-why" are codifiable, that is, they refer to knowledge amenable to being written down, codified, and transmitted. Thanks to modern communication technology, codified

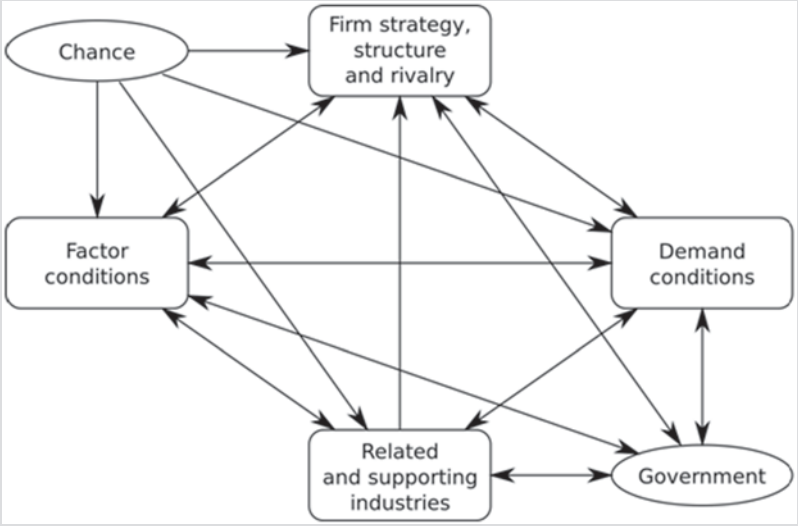

Fig. 5.1 Porter's diamond model (Porter 1998)

Porter (1998) popularized the Diamond Model as a way to analyze a region's strengths and weaknesses. Factor conditions refer to a region's inherent properties, such as skilled labor, access to capital, natural resources, and institutions. Demand conditions describe the structure of a region's home market. If the region's home market contains many sophisticated consumers of a technology, the region will be at an advantage because of the rapid market feedback they can receive. The web of supportive and related industries can also play a key role for the emergence of a cluster. Companies with active and engaged suppliers are more likely to innovate. Firm strategy, Structure, and Rivalry define how firms in a regional cluster will relate to one another. Collaborative, open relationships can speed the transfer of knowledge among market participants, but rivalry can also spur innovation through competition.The government can influence all aspects of market environment through its use of regulations, subsidies, taxes, education policy. Finally, chance can heavily influence the developmental trajectory and cannot be fully controlled by either firms or the government (Fig. 5.1).

knowledge can be transmitted around the world in a matter of seconds. Imagine a racing automobile; there is a great deal of information which can be transmitted about its qualities, specification, and care. This information can be found in blueprints, owner's manuals, cost invoices, and in detailed engineering test data. However, one would be hard pressed to take all this data and put together a championship Formula One racing team from even the most intelligent and athletic group of people unfamiliar with auto racing.

This is because a third kind of knowledge the "Know-how" is also critical. Tacit knowledge, also referred to as "learning through doing", is not easily transferred over long distances. Such knowledge, like the ability of a mechanic to instantly diagnose an unusual engine problem or a driver to know exactly how much to engage the clutch when approaching a hairpin turn cannot be appropriated through reading a book. Tacit knowledge is said to be "sticky" not moving fast or far from those who have it. Many industrial processes involve a great deal of tacit knowledge. Only by working side by side or closely collaborating can individuals fully master the ability to efficiently complete certain tasks.

Finally, "Know-who" refers to who knows how to do what, that is, information linking individuals and organizations to particular pieces of knowledge. Put differently, networking is the intimate knowledge of which individuals are truly important as innovators and institutional gatekeepers. Reputations can be difficult to judge from afar. Media sources may report on scientists who are the most interesting to readers or "colorful" while ignoring those in the field who are truly driving progress. Similarly in government or corporate bureaucracies, someone who holds a certain high rank or title may not actually be the key to an organization's management.

Location makes a significant difference for the application of all four types of knowledge. While tacit knowledge and networking are most obviously tied to geography, it turns out that much of analytical knowledge is as well. A study of research cited in patents, for instance, reveals that papers from nearby universities are more likely to be cited than papers from universities located farther away (Fagerberg et al. 2005).

5.2.3 Agglomeration Vs. Innovative Clustering

Cities have long contained districts which cater to a specific type of industry. Sometimes this occurred because of deliberate policy—grouping all butchers and abattoirs in one block to separate the process of animal slaughter from the rest of the city. Often though, and especially as modern industry began to emerge, clusters formed organically as tradesmen grouped together to leverage economies of scale and to more effectively compete for business. A history of the original industrial revolution in Britain testifies to the importance of such clustering (Mathias 2001):

> Very shortly other 'external economies' developed. Once a pool of skilled labour grew up in a mill town that added to the 'inertia' of location. It made it more worth the while for expansion to occur in the same locality. A factory-trained labour force, of semi-skilled women and adolescents, was also an immense local advantage by the second generation. Another very important external economy was the convenience of specialized service industries—such as the bleaching firms, the machine-making shops, machine-servicing facilities which grew up in the shadow of the mills. All these things exercised a 'centripetal' pull on the cotton industry.

However, industrial clustering should be differentiated from simple agglomeration. While not a cut and dry proposition, one key difference is the degree of backward and forward linkages between firms (Karlsson et al. 2005). Some regions, perhaps

because of easy access to a vital natural resource tend to specialize in the production of a particular good. While such groupings may contribute to certain positive externalities such as a deep talent pool, they may not on their own lead to an innovative or competitive environment (Delgado et al. 2010).

Local Living Conditions—Amenities as a Strategy for Talent Attraction

While the greatest force which pulls skilled workers to a cluster is the promise of continuous employment because of the large number of specialized local firms, secondary locational traits can help to lure employees towards an emerging cluster. Bangalore sits on a plateau, unlike other major Indian cities which are located near the ocean or in tropical lowlands. The pleasant climate is a real advantage. Boulder, Colorado, a fledgling tech hotspot, is located on the front range of the Colorado Rockies. The scenic views and opportunities for outdoor recreation represent a significant recruiting tool, as employers seek to attract highly educated and highly mobile workers. Universities, too, serve to enhance the appeal of an area. Cultural events such as concerts, lectures, and art exhibits that universities often sponsor provide opportunities for recreation and intellectual stimulation which may be otherwise lacking in industrial towns. Developing countries with significant foreign diasporas seek to attract their citizens back home with similar incentives. For top performers they offer high-quality housing, personal attendants, drivers, and recreational facilities along with plum administrative positions.

Linkages are crucial, especially between SMEs. One of the advantages of a large corporation is the degree of communication that can occur within a company. Bureaucratic politics aside, employees of the same large company are essentially working towards the same goal. But SMEs are often in direct competition with one another. Strong communication that leads to innovation separates an innovative cluster from a stagnant agglomeration.

Backward linkages are the connections between businesses and their suppliers. *Forward linkages* are the ties between businesses and their customers. The more information that flows up and downstream, the more innovative and responsive a company can be. Knowing that a battery supplier is close to a breakthrough in lightweight battery research and also having a market survey which shows that joggers dislike the heavy weight of current music players, could put a company in a good position to develop a new model music player developed specifically for the jogging market. Without the information the company might continue to produce the same heavy music player mindlessly until it was forced to adopt the new battery by its competition.

Cities: People Magnets in Flat World

Thomas Friedman (2005) popularized the concept of the "flat world" in which information and communication technologies combined with widespread political and economic reforms over the last 20 years have changed nature of international trade and competition. While previously nation-states and then multi-national corporations were the main drivers of globalization, Friedman argues that individuals are now competing on a global scale. Furthermore new technology means that the best and brightest from all over the world can compete without needing to move to a "leading" country to be successful.

Richard Florida (2008) also views people as the key to public policy surrounding innovation. In contrast to Friedman though, he argues that people's talents aren't likely to be fully expressed unless they can live in close contact with other skilled people. Florida looks to cities as the engines of economic growth, and says that while the world may be flattening for 2nd and 3rd tier cities and workers in manufacturing, 1st tier cities with a high degree of innovation are pulling even further ahead. He calls these cities "spiky" because of their high degree of economic and innovative activity in contrast with the surrounding countryside.

Florida points out that people look for different amenities in cities at different times during their lives. Young people are looking for lots of economic activity and a large potential mating pool. Middle-aged workers tend to want safe neighborhoods and excellent schools for their children. Top knowledge workers want to live in diverse cities that accept creative individuals and their sometimes non-conformist behavior.

5.2.4 Case Studies in Cluster Formation

5.2.4.1 Silicon Valley

Much of the enthusiasm for clusters is linked to success of the first, modern high-tech cluster, Silicon Valley. Despite advances in other regions throughout the US and the rest of the world, this area south of San Francisco, California still attracts the best and brightest minds in engineering, software, and web development. Silicon Valley did not emerge as the tech powerhouse it is today overnight. In fact, the San Francisco Bay region has been an important center for innovative radio and electronic research since the early twentieth Century.

Silicon Valley's name though, is a hint at the key driver of large scale growth. The development of the transistor or semiconductor, a key ingredient of which is silicon, was central to the region's success. The Dean of Engineering at Stanford University, Frederick Terman, helped create the Stanford Industrial Park in 1951. Companies, including many founded by Stanford grads, moved onto this real estate

to be closer to the research being done at the University and to have better access to promising young engineers. Beginning with the seminal Shockley Semi-Conductor Laboratory in 1955, a series of spin-offs and startups led to rapid innovation in the high-tech electronics field. These early firms were heavily supported by procurement from the US government, especially the military which used the hardware in aircraft, missiles, and other advanced weaponry. Activity was accelerated by the spin-off culture. Partially a result of the region's existing business culture, it was also aided by the state of California's ban on non-compete contracts. In many states employees are barred from starting work on new projects that could directly compete with their former employer. In California, without such restrictions, there are stronger incentives to take advantage of business opportunities provided by technological advancement.

Technical expertise and an entrepreneurial culture weren't the only factors contributing to the Valley's rise. As early as the late 1960's, Venture Capital firms and boutique law firms began to do business in the area. These specialized legal and banking services made it easier for first time businessmen to make the leap from employee to owner. As the number of people with start-up experience grew, there were more opportunities for mentoring relationships to develop. Experienced investors guided their protégés in business development. Strong social links were formed between entrepreneurs, stimulating the flow of information about technological developments and investment opportunities.

Some of the drivers of Silicon Valley's growth have remained constant; a cooperative, collaborative, and entrepreneurial business climate, a strong talent base of scientists and engineers, regional pride and rivalry, and close university-industry relations. Others have developed later and aided growth or have faded away, such factors were; government procurement contracting, venture capital infrastructure, specialized legal firms, high intra and inter-national immigration, and cheap land values (Kenney 2000; Hospers et al. 2009).

5.2.4.2 Bangalore, India

Bangalore in the state of Karnataka, India was once known primarily as a resort for retired persons. Today it is the third most populous city in India and the center of the country's telecommunication, defense, computer, and IT industries. With a fast growing and dynamic economy, Bangalore attracts skilled engineers from across India and transnational corporations hoping to utilize this talented, skilled workforce at lower cost than in the West.

Bangalore's success stems in part from two structural components which are similar to Silicon Valley. The first is presence of large companies working for the Indian government working to develop high tech products for telecommunications and defense. The second is the large number of quality post-secondary educational institutions in Bangalore. The decision to concentrate such activities in Bangalore was made years ago when India maintained a highly regulated domestic economy. As trade liberalization began in the late 1980s and early 1990s, exposure to imported

goods produced by foreign manufactures increased the level of competition among firms to produce higher quality products. Businesses owners in the region are tightly linked through a variety of ties, including college alumni and business clubs.

The opening of a Texas Instruments plant in Bangalore in 1985 was a watershed moment. Since then, many other foreign technology companies, including Google, Microsoft, IBM, and Oracle, have invested in Bangalore, often in one of two high-tech industrial parks, Electronic City and Whitefield. Many foreign companies view Bangalore as a cost effective location for research and development. Indian high-tech companies specializing in IT, engineering, and management consulting have seen rapid growth. Wipro and Infosys are the second and third largest ICT Indian ICT companies and are headquartered in Bangalore. From 1995–2005 the ICT sector has grown to over 70% of Bangalore's total exports. In 1995 Bangalore's ICT sector accounted for less than 0.25% of India's total exports, by 2005, that figure had reached 6%. Bangalore stands as a prime example of how to leverage its strengths: English speaking, high skilled, low cost labor to attract foreign companies and in turn foster the development of innovative and globally successful domestic firms (Van Dijk 2003; Grondeau 2007).

5.2.4.3 Silicon Wadi (Israel)

Over the past 20 years, Israel has established itself as a world leader in a variety of ICT businesses. This success stems from a variety of factors, including deliberate government policy. Israel's human capital provides its main competitive advantage. Israel's commitment to education, especially in computer science and engineering, along with an influx of scientists and engineers from the former Soviet Union in the early 90s, have provided a strong pool of potential knowledge workers. These workers have strong networks with one another because of the small number of Israeli universities and compulsory service in the Israeli Defense Force (IDF).

Israel spends a sizable portion of its budget on military R&D and in the 1960 and 1970s made significant advancements in secure networking and encryption technologies. This in-country research placed Israel in a strong position when the internet began to mature and a need for such technology became apparent. As new firms began to grow, a need for stronger venture capital markets was identified. In response, the Israeli government set up a special venture capital program called Yozma in 1993, which promised to match private investment in Israeli technology companies. Since then it has seeded 10 VC Funds with $20 million each giving them a 40% Government share and 60% private. Eventually, in all but one case of these seeded funds the government share was bought out by private investors. Today, total venture capital under management in Israel stands in excess of $10 Billion with around $1.5 billion invested annually (Wylie 2011; Engel and del-Palacio 2011). The Israeli government also started a number of incubators but after poor initial performance these were privatized and have since become more successful.

Like other developing clusters, Israel has successfully leveraged its nationals living abroad. Significantly, it has recruited Israeli engineers and entrepreneurs

working in the US to develop strong links with Silicon Valley. A few years ago Silicon Wadi boasted the highest number of non-US companies listed on the NASDAQ exchange, while many American firms already operated subsidiaries within Israel (Bresnahan and Gambardella 2004).

5.2.5 Can Governments Stimulate Cluster Growth?

Every city planner, regional politician, and national economic official hopes to emulate the success of Silicon Valley or one of the other dynamic regional clusters mentioned above. But each example hints that "blank slate" innovative industrial development is not a simple, fast, or easy process. Various strategies have been used to stimulate "cluster-like" economic development across both the developed and developing world. The good news is that some policies can improve the performance of local firms and spur innovation. The bad news is that there is no "out of the bottle" solution for creating high-tech innovative clusters. Most cluster-based development policies have been at best mildly helpful. At worst they use up resources that could better be used elsewhere and produce no discernible impact (Braunerhjelm and Feldman 2006; Colombo and Delmastro 2002).

Korean Clustering—Grappling with Tradition

For the last half century of Korean economic development, young clever workers have sought corporate positions in the Chaebols (large conglomerates). These leading companies were considered national champions and employment at a chaebol carried great social prestige. Entrepreneurship was seen skeptically, an indication that someone had failed to make the cut at a larger firm. However, as the Korean government has recognized the economic potential of small, innovative startups (and the limits of older industrial policies), the authorities have taken steps to encourage dynamic technology clusters. One such example is DaedeokInnopolis located in Daejeon, Korea, south of Seoul. DaedeokInnopolis started as a science park called Daedeok Science Town in 1973.

Despite having the advantage of being collocated with KAIST, Korea's leading research university, and significant government and corporate support, the science park was not particularly successful in stimulating the formation of new high-tech firms. The government has struggled to turn the science park into a self-sustaining cluster. Since the 2005 renaming of the science park, Daedeok has begun to see improved performance, between 2005 and 2009 sales increased from $2.5 to $12.3 Billion. Additionally it added 13 new companies to the KOSDAQ, an impressive number since previously the park had only produced 11 in total. However, the challenge of altering

Korea's traditional business culture will remain. Tax rules have been changed to allow new family businesses to enter the tax system more easily and bankruptcy laws have been altered to make the consequences of failure less dire (Watson 2011). The new Korean administration is pressing very much in that direction under the banner of the "creative economy".

5.3 Science Parks and Incubators

This section examines two related strategies for promoting innovation and regional economic development. *Science Parks* or *Research Parks* are mixed-use real-estate developments built close to Universities which seek to encourage Industry-University knowledge transfer. *Business Incubators* are also often located near universities (sometimes within science parks) and offer incentives such as low-rent property and networking opportunities to encourage spin-offs from university research and the establishment of new firms by entrepreneurs.

5.3.1 Science Parks

Taking Stanford's pioneering park as an example, many universities began building science parks and encouraging private industry to open branch research offices on or near campus where they would have easy access to talented graduates. The goal was increased knowledge spillovers and product commercialization. Science parks were envisioned as a location where government, industry, and the university could collaborate and share ideas. This collaboration would hopefully result in entrepreneurship and human capital development, which could serve as kernel for developing a regional agglomeration of knowledge workers.

Another impetus for creating science parks was desire to garner greater benefit from science research. In the United States, a great deal of public research funding is funneled through university departments. The rationale for basic research was partially predicated on the assumption that such research would lead to economic growth. As public science funding came under budget pressure in the 1970s and 1980s and as the US faced economic competition from Europe and Asia, science parks began to be seen as method for increasing technology transfer. Since the emergence of the first science parks in the United States during the 1950s, the concept has proliferated with over 400 parks worldwide. In North America there were 174 research parks by the middle of the previous decade which collectively employed over 350,000 workers and occupied over 47,000 acres (Battelle 2013) (Fig. 5.2).

At their start, science parks were essentially real-estate developments aimed at attracting high tech firms. Local municipalities or Universities used the prospect of cheap land and tax incentives to encourage high tech industry to move to the

Typical North American Science Park		
Size	Financing	Tenants
750 Employees 114 acres 6 buildings 314,400 sq. ft. of space, 95% occupied Only 30% of total estimated sq. ft. at build out currently developed 30,000 sq. ft. of incubator space	Less than $1 million per year operating budget Revenues primarily from park operations but funds also come from universities and state, local, and federal government Limited or no profitability; 75% of the parks have no retained earnings or retained earnings of less than 10% per year.	72% are for-profit companies 14% are university facilities 5% are governmental agencies Major industry sectors: IT, drugs and pharmaceuticals, and scientific and engineering service providers

Fig. 5.2 Science Park Characteristics (Battelle 2007)

research park. One of the primary reasons for the creation of science parks in the developed world has been the relative resiliency of universities in the face of economic decline. In many regions which have experienced de-industrialization, universities remain one of the few functioning large institutions and so attempts at economic rejuvenation are centered on the university. A similar logic prevails in developing countries, which are attempting to build an innovative environment from scratch. In either case, ties to a university lend credibility to such developments and imply a longer-term commitment by policy makers.

Ciudad Del Saber (City of Knowledge)—Redevelopment

As Panamanian officials prepared to take control of the former US-controlled region called the Canal Zone, they looked for ways to utilize the buildings and other infrastructure that were being abandoned by the Americans. Ciudad del Saber (CDS) was established by a private, non-profit organization in 1999, at the site of Fort Clayton, a former US military base. CDS houses a variety of affiliates within its properties including businesses, educational programs, and international organizations and NGOS. The park focuses on five major "work areas": Information Technology, Biosciences, Environmental Management, Human Development, and Business Management and Entrepreneurship. CDS also houses an onsite business incubator. Some of the main draws for the park are its reliable access to electricity and telecommunications, a business friendly tax policy, and proximity to Panama City and a nearby tropical ecosystem region called the Panama Canal Basin. CDS has become a UN hub (housing many UN agencies servicing Latin America), and currently houses 27 academic affiliates, 59 business affiliates, and 53 NGOs/IOs.

The sophistication of science parks has increased since their initial development. Initially, land and access to skilled graduates of the university were the main draws for business to move into the parks. As it became apparent that these loose ties were ineffective in promoting robust development, policy makers began to recommend a more activist approach to park administration. Stronger ties between faculty members and park tenants were encouraged. Business assistance services became more common. The focus began to shift from recruitment ties with large corporations to promoting the establishment of start-up companies. Efforts to increase the number of innovative small businesses led to the incorporation of business incubators into many science parks (Fig. 5.3).

Hsinchu Science and Industrial Park Taiwan—A Success Story

Beginning in the 1960s and 1970s, Taiwan began to be seen as a low cost manufacturing destination for basic electronics for foreign firms, and local SMEs began to make imitation products. In 1980 the Taiwanese government decided to invest in a science park near two well-regarded technical universities. Additionally, the organization exemplifying the national effort to research semi-conductors, ERSO (Electronics Research and Service Organization) was moved into the park. The park hosted many small emerging computer and electronics companies that were augmented by the government's policies for seeding venture capital funds. Rather than backing individual companies (picking winners and losers) the government sought to create a competitive local environment with incentives tilted towards the creation of IT companies.

One key to the park's success was luring back Taiwanese scientists and engineers who had been living and working in Silicon Valley. These individuals were offered substantial incentives, such as 49% government investment in any firm they started within the park and management positions within companies and park administration. These returnees brought with them knowledge about how to start and run high-tech companies and also founded the first private VC funds in Taiwan. The science park augmented the knowledge base of local companies which were already aggressively expanding. The park served to funnel knowledge from the universities and abroad into the private sector. From 1988 to the pre-recession height of 2007, annual sales from the science park grew 132% from 489.86 Billion NT to 1.14 Trillion NT (US $37 Billion) (Bresnahan and Gambardella 2004).

Proximity between industry and universities does not automatically result in collaboration. Science parks may succeed on some level, but there is little hard empirical evidence to suggest they stimulate new economic growth. They do provide an environment conducive to communication and coordination between industry, government, and academia. The most effective parks are deeply integrated into the communities where they are located. They

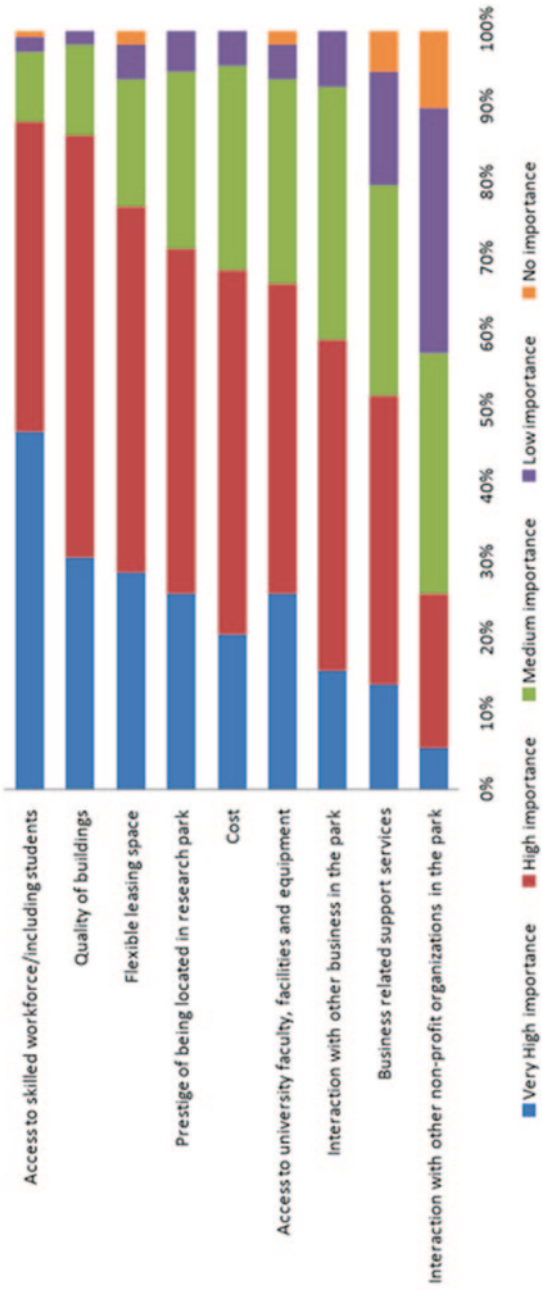

Fig. 5.3 Reasons Why Tenants Locate in Research Parks (Battelle 2013)

must acknowledge the occasionally competing goals of various local stakeholder groups. These goals include providing jobs for local workers, corporate access to university R&D, regional development, and enhancing university prestige and revenue from technology transfer. Policy makers must also realize their own bias looking at "success stories".

In certain cases, universities and their industrial relations have played a key role in producing self-sustaining clusters, but many other factors are responsible for regional economic development. Realistic time horizons must also be kept in mind. Even successful science parks such as Research Triangle in North Carolina have taken over 50 years to become fully established. An attractive campus with several prestigious sounding businesses grouped closely together may make science parks an attractive option for policy makers seeking an impressive looking end product, but they are unlikely to rapidly contribute to economic growth and development (Bresnahan and Gambardella 2004).

5.3.2 Knowledge Business Incubators

Widely used by local governments to encourage general entrepreneurship, business incubators which specifically focus on high-tech sectors are a sort of inversion of the science park model. Whereas science parks try to attract businesses to co-locate and hopefully collaborate with universities, business incubators seek to encourage spin-offs and start-ups. Incubators try to create a welcoming environment for entrepreneurship by lowering startup costs and providing consulting services. Key features of incubators are temporary leases in business rental property offered at below market rates, professional business managers, and structured networking opportunities with venture capitalists.

Technological MIDI—Brazil

The southern Brazilian city of Florianopolis has sought to encourage the development of a high-tech innovative economy but faces difficulty because of its distance from the commercial and financial hubs of São Paulo and Rio de Janeiro. The local technology business council ACATE, founded Technological MIDI in 1998 with the aim of incubating up to 10 companies. In 2001 they expanded the facility to house a total of 14 companies. MIDI offers many of the same services as other incubators including rent at half the market rate, access to business and financial networks, business consulting, and tax relief. Its close ties to the local business community and the national government are helpful as well. It is registered to receive federal subsidies under Brazil's so-called "IT Law", which encourages domestic IT innovation. By 2007, companies which had graduated from the incubator had achieved sales of US $13.9 Million and employed 385 people. This success earned the incubator the best technology incubator award in 2008 from the Brazilian innovation and entrepreneurship association ANPROTEC.

Some of the key services provided by business incubators include (Johnsrud et al. 2003):

- Provision of a facility to house client firms, including office space, business services and access to laboratory and other technical resources needed for prototyping, testing and analysis for technology-based clients
- Agreement among stakeholders on the objectives of the incubator, including short-term and long-term expectations about tenants' growth and maturation
- Experienced incubator managers who can design and deliver customized services to address the unique needs of client firms
- Design or use of long-term financial support strategies that draw on locally available investment sources, client fees, and downstream equity or royalty returns
- Reliance upon a supportive community infrastructure to facilitate access to the widest possible range of financial, management, marketing, technical, legal and information resources needed for tenant training, networking, market analyses, regulatory compliance and product development.

Business incubators have become even more widespread than science parks, not least because of the fewer resources needed to establish one. Incubators carry additional appeal because of how far along they are in the continuum from basic research to marketable product. The primary rationale for high-tech business incubators is that small, innovative companies are the most likely to create transformative technologies that will benefit society at large, potentially even leading to the creation of new industries especially in advanced economies.

Beginning entrepreneurs have difficulty evaluating the market potential of innovative technology, and even less understanding of the necessary steps towards commercializing a product. This experience gap is a serious barrier to universities that are encouraging their faculty members to spin off new firms. Since such businesses are inherently risky and unproven, they suffer from a lack of investment. Governments seek to correct for this market failure by subsidizing the establishment of such firms (OECD 2006). Incubators attempt to bridge this gap in three key ways, by providing infrastructure, business support, and access to networks.

5.3.2.1 Infrastructure

New businesses face substantial hurdles in acquiring office space, support staff, parking, storage, telecommunications, and other basic overhead requirements. Business incubators help new businesses by simplifying this tedious and time-consuming phase of establishment. By offering package deals at below market rates, firms find themselves at an immediate advantage. The act of renting a real office (rather than maintaining a virtual office or working out of a home) confers added legitimacy to new firms at time when this image is especially important for attracting investment. Business incubators typically house multiple firms. These firms are able to share the costs of the various services such as a receptionist, audio/visual equipment, printers and faxes, and insurance. Interactions between tenants can stimulate further growth as synergies between complementary firms can develop.

5.3.2.2 Business Support

The level of business support varies widely by incubator but can include help with composing business plans, mentoring or coaching from more experienced managers, training sessions, accounting services, IT support, legal assistance, as well as other options.

Equity Stakes

Incubators that are started by the public sector tend to be focused on economic development and increasing local employment levels. As a consequence they tend to ask little financially in return from the entrepreneurs they host. Private incubators, however, may require an equity stake from the firms they incubate. Leading private sector incubators, Y-Combinator and Techstars require around a 6% equity stake from their startups. This cuts both ways; entrepreneurs trade away some of their value, but this incentivizes incubators to work harder since they will share in the final success of the start-ups. According to the National Business Incubators Association, 24% of US tech incubators require some sort of equity stake (Bass 2012).

5.3.2.3 Access to Networks

Of course the main barrier start up business face as they attempt to expand is access to capital. Often this is because entrepreneurs lack contact with venture capitalists and angel investors. Incubators can arrange for their tenants to network with prospective investors. This could be in the form of events where founders make pitches to investors or business lunches with local leaders to gain social capital.

Other Types of Incubators

Accelerators: Rather than allowing for slow growth like more traditional incubators, business accelerators aim to rapidly bring entrepreneurs from the initial idea phase forward to a solid business plan and a prototype or website. They often try to connect budding firms to venture capitalists or angel investors. Examples include Y-Combinator and TechStars.

Virtual Incubator: Some firms already have office space or infrastructure in place but need help with other aspects of business development. Virtual incubators use the internet to connect entrepreneurs with management counseling and other services without having to move to a central shared location.

5.3.2.4 Assessments of Effectiveness

The word "incubator" is key. Business incubators aim to "graduate" companies from the incubator and into the regular market once they become established. Successful operation of a knowledge business incubator requires solid selection criteria and robust standards for firm exit. By being selective about which firms they choose to house, incubators can increase the chances of success. Similarly being clear about when firms must exit provides certainty and encourages firms to expand quickly to become profitable enough to survive outside the incubator.

ICEHOUSE—New Zealand

The ICEHOUSE business growth program was founded in 2001 as part of an effort to increase the number of high-tech SMEs in New Zealand. Its stated purpose was to launch 350 firms to meet a national goal of 3000 new SMEs. Partners for ICEHOUSE included the University of Auckland Business School, BNZ, HP, NZTE, Gen-i, Ernst & Young, Paul Diver, Grafton Consulting Group, and Microsoft. The ICEHOUSE incubator is linked to New Zealand's largest network of angel investors and has a monthly event where 25 entrepreneurs can attend a seminar explaining how to launch a start-up and have the opportunity to meet with incubator staff about joining ICEHOUSE. The incubator offers 3 basic levels of service, market validation, business plan development, and full incubation. ICEHOUSE primarily aims to incubate companies with an intellectual property component with a high growth potential in an emerging market. Since 2001 it has launched 75 companies and attracted $50 Million in angel investment. It was ranked as one of the top 10 technology incubators in the world by Forbes magazine in 2010.

Y-Combinator

One of the most successful tech accelerators was founded in 2005. Y-Combinator takes selects prospective entrepreneurs through 3-month "bootcamps" designed to quickly launch promising companies. After the 3 month period, entrepreneurs pitch their ideas to a group of investors and venture capitalists at a presentation called "Demo Day", an event which has become extremely influential.

Applicants are rigorously screened, but Y-Combinator seeks to invest a small amount of money across a large number of companies. Those accepted into the program are given approximately $18,000, business training, and access to Y-Combinator's network of experienced entrepreneurs and investors. The budding companies cede a 6% equity share to Y-Combinator in exchange for their service. To date, this accelerator has launched 380 companies, including notable internet businesses such as Dropbox and Reddit. (http://ycombinator.com/2012)

It is critical for policy makers and the managers of a business incubator to be clear about the objective of the operation. There is a wide range of potential incubator sponsors including municipalities, universities, government agencies, and nonprofit agencies, who may all seek different end goals. This includes privately owned business incubators whose goal is to achieve a profit. This can sometimes come at the expense of local economic development. If the goal of a knowledge business incubator is to spawn numerous high technology companies to stimulate growth, this must be explicit. Managers may choose to allow successful businesses to remain on site too long because of the steady revenue from rent and fees. Similarly, they may allow unrelated businesses to rent what is essentially subsidized office space. These practices consume resources that could be used by desired technology startups.

Knowledge business incubators are a cost-effective way of stimulating the creation of high tech businesses and fostering a local culture of innovation. However they must be carefully managed and focused on their specific objectives. Innovation and quality should be more highly prized than simply filling space within the incubator (Lalkaka 2002; Almubartaki et al. 2010).

5.4 Conclusion

The process of creating self-sustaining high-tech clusters cannot be fully controlled by governments. While there is no well-defined recipe for this type of economic development, certain ingredients may be helpful. These include strong links between research and development at universities and emerging industries, access to capital markets, and a local culture of competition and collaboration.

Policies such as the creation of science parks and knowledge business incubators can help foster technology transfer and entrepreneurship but are unlikely to stimulate self-sustained economic growth in the absence of other factors. They cannot alone make up for deficiencies in local systems of innovation. Without stable macroeconomic environments, strong labor and capital markets, respectable intellectual property protection, a reasonable research and development base, rule of law, and other basic requirements, an entrepreneurial high tech business culture is unlikely to take hold (Fagerberg et al. 2005; Asheim et al. 2006).

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