Journal of the Society of Korea Industrial and Systems Engineering
Vol, 27, No. 2, pp.86－92, 2004.

Creating a Silicon Valley: Lessons Learned from Taiwan

Soo-Duck Chang

School of IT Venture Business, Hyechon College, Daejeon, Korea

하이테크 클러스터의 경쟁력: 실리콘밸리와 대만의 사례

장 수 덕

혜천대학 IT벤처창업전공

미국의 실리콘밸리와 대만의 신주공업단지는 종종 첨단 산업집적단지의 성공적 모델로 불리어진다. 이들 두 지역의 성공 및 경쟁력에 대한 지배적 설명은 전통적으로 경제활동의 공간적 집적이 가져다주는 경제적 이익을 제시하기 위해 사용된 "외부규모의 경제"에 이론적 기반을 두고 있다. 그러나, 외부경제란 개념만으로 이들 지역의 역동적 발전과 모방하기 힘든 경쟁력을 설명하기에는 부족함이 많았다. 본 논문은 이들 지역에서 역사적으로 전개되어진 기업과 외부 경제주체들과의 관계를 사회적 자본, 네트워크 기반 산업시스템 분석, 자원기반이론 등을 토대로 분석하여 이들 두 지역이 첨단집적단지로서의 성공요인과 경쟁우위에 대해서 살펴보고자 했다. 아울러 본 논문은 이들 두 지역에 있어서 발전적 협력관계를 분석함으로서 국내에서 이러한 첨단산업단지를 개발하고 발전시키기 위해 필요한 것이 무엇인지를 검토하고 이에 필요한 정책적 시사점을 몇 가지 제시했다.

Keywords : high-tech cluster, regional competitive advantage, Silicon Valley, Hsinchu

1. INTRODUCTION

Silicon Valley in California and the Hsinchu-Taipei region in Taiwan are frequently called successful high-tech clusters, as many high technology firms are densely located in those areas. Spatial proximity or geographical concentration aids in the diffusion of knowledge and technology between firms through the frequency of their interaction (Busch and Reinhardt, 1999). It also provides benefits to each other by sharing fixed costs of common resources: infrastructure and services, skilled labor pools and specialized suppliers, and a common knowledge base. Alfred Marshall (1920) developed the notion of "external economies of scale" to refer to these sources of productivity increase that lie outside of individual firms. According to his view, Silicon Valley and Hsinchu can be treated as classic examples of Marshallian external economies, in which the localization of skill, infrastructure, venture capital, specialized materials and inputs, and technological know-how generate cost reductions for individual firms (Krugman, 1991).

In the classical view, when the factors of production are geographically concentrated, firms gain the additional benefits of spatial proximity, or "agglomeration economies," such as cost efficiency and spillover of knowledge. Once established in a locality, such an advantage self-reinforces through a dynamic process of increasing returns (Arthur, 1990; Krugman, 1991). From the point of view of external economies to regional scientists and economic geographers (Krugman, 1991; Porter, 1990), the competitive advantage of industrial clusters depend on a certain amount of economic incentives and tangible infrastructures deemed necessary for economic activities. They emphasize that proximity to universities, convenience of transportation, agglomeration of technical skill, capital, and labors are crucial factors for regional development. But their accounts are not sufficient in explaining the sources of competitive advantage, because

economic incentives and tangible infrastructures are easy to imitate, and do not endure more as competitive advantages (Venkataraman, 2000; Lee et al., 2001). For example, in spite of their common origins in postwar military spending and university-based research, Silicon Valley and Route 128 respond differently to intensified international competition. Both regions faced economic downturns in the 1980s. Although Silicon Valley quickly recovered from the crisis suffered by its leading semiconductor producers, today, Route 128 still shows few signs of reversing a decline that began in the early 1980s (Saxenian, 1994).

Based on social network (Granovetter, 1985), social capital (Putnam, 1993) and industrial system or structure (Porter, 1990; Saxenian, 1994) theories, this paper traces the evolution of the transnational community linking Hsinchu and Silicon Valley and examines the relationship between transnational communities and regional development. In addition, this paper tries to examine historically-evolved relations between firms and their connections to social structure and institutions, and suggests the competitive advantage and success factors of high tech clusters in U.S. and Taiwan. And a concluding section suggests several policies learned from this historically-evolved approach.

2. A BRIEF HISTORY OF THE SILICON VALLEY

The seed for the Silicon Valley was sown in the 1950s financed by defense spending and the presence of three great institutions: Stanford University, Fairchild Semiconductor, and IBM. Stanford pioneered the structure for university-industrial collaboration: taking basic research to the market place. Fredrick Termin, an electrical engineering professor who moved to Stanford from MIT, encouraged and financially supported his two graduate students William Hewlett and David Packard, founders of the Hewlett-Packard Company (founded in 1937), to commercialize an invention known as an audio oscillator (Tajnai, 1985). And Terman initiated the idea of an industrial park, leasing university land (by the terms of its founding deed, Stanford cannot sell its endowed land) to technology firms. The very first tenant is Varian Associates, in the early 50s. Hewlett-Packard followed suit a few years later. The Stanford Industrial Park facilitates the interaction between basic academic research and its productive commercial applications. Its geographical reach eventually expanded southward to create the Silicon Valley.

The root of Fairchild Semiconductor can be traced to Shockley Semiconductor Research Center, established in 1955. Shockley recruited eight young talents from the east coast to join the research center. Unfortunately, his stubbornness and lack of tact soon alienated many of his colleagues and caused them(known as the traitorous eight) to resign from his firm and form their own company, Fairchild Semiconductor Corporation in 1957 (Tajnai, 1985). Two years later, Fairchild Semiconductor developed integrated circuit technology, which paved the way for the birth of the Silicon Valley, as well as the semiconductor industry in the valley and worldwide. The independent and risk-seeking spirit of these Fairchild pioneers to strike their own fortune typifies the energy and diversity of the Silicon Valley culture. Rogers and Larsen (1984) estimated that more than 70 high-tech companies are direct or indirect descendants of the Fairchild Corporation. The sheer size of IBM makes it a force to be reckoned with, from industrial direction to real estate development. Wherever IBM established a presence, the local real estate market prospered due to the scale of its employment.

The second stage of the Silicon Valley chronicle can be tied to the birth of the Apple computer in the 70s, which led to the proliferation of the personal computers and the related supporting industry. The term Silicon Valley was popularized in a series of articles, "Silicon Valley USA," written by Don Hoefler for Electronic News in the 70s, which marked the christening of the region a name and concept that have been copied worldwide ever since. There was some doubt about the vitality of the Silicon Valley in the 80s when the semi-conductor industry was in a slump due to severe competition. This scintillate of doubt was lifted with the personal computer revolution, the telecommunications integration with multimedia applications and now the Internet related industry. By the early 1970s, venture capital (specifically, venture capital limited partnerships) came to replace the military as the lead source of financing for Silicon Valley start-ups. The explosive growth of venture capitalists in the region paralleled the growth of the local semiconductor industry itself. By 1988, Silicon Valley was attracting 40% of the national total of venture capital investment (Florida and Kenney, 1990). The availability of capital is unmatched in the Silicon Valley with

the most resourceful venture capital firms concentrated on one of the most expensive real estate strip in the world, the Sand Hill Road in Menlo Park. These venture capital firms bring management and marketing expertise to hopeful start-ups, navigating them through the uncharted waters from ideas, to products and the ultimate IPO (Initial Public Offering).

3. A BRIEF HISTORY OF SILICON VALLEY-TAIWAN CONNECTION

Many Chinese (in the early days from the 60s, and mainly from Taiwan and Hong Kong) came to the U.S. for higher education, with the goal of staying on to realize the American dream. Taiwan, like most other Asian countries, was historically limited to a maximum of 100 immigrant visas per year. As a result, only 47 scientist and engineers immigrated to the US from Taiwan in 1965. Two years later, in 1967, the number had increased to 1,321 (Chang, 1992.). The influx of highly skilled immigrants coincided with the growth of a new generation of technology industries in Silicon Valley. As the demand for technical skill in the electronics industry exploded, it attracted recent graduates to the region. In the early days, most of them were awarded fellowships and assistantships because of their excellent academic record. They were all top-notch students. As the regional economy heats up in the Pacific rim, coupled with changing immigration policy, many came with their own funds from well off families; with some shifting of focus from pure technology to a mixture of technology, management and international trade.

The Chinese Institute of Engineers (CIE) is commonly regarded as the "grandfather" of the Chinese professional organizations in Silicon Valley. A small group of Taiwanese immigrants started a local branch of CIE in 1979 to promote communication and cooperation among the region's Chinese engineers. In subsequent years, Silicon Valley's Taiwanese immigrants organized a variety of other technical and business associations, including the Chinese American Semiconductor Professionals Association (CASPA), the Asian American Manufacturers Association (AAMA), the North American Taiwanese Engineers Association, the Chinese American Computer Corporation, the Chinese Software Professionals Association, etc. Established in 1991, CASPA brought together participation from Taiwan and mainland China. CASPA organized an annual conference on microelectronics advances in Taiwan, with key participation from Taiwan, mainland as well as Singapore. Topics of the conferences range from chip design to manufacturing technology and yield management.

The Silicon Valley-Hsinchu in Taiwan business connection was institutionalized in 1989 with the formation of the Monte Jade Science and Technology Association (MJSTA). Monte Jade was started in 1989 by a group of senior Taiwanese executives with the intention of promoting business cooperation, investment, and technology transfer between Chinese engineers in the Bay Area and Taiwan (Saxenian and Hsu, 2000). The official communication medium is Mandarin, thus serving almost exclusively Taiwan manufacturers. Membership unit is by manufacturer; contrasting with the engineer membership orientation of the English language Bay Area Institute of Chinese Engineers. MJSTA is a private entity with its financial independence supported by its membership. However, MJSTA does receive human and administrative resources assistance from the Taiwan government (indirectly from the Science Group). MJSTA gradually expands to establish branches in New York, Chicago, Washington, D.C., New England, Pittsburgh and Atlanta. An Asian American MJSTA was established in 1995 targeting the younger generation membership. An Overseas Young Professionals Visiting Delegation is assembled each year to visit Taiwan. MJSTA sponsors a large annual meeting as well as an evening banquet and promotes entrepreneurship as well. Policy-makers in Taiwan sponsored frequent technical meetings and conferences that brought together engineers based in both the US and Taiwan (Chang, 1993). These frequent meetings and conferences supported close and ongoing interactions, and these interactions were by no means unintentional.

4. THE DEVELOPMENT OF THE U.S. AND TAIWAN CONNECTION

The first reverse immigration wave (or reverse brain drain, as the U.S. would characterize it) occurred in the early 80s. This wave was associated with the semiconductor industry, facilitating the Taiwan-to-U.S. capital flow and a corresponding U.S.-to-Taiwan technology flow. The second wave occurred in late 80s and early 90s when

the Taiwan semiconductor industry began to mature. In 1976, the Taiwan semiconductor industry signed a ten-year contract with RCA for training as well as cooperative development. Twenty-five people were sent to RCA for training. Using RCA optical mask technology, the first wafer was manufactured in 1997. The next step was to grow its own domestic design expertise. UMC was the first semiconductor fabrication plant to start production in 1982. The third step migrated from NMOS technology to use the more energy efficient CMOS, with the intention of bringing in more overseas expertise. During this period (around 1984), three critical groups of semiconductor experts set up shops in Taiwan. They established three catalytic companies in Taiwan: Quasel, Mosel, and Vitelic.

These pioneers arrived at Taiwan with much fanfare, viewed as overseas scholars giving up huge salary returning to serve the mother land. However, their timing was less than ideal, with the global shake-down in the semiconductor industry. Quasel eventually closed its door. Mosel and Vitelic had to license their technology (to Korean and Japanese companies) to survive, instead of the original plan to manufacture and market their products. Mosel and Vitelic merged and went public in 1994 when the semiconductor industry rebounded. The return of these three group of talents accelerated the semiconductor industry in Taiwan and achieved the goals set by the government policy makers by several years. Mosel was funded by a consortium of private and government venture and it was in the SRAM business. They leased manufacturing capacity from government research facilities. Vitelic and Mosel formed a strategic merger creating Mosel-Vitelic in 1991 and went public in 1995.

In 1989, 60 Minutes (a CBS news magazine program) Mike Wallace highlighted the return of 28 overseas engineers to Taiwan as reverse brain drain. Macronix was established to target high-end products: Mask Rom, systems-on-chips, and flash memory. They also have a branch office in San Jose. In the mean time, the Taiwan government also established the Electronics Research and Service Organization (ERSO) under the Industrial Technology Research Institute (ITRI). It is not a public organization. Its funding is a mixed public-private financing with the government providing a 1-1 matching to private capital. It focuses on product development and licensed its technology to the highest bidder(s). The challenge is not to compete with private enterprises. It creates technology with government support. While only 184 Taiwanese had returned from the US to work in the Hsinchu Science Park in 1989, a decade later the total had increased more than ten-fold to 2,840. And these returnees were disproportionately likely to start their own companies. Some 40% of the companies located in the Science Park (110 companies out of a total of 284) in 1999 were started by US-educated engineers, many of whom had considerable managerial or entrepreneurial experience in Silicon Valley. These returnees in turn actively recruited former colleagues and friends from Silicon Valley to return to Taiwan. These returnees transferred elements of the Silicon Valley management model and carried technical knowledge as well as contacts, capital, and information about new opportunities and mew markets.

In 1980, the Taiwan government proposed to establish seven Science groups to serve, network overseas technology human talents (just to nurture relationship). Eventually, five science groups are formed in Washington D.C., Los Angeles, Houston, San Francisco, and Chicago. Scientists were sent to US as visiting scholars to study technology management and to develop long term collaboration and development strategy. In the early 80s, Taiwan also started science park. Visiting programs were also initiated to encourage science, technology as well as management exchange. Oversea Chinese were encouraged to return as investors and most importantly as technologists. The Science groups also spent a large amount of time to establish a database of scholar profiles to target recruiting. Many spin-offs were also created to focus on various domain areas: laser, software, telecommunications, the web, and semi-conductor. The original science group acts as an incubator for other domain focus groups.

5. THE SUCCESS FACTORS OF SILICON VALLEY AND TAIWAN

As seen in the above brief description, many interacting and inter-connecting activities have been taking shape across the Pacific ocean between the technology/finance worlds of the U.S. and Taiwan. Some of the activities were coordinated and others happened independently. Some government initiatives and coordination were carried out to achieve policy objectives, particularly the industrial park and the Industrial Technology Research Institute (ITRI), both established in Hsinchu. The industrial park takes after

the Stanford Research Park (in Palo Alto), which provides space and tax advantage for high tech industry to establish manufacturing and research facilities. Government matching fund is supplemented by private capital to finance ITRI. Its technology is considered to be public knowledge, with licenses awarded through a bidding process. Researchers are encouraged to spin off its technology on an equity sharing basis with the Institute. Its operation enjoys autonomy with no official interference from the government.

By analyzing the cases of Silicon Valley and Taiwan and their connections, this paper can draw out Success factors of Silicon Valley and the Taiwanese Strategies. And summarized these factors briefly as following.

5.1 The Silicon Valley Success:

This paper has identified the following success factors of the Silicon Valley: world class universities, world class technology base, well-educated workforce, closed university and industry ties, concentration of capital, role of government, business culture, etc.

First, the great research universities: Stanford, UC Berkeley and UC San Francisco (UC Medical school) with 1) their innovative approach that creates tight relationships to outside actors who commercialize applications of their research and researchers and 2) their recruitment of faculty and graduate students from all over the world, not just locally or nationally (Cohen and Fields, 1998).

Second, the flexibility of labor market: the Valley attracts not only graduates from the universities in the region but also brilliant scientists and entrepreneurs throughout the world. The ethnic/cultural diversity of the region makes foreign workers feel far less alien than any other places in the world. There is rapid turnover. People shift from company to company freely, and no stigma in leaving a large and very successful company such as Hewlett Packard or Sun Microsystems to launch a start-up in the region. This has many consequences, one of which is technology diffusion.

Third, the role of government policy: in order to attract, retain and expand business in Silicon Valley, governments sponsor a partnership between the private and business sectors. In addition to, government immigration policies also facilitate for high-tech companies to recruit foreign-born scientist and workers.

Fourth, richness of resources and connections among them: world class technology base, venture capital, law firms, business networks, etc. 1) Venture capital firms perform not only as source of early-stage capital support but also as Godfather's role to venture firms such as the critical moments of a firm's development, strategic and operational advice, links and leads to potential customers and partners. 2) Law firms, which provide another source for locating key personnel, finance contacts, as well as corporate and intellectual property legal services, and who often take payment in stock rather than cash (Cohen and Fields, 1998). 3) Except formal network channels such as venture capital, law firms and institutions, informal channels such as angel and irregular conferences are abundant in the area, and they perform the role of informal focal points for exchange of ideas and informal communication channels.

Fifth, business culture (called "Silicon Valley-Way"): one reason to do business in Silicon Valley could be the valley's unique business culture, which is summarized such as a culture of pioneering spirit, the desire and willingness to take risk, entrepreneurship and experimentation, friendship with competitors, and cooperation among firms.

Sixth, closed university and industry ties: the linkages between the university and industry provide jobs to skilled graduates and facilitate the development and transfer of knowledge and technologies. Some of the most innovative technology transfer results from collaborations between university and industry. In these arrangements, personnel, equipment, facilities and research capabilities may be shared for mutual benefit.

5.2 The Taiwan Success:

This paper has identified success factors of the Hsinchu in Taiwan as following:

The first ingredient is an unplanned accident: The first wave of immigrants (to the U.S.) from Taiwan is an unplanned activity. Individuals seeking a better opportunity came to the U.S. in the early 60s for an education with the intention of permanent residency. They finished their education, stay in the high tech environment. Coincidentally, they acquire knowledge, management skill and (most importantly) a valuable network (of people and technology).

Second, the Taiwan government has the resource and foresight to create an industrial park (in Hsinchu) as well a

semi-private (with public matching fund) research infrastructure (Industrial Technology Research Institute, again Hsinchu). The ITRI organization has a flexible structure to allow for elimination and creation of research foci.

Third, the ITRI has an open door policy for its research: it is considered to be public knowledge. Its mission is for the dissemination of information to encourage information exchange (much as in an university environment).

Fourth, the culture of ITRI encourages commercialization of its products by its researchers through seed funding (much like venture capital) as well as the management expertise of the investment world. This economic incentive makes up for the low-paying position of a researcher in ITRI.

Fifth, nearby top universities: Tsinghua, for example. This aspect of Hsinchu mimics the Silicon Valley. The ITRI creates the opportunities and environment for academic-industry interaction. Researchers seek applications for their new technology innovations.

Sixth, the timing was right. Several critical and complementary factors contribute to the success of the Taiwan industrial policy, some intentional and some accidental. The immigrant factor is an unplanned one. The early wave of immigrants did not plan to go back. They stayed and acquired the unique blend of attributes collectively as a group. These attributes are: western technology, corporate network of connection, Chinese work ethics, a hidden desire to return and serve (the motherland), western management perspectives. The entrepreneur ones created their own start-ups, the corporate bunch started climbing the corporate ladder, the scientific ones continue to acquire technology knowledge. Three things then happened. First, the Asian economic bloom creates a surplus of capital within Taiwan. Secondly, the corporate group starts hitting the glass ceiling. Thirdly, the Taiwan government initiated the industrial complex in Hsinchu, and started aggressive marketing and recruiting. With this background, many international companies (many with ties to Taiwan, either due to its Taiwanese founders, or executives with Taiwan ties) established their presence in Hsinchu. Taiwan venture capitals assisted start-ups with Taiwan ties.

6. CONCLUSION

What does it take to create a "Silicon Valley"? This question is asked repeatedly in many parts of the world. Silicon Valley has the following attributes: location with its diverse population, good weather and embracing culture which makes one feel welcome, technology base with close ties (physical as well as intellectual) to world class universities, concentration of venture capital firms, entrepreneur corporate culture that encourages innovation and risk taking, Pioneering spirit (daring to experiment), and multi-cultural environment that attracts international talents and embraces diversity. To duplicate this success, one has to create similar environment with local improvisation. This paper can identify several critical ingredients that will create a nurturing environment, i.e., human capital, infrastructure, network, financing.

Appropriate government policy is critical to combine with the local environment. First, there has to be a magnetic core: a first class research university. This criterion will limit the number of candidate locations because you cannot build a world class university over night. Government policy is then needed to create the necessary infrastructure: industrial park, technology transfer/commercialization rules, tax incentive and a clear commitment statement. An active recruiting effort is needed to attract a right core of human capital. The availability of this human capital is not automatic. Taiwan has the fortune of a human resource base from the Silicon Valley (which was unplanned), as discussed earlier. If this is set up correctly, one still needs financing capital. Taiwan was also fortunate in the timing when its economy bloomed and the U.S. economy faltered (in the earlier 80s). High salary and opportunities attract top talents. The glass ceiling factor also contributed to the recruiting success. The networking aspect comes with years of corporate experience for this first wave of immigrants (also unplanned).

When these four ingredients are present, business opportunities will present themselves and the free market profit seeking motives will take care of the rest. There will be successes and failures, which are just the result of free market enterprises. The industrial complex should provide a place for low cost experimentation so that ideas can be tested economically. There also has to be technology and market intelligence to track industrial trend and consumer needs. Government support has to be carefully structured

so that such support should not hinder market forces. Financial incentives usually lead human behavior. The stock options structure in the Silicon Valley allows ownership participation by employees and has proven to be effective. The first step to attempt the creation of a Silicon Valley is to take stock of the local condition: what is present and what is lacking in the key ingredients. Improvisation and innovation is needed to plan out a strategy. Never underestimate the local conditions, you can only use what you have inherited.

Reference

Arthur, B. (1990). "Positive Feedbacks in the Economy." *Scientific American*, 262(2), 92-99.

Busch, M. L. and E. Reinhardt (1999), "Geographic Concentration and Political Mobilization: The Spatial Determinants of Collective Action in Trade Politics," *Working Paper.*

Chang, S. L. (1992), "Causes of Brain Drain and Solutions: The Taiwan Experience," *Studies in Comparative International Development.* 27(1): 27-43.

Chung, Y. L. (1993), "Government's Role in Developing a High-Tech Industry: the Case of Taiwan's Semiconductor Industry," *Technovation*, 13(5), 299-309.

Cohen, S. S. and G. Fields (1991), "Social capital and capital gains in Silicon Valley," *California Management Review*, 41(2), 108-130

Cohen, S. S. and G. Fields (1998), "Social Capital and Capital Gains, or Virtual Bowling in Silicon valley," Working Paper.

Florida, R. and M. Kenney (1990), "Silicon Valley and Route 128 Won't Save Us," *California Management Review*, 33(1), 68-88.

Granovetter, M. (1985), "Economic Action and Social Structure: The Problem of 'Embeddedness'," *American Journal of Sociology*, 91(3), 481-510.

Krugman, P. (1991), *Geography and Trade*, Cambridge, MA: MIT Press.

Lee, J., Chiu, S. Kim, S. and S. Chnag (2001), "Success Factors of High-Tech Clusters: Case Studies in America, Taiwan, and Israel," *The Korean Small Business Review*, 23(1), 3-33.

Porter, M. (1990). *The Competitive Advantage of Nations*, New York: The Free Press.

Putnam, R. D. (1993), *Making Democracy Work: Civic Traditions in Modern Italy, Princeton*, NJ: Princeton University Press.

Rogers, E. M. and J. K. Larson (1884), *Silicon Valley Fever*, NY:Basic Books.

Saxenian, A. (1994) *Regional advantage: Culture and competition in Silicon Valley and Route 128.* Cambridge, MA: Harvard University Press.

_____. (1999), *Silicon Valley's New Immigrant Entrepreneurs*, San Francisco, CA: Public Policy Institute of California.

_____. and J. Y. Hsu (2000), "The Silicon Valley-Hsinchu Connection: Technical Communities and Industrial Upgrading," *Working Paper.*

Tajnai, C. (1985), "Fred Terman, The Father of Silicon Valley." http://www.internetvalley.com/archives/mirrors/terman.html.

Venkataraman, S. (2000), "The Birth and Evolution of Great Entrepreneurial Regions/Economies," *Creating a Silicon Valley in Korea: Lessons from the Cases of US, Taiwan, and Israel*, Presentation Paper.