XX IASP WORLD CONFERENCE ON SICENCE AND TECHNOLOGY PARKS
June 1-4, 2003 - Lisbon, Portugal

ON THE TRANSFORMATION OF SCIENCE PARK—THE CASE OF THE HSINCHU SCIENCE-BASED INDUSTRIAL PARK

James Lee, Shih-Chang Hung
HSINCHU SCIENCE-BASED INDUSTRIAL PARK ADMINISTRATION
2 Hsin Ann Road, Hsinchu 300, Taiwan
TAIWAN
Phone +886-3-5773311 Fax: +886-3-5776222
E-mail: jameslee@sipa.gov.tw
Internet: http://www.sipa.gov.tw

Abstract

Similar to management of an enterprise, development of science parks have to face challenges in the process of growth. Transformation and ways to counter the challenges determine the future development of science parks. This study aims at investigating the success factors of the Hsinchu Science Park, analyzing the problems occurred in the process of transformation, and trying to figure out strategies to cope with the transformation and transformation-related challenges.

1. Introduction

Since 1980, the IT industries at Hsinchu Science Park created a high-tech industrial and economic prosperity and outshined most global science park peers, which consequently made Taiwan's industries a crucial part of global economic development and thus turned Taiwan into a renowned global IT manufacturing country. The outstanding performance and the successful experience of the Hsinchu Science Park then became a model for duplication.

However, the superiorities of the Hsinchu Science Park gradually fade in color due to a strenuous competition of global science parks and a overwhelming local assessment of environmental protection. As the interaction between Mainland China and Taiwan expands gradually in high-tech industries, the Hsinchu Science Park encounters to a number of challenges, e.g. industrial elevation, move-out of high-tech professionals, insufficiency of R&D competence, etc. How to solidify R&D competence, develop key technology, take a unique and solid stand among global competitive environment and threats from mainland China, and maintain a harmonious relation with local communities are the main issues that the Hsinchu Science Park has to face for the coming transformation.

This study aims at investigating the following issues: a. clarifying the competitive position of the Hsinchu Science Park among local industrial parks, new science parks in Mainland China, and other global science parks, so as to figure out the strategies to cope with competitions of global science parks which attract investment by means of superior encouraging benefits, b. figuring out the renew mechanism for the existent tenants at the Park together with strategies for expelling unfitted Park tenants via quantity and quality analysis and examining the innovation mechanism of industrial clusters and searching for ways to elevate the innovation competence of the Park.

2. Development of the Hsinchu Science Park

Concept of science parks was initiated at Stanford University. Originally, the Science Park at Stanford University functioned as an interface turning R&D outcomes from lab to market. Thus the characteristics of a science park should cover the integration of technical innovation and industrial manufacturing. A number of studies suggested that science parks should extend close links with adjacent universities and research institutes in solidifying R&D and innovation competence. As for industrial implementation, a science park should link closely with industries and market and materialize the R&D outcomes into industrial products and yield economic benefits. The relation between industries and science parks has been elaborated into a model by Monck, C. S. P. et. al. in 1988, i.e. the so-called "linear model of innovation." Based on the model, research institutes and industries are incorporated into the following

structure:

Theoretical science(Universities)→Applied science(Research institutes) →Technological implementation(Manufacturers)→Market

Many researches and studies used to take the Silicon Valley as a classic and a model of science parks, thus the establishment of new science parks in many countries often duplicates the experience of the Silicon Valley and chose to locate in the vicinity of universities or research institutes.

The Hsinchu Science Park bore more responsibilities and expectations comparing to most global science parks. Initially, the Park was established to attract foreign investment and overseas Chinese and push an industrial elevation in Taiwan. The location of the Hsinchu Science Park chose to set nearby National Tsing-hua and Chiao-tung universities, the best universities in the fields of science and technology in Taiwan at that time, and the Industrial Technology Research Institute, expecting a successful integration of technology innovation and industries. In the aspect of professional personnel cultivation and technology transfer, adjacent universities and research institutes did contribute significantly to the development of the Hsinchu Science Park. However, the development of the Hsinchu Science Park did not follow the above linear model of innovation if we take the characteristics of overall high-tech industrial environment at that time into account. In the process of Taiwan's economic development, ratio of locally oriented technological innovation was not high, even local industries exhibited a significant growth. A higher ratio of technological innovation was resulted from brought-in technologies and duplication of advanced technologies. Fortunately, the process of technology bring-in, imitation, re-learning, and self-innovation happened in Taiwan's high-tech industrial development coincidentally paced with the product cycle of global high-tech market. Thus the introduction and bring-in of technical know-how and facilities together with the self-developed technologies have successfully transformed Taiwan from a technology user into a technology provider. Pragmatically, the success of the Hsinchu Science Park appeared a different shape with most global science parks.

The major part of technologies obtained by the Park tenants was not resulted from self innovation nor brought-in ones, how can the Park survive from the global competitive environment? Exclusively, the success factors lie in courageous trial and innovation spirit of new technologies brought in from technology-advanced countries. A comparatively higher risk and uncertainty have to be taken by most Park tenants at that time under this condition. Besides, the Park tenants possessed relative sound competence in technological innovation and R&D. If the trial spirit of high-tech

industries does not come into view, then a fast innovation and development of new technologies will be impossible. This trial spirit and fast learning competence made Taiwan shoot out from the existed linear models and fund a corner stone of Taiwan's high-tech industry development, which accordingly enhanced technical bring-in effects, diffused industrial technologies, and strengthened industrial development scale.

The high-tech industrial clusters at the Hsinchu Science Park linked closely with the industrial clusters at the Silicon Valley and made Taiwan a major hardware provider amid global task-partition of IT industries. This crucial role did not fade out since the prosperous development of PC related industries in the 80s till a overall development of semiconductor industries in the 90s. Dr. Manuel Castells, a professor at the University of California, ever depicted at the annual conference of the IASP in 2001 that "We cannot think about Silicon Valley without thinking about Taiwan and …Bangalore." In 2000, the development of the Hsinchu Science Park reached the peak in it history. Within a land area of 605 hectares, the Park included 289 enterprises, employed more than 100,000 professionals, where 1/10 of them were researchers, and created a revenue around 30 billion US dollars. Almost two third of semiconductor revenue in Taiwan was contributed by the Hsinchu Park in the same year. It can be said that the Hsinchu Science Park successfully brought in Taiwan's economic prosperity and high-tech industrial development.

The success factors of the Hsinchu Science Park can be concluded into the following three parts:

a. Government policy support

   Government policy supports played important roles in the development process of the Hsinchu Science Park. Government's involvement in the development of the Hsinchu Science Park included infrastructure founding, investment encouragement, efficient administrative services, sound land development policies, and investment in potential startup companies. Establishment of science parks was sophisticatedly manipulated by the government and the Hsinchu Science Park was a successful case. Importance of policy supports for the development of science parks attracted a wide discussion at annual conferences of the IASP, e.g. Wu, 1997 and Dubarie, 2002.

b. Cultivation of industrial cluster effect

   The industrial cluster effect around the Hsinchu Science Park is crucial for technology diffusion. The integration of up-stream and down-stream industries reduces the cost and increases the elasticity of high-tech industries. The effect significantly revealed in IC and PC related industries. Cluster effect is the most

important factor that pushed a fast growth of the Hsinchu Science Park.

c. Global linkage

The establishment of the Hsinchu Science Park was reckoned as the main factor that drove overseas Chinese technical talents back to Taiwan. As a technology follower twenty years ago, technology elevation was the crucial issue for bringing up Taiwan's technology industries. Overseas Chinese high-tech elite brought back remarkable new technology and ideas and consequently enhanced the technical diffusion of high-tech industries. Besides, returned Chinese engineers built a close link with the technology communities at the Silicon Valley and thus speeded up the introduction of new technologies as well as enhancement of market sensibility.

3. Challenges and Transformation

Over the past twenty more years, the Hsinchu Science Park has grown up and mature. New challenges gradually come out as the shift of investment environment and industrial changes. The major challenges include:

a. From the request of efficiency to justification of resources distribution

The primary request for most enterprises at the Hsinchu Science Park at early time was industrial efficiency and revenue. The situation changed after the development of the Park reached its maturity. Land, water, power, and adjacent traffic problems are waiting for proper solutions at present. Related social justification on distribution of resources and assessment of environmental protection thus attracted wider attention. Scope of coordination on positive and negative issues of the Park expanded significantly comparing to earlier stages. How to maintain the existed competitiveness and satisfy the social justification on resource distribution and assessment of consistent development became a great challenge for the Park.

b. Severe global competition

Shooting up of new science parks imitating the experience of the Hsinchu Science Park became new competitors of the Park. Newly established science parks in neighboring countries attracted investment and technical personnel via better investment conditions, appealing benefits, and cheaper land and labor cost. How to cope with the environmental changes and coming competitions and to sketch future strategies became a great challenge for the Park.

c. Organizational idleness

Establishment of science parks aims at encouraging innovation and R&D of new products and technologies. As industries and products turned into maturity in it life cycle, innovation became an important issue to activate the vitality of the

park industries. Industries established at the Park in earlier stages may no longer fit new definitions of high-tech industries at present. Renew mechanism and enhancement of technology diffusion as well as resource distribution are challenging the Park.

Transformation of the Hsinchu Science Park is necessary and urgent while facing the inner pressures and outer competitions. Emphasis on innovation as well as industrial manufacturing together with balanced resource distribution and cost reduction became crucial issues for the Park to find a way out among the competitive factors.

Theoretically suggested that the superiority of a science park will fade out gradually because of newly established science parks in the neighborhood via attraction of better investment benefits and cheaper cost. Transformation of science parks thus becomes a necessity under the circumstance and has to cope with the dynamic changes of industries and market. New superiorities have to develop so as to root in new foot stands. Similar situation happened at the Hsinchu Science Park, ways to counter with new competitors and progress over leading peers are the key issues to resolve at present.

Besides, transformation of the Hsinchu Science Park has to take the existent competitive superiorities of local industries as well as cluster innovation mechanism into account. Similar tracks can be found in the development experience of the Silicon Valley. The following two figures depicted the industrial structure changes of the Hsinchu Science Park and the Silicon Valley in 1992 and 1999 respectively, where the labor structure shifted from computer related industries in 1992 to semiconductor industries in 1999 at the Hsinchu Science Park and at the same period of time at the Silicon Valley, the labor structure shifted from defense/aerospace industries to software and services oriented industries. Transformation tendencies at these two parks revealed individual superiorities and structural differences, which functioned as important references for the transformation of the Hsinchu Science Park.

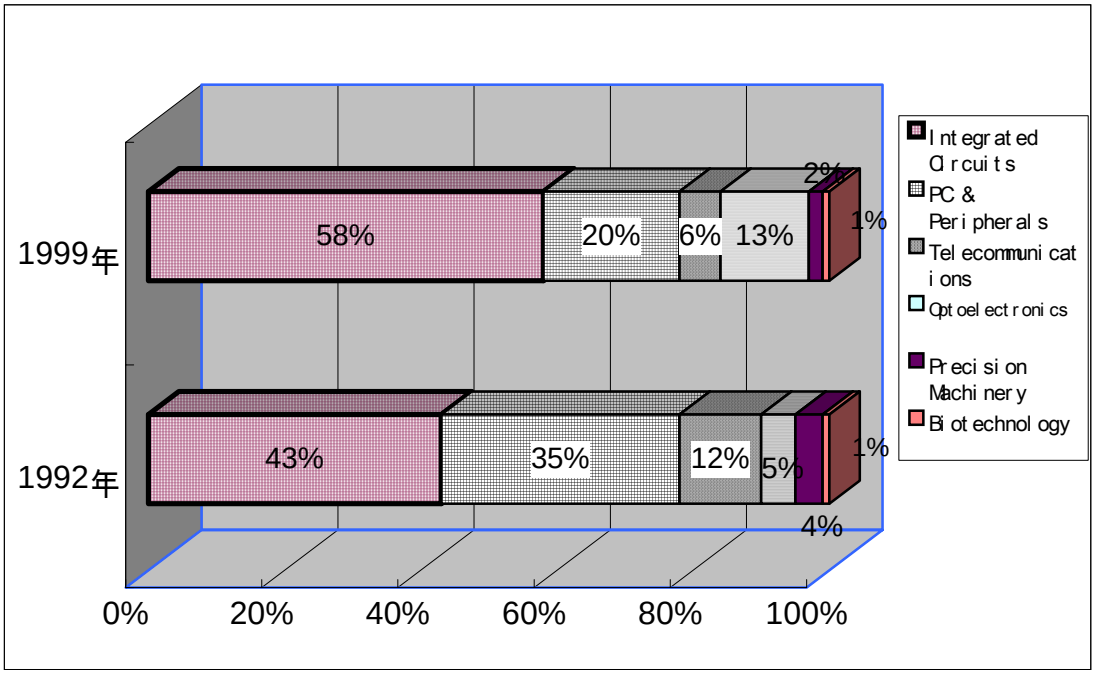

Figure 1 Labor structural changes at Hsinchu Science Park in 1992 and in 1999

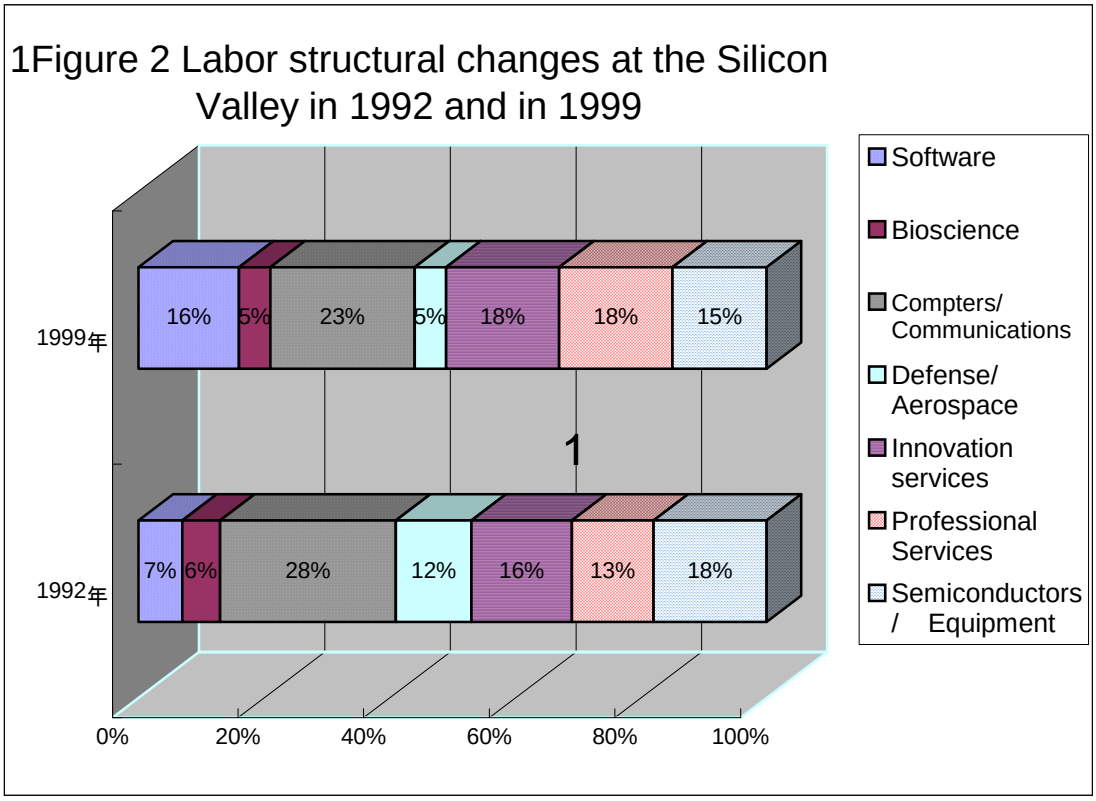

Figure 2 Labor structural changes at the Silicon Valley in 1992 and in 1999

The prosperous development of semiconductor industries at the Hsinchu Science Park

exhibited a significant cause-and-effect relation with the adjusted development direction of the semiconductor industries at the Silicon Valley. The industries at the Hsinchu Science Park were impressed significantly by the technical innovation at the Silicon Valley at that time and excited a remarkable global industrial linking effect. This linking effect and industrial similarities between these two parks fermented in computer related and telecommunication industries at the Hsinchu Science Park and led to the success of Taiwan's high-tech industrial development. Differences of structural changes between these two parks further led to a confined development in innovation competence and professional services industries at the Hsinchu Park due to a governmental manipulation of the Park's development.

In the labor structural changes at the Silicon Valley from 1992 till 1999, innovative and professional services industries revealed significant growth in addition to the expansion of semiconductor industries. This phenomenon suggested that research institutes and R&D organizations played important roles in forming the industrial cluster effect and ensuring a steady growth of innovation competence at the Silicon Valley, though most manufacturing capacities followed the global task-force partition mechanism and moved toward areas with cheaper cost. The science parks in Taiwan will follow the track and advance on the cultivation of innovative and professional services industries. To elevate domestic technological level amid global task-partition of industries, industrial development in Taiwan will follow the rules of product life cycle and make the best use of capacities in areas with cheaper cost. As the innovation competence elevates in Taiwan, innovation services industries will become a development target.

Cultivation of innovative services industries relied mainly on the development of professional services industries. The innovative activities at the Silicon Valley come out not only from large enterprises but also from a wide variety of small companies, where activities such as capital raising, patent application, and merchandising of R&D outcomes bring a large service necessity. The patent number obtained by the tenants at the Hsinchu Science Park grew significantly in recent years. However, such kind of innovation activities were the privileges of large enterprises merely. Small companies could not afford for related expenses due to confined resources. Though the Park provides efficient administrative services, e.g. banking services, law services, coordination of human resources, etc, the scope and elasticity of overall professional service industries at the Hsinchu Science Park are inferior to the ones at the Silicon Valley. There is still a wide room for the Hsinchu Park to develop in the aspect of flexible innovative and professional service industries.

4. Transformation Planning of the Hsinchu Science Park

a. Encouraging facilities and strategies

The transformation of the Hsinchu Science Park should take many factors into account, e.g. superiorities of other local science parks, existed competitive superiorities at the Park, technical and business interaction with science parks in neighboring countries, global task-partition, competition and collaboration relation between science parks, etc. From the viewpoint of competition and collaboration, the transformation of the Hsinchu Science Park can be outlined as follows.

Competitions among science parks can be classified into three categories, namely, a) price competition, i.e. appeals of essential cost, b) quality competition, i.e. appeals of public infrastructure and executive efficiency, c) innovation competition, i.e. means to elevate the innovative competence of Park enterprises. For future prospect, the Hsinchu Science Park is suggested to reach a balanced development among three types of competition and try to grasp superiorities from the transformation of price competition toward quality competition and innovation competition. Superiorities over the price competition strategies can efficiently attract investment and enhance the industrial cluster effect but the attraction of low efficiency manufacturers which eagerly seek for policy supports may not be helpful for long-term development of the high-tech industries. Superiorities over quality competition strategies are crucial for forming industrial cluster effect via sound infrastructure and efficient administrative services, which function as useful tools to phase out low efficiency tenants gradually by means of competitive pressure. Thus, the innovation competition strategies are suggested to adopt for the Hsinchu Science Park in order to form a sound innovation cluster effect and help the park tenants to elevate innovation competence.

Collaboration relations among science parks can also be classified into three categories, namely, a) introduction of technology and personnel, which is similar to the strategies of the Silicon Valley, b) reduction of manufacturing cost, such as the investment attraction tools utilized by most shooting science parks in south-eastern Asia and mainland China, c) development of overall industrial cluster effect and superiorities, which includes the development of local science parks, e.g. Tainan Science Park, Taichung Science Park, etc. Regarding the target strategies of future transformation of the Hsinchu Science Park, the Park is expected to develop industrial cluster effect and elevate the innovation

competence of the industries via global task-partition networks.

Substantial strategies for the transformation of the Hsinchu Science Park can be concluded as follows.

a) Enhancing interaction between local industries, universities, and research institutes, bringing in knowledge-based R&D and innovative industries, and encouraging strategic alliances and R&D collaboration of global and local industries.
b) Forming multiple high-tech industrial clusters based on three core science parks in north, middle, and south Taiwan according to local resources and industries characteristics.
c) Strengthening public infrastructure, transportation facilities, and networks, revising related laws and regulations, promoting technology exchanges and transfer of high-tech industries, enhancing interaction between domestic and foreign Taiwanese manufacturers, and utilization of low-cost global resources, products, labors, and markets.
d) Improving the quality of water and power supplies and resolving industrial development bottlenecks.
e) Establishing waste treatment and recycling facilities and enhancing resource management and utilization.
f) Simplifying executive procedures and regulations and inspiring enterprise vitality.
g) Cultivating the environment for innovation services industries and incubators.

b. Renewing mechanism

In addition to strengthening the services quality and innovation services of administrative units, the competitiveness of the Hsinchu Science Park mainly comes from the manufacturing efficiency and innovation competence of the Park enterprises. Thus transformation strategies of the Park should take the renewing mechanism of moved in enterprises into account so as to enhance the competitiveness of Park enterprises. In practices, the renewing mechanism is suggested to include the following strategies, e.g. encouragement of strategic alliances and R&D collaboration between domestic and foreign industries, collaboration between industries and academia and improvement of investment attraction tools and renew mechanism for Park tenants, in an eye to increase the innovation competence and manufacturing efficiency at the Park.

Establishment of incubators is a good tool to enhance innovation competence. Incubators were not available at the Hsinchu Science Park until the revision of related regulations at the end of 2001. Most incubators in foreign countries are closely related to adjacent universities and research institutes and function as interfaces of technological transfer between innovation at academic institutes and implementation at science parks. The situation is different at the Hsinchu Science Park, where incubators have long been established at adjacent universities or research institutes. The planned-to-establish incubators at the Park have to care about the functional partition with existed incubators at adjacent universities and research institutes and are suggested to incorporate with the Park industries to carry out implementation services of innovative technologies.

Besides the overall innovation environment cultivation and transformation driven by incubators at the Park, the operation mechanism of the Park is suggested to aim at integrative development of innovation environment, incorporating the cultivation of professional services industries like banking facilities, law services, consulting services, etc. to vitalize the innovation environment at the Park by means of balanced industrial development. Via the development of professional services industries and venture capital services industries, the Hsinchu Science Park is expected to achieve a sound expansion and transformation.

REFERENCE:

1. **Bakouros, Y. L., Mardas, M. C., Varsakelis, N. C**. (2002), “Science park, a high tech fantasy?: An analysis of the science parks of Greece,” Technovation, 22(2):123~128
2. **Benjamin Coriat, Olivier Weinstein** (2002), “Organizations, firms and institutions in the generation of innovation,” Research Policy , 31:273–290
3. **Castells, Manuel**(2001), “Resources for Innovation in the Era of Global Networks”, XVIII IASP world conference.
4. **Dubarle, P.** (2002), “Toward a new agenda: business, social and urban development impacts,:, XIX IASP world conference. 23-40
5. **Freeman, C.** (1982), The Economics of Industrial Innovation, 2nd ed. London: Frances Pinter.
6. **Gibb, J. M. ed.** (1985), Science Parks and Innovation Centres, Elsevier.
7. **Lee, Wen-Hsiung, Yang, Wei-Tzen** (2000), “The cradle of Taiwan high technology industry development - Hsinchu Science Park (HSP),” Technovation, 20:55-59.
8. **Löfsten, H., Lindelöf, P**. (2002), “Science Parks and the growth of new technology-based firms - academic-industry links, innovation and markets,” Research Policy, 31(6): 859-876.
9. **Mathews, J. A.** (1997), “A Silicon Valley of the east: Creating Taiwan's semiconductor industry,” California Management Review, 39(4):26-54.
10. **Monck, C. S. P. and et al.,** (1988), “Science Parks and the Growth of High Technology Firms,” Reprinted by Routledge 1990.
11. **Porter, Michael.** (1990), The Competitive Advantage of Nations, New York: The Free Press.
12. **Richard R. Nelson, Katherine Nelson**.(2002), “Technology, institutions, and innovation systems,” Research Policy, 31:265–272
13. **Santoro, M. D.** (2000), “Success Breeds Success: The Linkage between Relationship Intensity and Tangible Outcomes in Industry-University Collaborative Ventures,” The Journal of High Technology Management Research, 11(2):255-273.
14. **Saxenian, A., Hsu, J.-Y.** (2001), “The silicon valley - Hsinchu Connection: technical communities and Industrial upgrading,” Industrial and Corporate Change, 10 (4): 893-920.
15. **Schmookler, J.** (1966), Innovation and Economic Growth, Harvard University Press.
16. **Swinbanks, D.** (1993), “Taiwan beckons researchers back from US,” Nature, 366(6454):397.
17. **Tilley, K. J., Williams D. J., Conway, P. P.** (1997), “Development and R&D

capability at manufacturing sites: Electronic multinationals in Singapore and Taiwan," Production and Operations Management, 6(2):131-152.

18. **Westhead, P**. (1997), "R&D 'inputs' and 'outputs' of technology-based firms located on and off Science Parks," R & D Management 27(1):45~63.
19. **Wu, Jisong**(1997),"New modes in science parks will direct the world into knowledge economy in 21st century," Delivering innovation: Key lessons from the world-wide network of science and technology parks, XV IASP world conference.337-353
20. **Zoltan J. Acs, Luc Anselin, Attila Varga** (2002). Patents and innovation counts as measures of regional production of new knowledge ,Research Policy ,31:1069–1085