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Clusters and Innovation: Beijing's Hi-technology Industry Cluster and Guangzhou's Automobile Industry Cluster

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Abstract

This paper proposes a flowchart approach to the automobile industry cluster policy and the hi-technology industry cluster policy to prioritize policy measures. First, in the automobile industry cluster, suppliers of parts and components to anchor firms such as Honda, Nissan and Toyota of Japanese assembly makers in Guangzhou, China, can innovate partly because the suppliers have become independent of their anchor firms in the Japanese Keiretsu system. Second, concerning the hi-technology industry clustering in Beijing, we show that the existence of universities is a precondition for the industrial cluster policy and that the leadership of the Zhongguancun Science Park Management Committee of Beijing Municipality is crucial to the success of the industrial cluster policy. The flowchart for the hi-technology industry is different from the one for the automobile industry cluster.

Keywords: Flowchart approach, Prioritization, Innovation, Guangzhou, Beijing, Universities, Local government

JEL classification: O18, R11.

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1. Introduction

An industrial agglomeration helps its firms innovate. As is shown in Figure 1, we define a cluster as a combination of Step I: Agglomeration and Step II: Innovation. Can industrial cluster policy help high-technology firms and research institutes agglomerate and innovate? Is industrial cluster policy effective in helping firms to innovate? We should discuss the ordering of policy measures of industrial cluster policy to foster industrial clusters using our flowchart approach.

The following five stages of modernization are known as Rostow's stage theory (Rostow, 1960): (1) the traditional society, (2) preconditions for take-off, (3) take-off, (4) the drive to maturity, and (5) the age of high mass consumption. His theory implies that all societies pass through the same set of stages. However, realistically we had better find patterns of economic development whose stages change flexibly rather than those whose stages are fixed.

The World Bank (1998) examined what sequencing of reforms is the best to attain the targets of a policy. Johnston and Sundararajan (1999) discussed the sequencing of monetary policies. Our flowchart approach examines the ordering and prioritization of policy measures and decides 'yes' or 'no' at each step of policy measures by judging indices for the achievement of policy measures. We cannot proceed to the next step if an index indicates 'no' at a particular step. Then we must find actors who can clear the critical level of the index and solve the bottlenecks. For example, we must find actors, or economic agents, to construct roads when the number of roads is insufficient to implement industrial cluster policy. Candidates for economic agents are the central government, local governments, the quasi-public sector, and the private sector.

Samuelson (1947) introduced the analysis of comparative statics and dynamics through his "correspondence principle" which was applied to the dynamic stability. It is the task of comparative statics to show the determination of the equilibrium values of given variables (unknowns) under postulated conditions (functional relationships) with various data (parameters) being specified (Samuelson, 1941). But it would be fruitful if we examine policy measures to promote a shift in equilibrium from an old state to a new state at a higher growth rate. We propose a flowchart approach to make the shift in equilibrium possible.

Romer (1990) showed that spillovers could be strong enough to outweigh the drag caused by decreasing returns on capital and sustain growth in per capita output. Arnold (1994) described that endogenous growth models are very abstract, so that they do not yield specific policy prescriptions. Our approach is to propose concrete policy measures for industrial cluster policy to foster an industrial cluster.

The purpose of this paper is to propose a hypothesis for a flowchart approach to make firms in the hi-technology and automobile industries agglomerate and innovate. We hypothesize a flowchart for the agglomerated firms to innovate at Step II of innovation. Our hypothesis is one of conditions sufficient to ensure that industrial cluster policy leads firms to agglomerate as Step I and innovate as Step II. We derive the hypothesis based on our interview survey on the hi-technology industry cluster at the Zhongguancun Science Park (ZSP) in Beijing, China, and the automobile industry cluster in Guangzhou, China. Honda, Nissan and Toyota are located in Guangzhou and about 400 of their related Japanese suppliers have agglomerated in Guangzhou (July 2006) (see Kuchiki (2006)). By comparing Beijing's hi-technology cluster of ZSP with other clusters in the world, we can understand how large ZSP is in the number of firms. Silicon Valley in the United States has about 5000 firms and the Software Technology Park of India in Bangalore has 6121 registered firms (October 5, 2004). The number of firms in the information technology cluster in Austin in the United States is 1750, and in the biotechnology cluster in Cambridge in the United Kingdom it is 1250. The number in ZSP is about 17000.

Concerning the automobile industry cluster, suppliers supplying parts and components to anchor firms such as Honda, Nissan and Toyota of assembly makers in Guangzhou, China, can innovate partly because the suppliers have become independent of their anchor firms in the Japanese Keiretsu system. We obtain the following two conclusions on our flowchart for the hi-technology industry clustering in Beijing. First, the existence of universities with human resources is a precondition for clustering of the hi-technology industry. Second, the leadership of the Zhongguancun Science Park Management Committee plays a crucial role in agglomerating hi-technology firms in the ZSP. We made clear the mechanism linking universities and firms in the ZSP and the organization chart for the Zhongguancun Science Park Management Committee. It is noted that the flowchart for the manufacturing industry is different from that for the hi-technology industry.

According to Humphrey and Schumitz (2000), we define innovation as follows: process upgrading is transforming inputs into outputs more efficiently by reorganizing the production system; product upgrading is moving into more sophisticated lines in terms of increased unit values; functional upgrading is acquiring new, superior functions in the value chain such as design or marketing or abandoning existing low-value added functions: intersectoral upgrading is applying the competence acquired in a particular function to move into a new sector.

Section 2 explains our flowchart approach. Section 3 shows that suppliers to an assembly company in Guangzhou’s automobile industry become independent from their parent company and innovate due to construction of the second belt highway in Guangzhou. Section 4 derives a flowchart of the hi-technology industry based on the ZSP in Beijing. Section 5 analyses Step II of innovation in our flowchart approach to the ZSP. Section 6 concludes our paper.

2. Flowchart approach to industrial cluster policy

We cannot prove our hypothesis for a flowchart approach by inductive or deductive methods. We try to propose a sufficient condition for success in industrial cluster policy. That is, we can form an industrial cluster if we follow a flowchart that satisfies the sufficient condition.

It is noted that we can illustrate cases for which our hypothesis for a flowchart approach hold true and that we can increase the number of cases, but we cannot prove our hypothesis as a sufficient condition. Our flowchart does not deny the validity of other flowcharts whose ordering of factors or ingredients is different ours. We can show by increasing the number of samples that our flowchart may be generally applied to industrial cluster policy in other regions. Our flowchart approach is not an empty theory but a practical hypothesis applicable to industrial cluster policy in reality.

Our hypothesis is practical since we can form a cluster if we follow the following four steps.

(1) Find ingredients such as industrial zones, capacity building, joint actions,

and an anchor firm (Figure 2)

(2) Select the minimum number of factors from the ingredients found above for a flowchart (Figure 3)

(3) Order them along a flowchart (Figure 4)

(4) Specify actors to proceed at each step of the flowchart if the step goes, not to ‘Yes’ but to ‘No’

It is noted that our flowchart approach does not explicitly discuss the demand side of the manufacturing industry since conditions for the demand side are satisfied as follows:

Case 1:

(1) An anchor firm locates in an export processing zone and exports its products. Then there is little constraint on demand since its factory can attain its minimal optimal level of production by exporting to the world. In this case the logistics of the anchor firm are crucial to attain the minimal optimal level.

(2) Suppliers to the anchor firm can attain their minimal optimal level of production. The demand for the suppliers is “demand derived from their anchor firm.”

Case 2:

(1) An anchor firm sells its products locally. The market size in the place where the anchor firm locates should be large enough for the anchor firm to attain the minimal optimal level of production. An anchor firm decides to invest in a place once it judges that local demand satisfies its condition.

(2) Suppliers’ condition is the same as in Case 1.

Kuchiki (2007) discussed conditions to foster a new industrial cluster, applied the flowchart approach for Step I: agglomeration in Figure 1, and explained the mechanism of industrial agglomeration in northern Vietnam from the point of capacity building of (1) construction of industrial zones, (2) facilitation of physical infrastructure and (3) institution building. This paper illustrated an Asian industrial cluster in which Japanese trading corporations constructed industrial zones and invited Japanese firms into the industrial zones and formed industrial agglomerations.

Kuchiki (2006) explained the automobile industry cluster in Guangzhou, China, by the flowchart approach and made it clear that anchor firms play an important role in the industrial cluster policy and that Guangzhou Municipality as coordinator is a key in the success of the industrial cluster policy. We found that local governments are responsible for the success of industrial cluster policy.

We will explain Figure 5. First, specify a leader and make clear his or her incentives for Step I: agglomeration. Second, enforce intellectual property rights for innovation. Preconditions for Step II: innovation are as follows: 1) Related services: finance and insurance, logistics, marketing companies, repair shops, used car shops; 2) Professional and other services: lawyers, restaurants, retail shops, tourism.

Then start joint action for Step II as follows: 1) facilitate cluster skill centers; 2) establish collective projects; 3) create business associations; 4) take branding strategy.

Policy instruments for innovation are as follows. Linear instruments: 1) direct R&D aids; 2) transfer of research-based knowledge to firms; 3) financial support. Interactive approach: 1) improving institutions and programs providing technology transfer services; 2) policy to stimulate networking and business clusters.

Remove the following barriers to innovation: organizational thinness, fragmented regional system, and lock-in.

3. Innovation of suppliers those are independent of their anchor firms

Firms related of Toyota, that is, firms in Toyota's Keiretsu, become independent of Toyota and provide their part to Nissan and Honda. A belt highway which circulates Guangdong City allows the related firms to deliver their products to Toyota, Honda and Nissan within about an hour.

It is desirable that an anchor firm is close to its related firms in distance to achieve a just-in-time system, or a lean system of efficient logistics. Firms related to Nissan are located in Huadu, firms related to Toyota in Nansha, and firms related to Honda in Zengcheng, Guangzhou. But the districts of Huadu, Nansha and Zengcheng will all be linked in an hour after Guangzhou municipality constructs the second belt highway around the city. In sum, the construction of a belt highway is a condition for suppliers to be independent from their anchor firms. The suppliers can innovate due to their independence from their anchor firms. We apply the condition to the following districts.

(1) Sanshui District

It takes twenty minutes by car through the second belt highway from Sanshui District to Nissan's factory in Huadu, forty minutes from the district to Honda's factory in Zengcheng, and seventy minutes from the district to Toyota's factory in Nansha. The suppliers in the district can distribute their products to Nissan's factory, Honda and Toyota in about an hour.

(2) Nanhai District

Nanhai District is located in Foshan and has a Japanese advisor to attach importance to inviting Japanese firms. Japanese firms such as Toshiba TCL

HA Manufacturing Co., Ltd. and Honda Motor (China) Investment Co., Ltd. are located in the district. The Japanese firms of Toyota and Denso Corporation established a joint venture, Toyota Boshoku Foshan Co., Ltd. Takagi Auto Parts Foshan Co., Ltd., whose main products are precise molds of non-metal parts and their related parts, provides its products to all of Toyota, Nissan and Honda.

(3) Huadu District

Suppliers located in Huadu supplied their products to Nissan alone in the past. But some of them are now supplying their products to Toyota or Honda.

(i) Yorozu Bao Mit Automotive Co., Ltd.

Yorozu Bao Mit Automotive Co., Ltd. produces parts for suspensions by the production processes of pressing, welding and painting. Nissan, Honda and Toyota use Yorozu’s products. Its products are distributed in the milk-run method. The method is an efficient way to collect milk produced by dairy farmers in Japan. Each dairy farmer is set a time and a truck comes to its farm at the set time to collect its milk. The method is a way of collecting parts and components in a just-in-time system, or a lean system.

(ii) Guangzhou Imasen Electric Industrial Co., Ltd.

The local government helped Guangzhou Imasen Electric Industrial Co., Ltd. as 100 % ownership of capital to invest in Huadu in 2001. Products of Guangzhou Imasen Electric Industrial Co., Ltd. are sheet adjusters for automobile seats and reclining seats, and its production processes are welding, painting and assembling. Honda and Nissan use the products but Toyota does not.

We will explain how Nissan chooses a supplier. Nissan gives the design for parts for Nissan’s cars to several suppliers. The suppliers compete in producing the parts according to the design. Then Nissan chooses one of the suppliers. The selection processes are competitive among suppliers.

(iii) Guangzhou Kasai Automotive Interior Trim Co., Ltd.

Guangzhou Kasai Automotive Interior Trim Co., Ltd. used to be a supplier to Nissan, provided parts for Nissan's Sunny model of car and established a joint-venture with a Taiwanese firm. Nissan gives importance to cost efficiency and Toyota gives importance to quality in Guangzhou. Under the circumstances, Guangzhou Kasai Automotive Interior Trim Co., Ltd. targets providing parts to Toyota rather than Nissan.

(iv) Guangzhou Hitachi Unisia Automotive, Ltd.

The organization of the Japanese firm Hitachi is as follows. Hitachi's automotive system group is run by its management supervision headquarters. The group has an EMS business and a running control business. Hitachi, Tokico and Unisia merged to promote sales of hybrid electric cars that incorporate measures to meet environmental conditions and cars whose brakes and steering systems are controlled by electronics when they run. The merged firm named Guangzhou Hitachi Unisia Automotive, Ltd. focuses on the environment and safety. Tokico sells its products to Nissan, Ford and Toyota. Guangzhou Hitachi Unisia Automotive, Ltd. sells its products, which are different from those that Tokico sells, to Nissan and Honda.

Guangzhou Hitachi Unisia Automotive, Ltd. started to produce and sell hydraulic power steering systems in September 2004. The system is composed of a hydraulic power steering gear and a hydraulic power steering pump. A component crucial to the safety of cars depends on its computer-controlled inspection process. The computer at Guangzhou Hitachi Unisia Automotive in Guangzhou is linked to the computer in Japan so that the technology level in Guangzhou is the same as that in Japan. A car is changing from a low technology product to a high technology product since it is using more and more semiconductors. Semiconductor firms are starting to produce car components and innovate new products such as car navigators.

(v) MI Steel Processing Guangzhou Co., Ltd. (MISIP)

MI Steel Processing Guangzhou Co., Ltd. (MISIP) processes rolled steel and stores the steel for Nissan. MISIP buys rolled thin steel from Japanese firms, imports the steel to Guangzhou, China, and cuts it for Unipress Guangzhou, which is a supplier to Nissan and buys the cut steel. MISIP fulfills the roles of the storage industry, the logistics industry and the service industry for Unipress Guangzhou.

As is shown above, the Japanese suppliers in Guangzhou innovate partly because they have become independent of their anchor firms in the Keiretsu.

4. Flowchart approach to the hi-technology industry in Beijing

Beijing, together with Tianjin, is a core city in the Bohai Bay-rim economic region. Beijing is the capital of China and a center of education for science and technology, economic policy, information dispatch, and politics and culture. The ZSP in Beijing is a strategic region in the 21st century together with the Tianjin Binhai New Area (TBNA), following the Shenzhen Special Economic Zone in the 1980s and the Shanghai Pudong Development Area in the 1990s. The academic members of the Chinese Academy of Sciences (CAS) and Chinese Academy of Engineering (CAE) in Beijing account for 37% of the total Chinese academic members in China.

Our flowchart approach to industrial agglomeration policy on a hi-tech park presupposes the existence of universities and research institutes. Beijing city is abundant in human resources as there are 39 universities and 213 research institutes (December 2006). Two thirds of Ph.Ds in China are located in Beijing. We explain below that Peking University, Tsinghua University and CAS played a central role in developing the ZSP. The Zhongguancun Science Park Management Committee is leading the development of the ZSP. A sufficient condition of capacity building to invite investors is a flowchart for the construction of a science park, institution building, construction of a traffic infrastructure, and provision of living conditions. The flowchart makes it possible for firms in the hi-tech industry to agglomerate. As is shown in Figure 5, industrial agglomeration, Step I in our flowchart, is brought by (1) the existence of universities and research institutes, (2) the establishment of the Zhongguancun Science Park Management Committee, and (3) the capacity building mentioned above. Characteristics of the ZSP are partnership between firms, universities and governments, and partnership between the ZSP and Silicon Valley in the U.S. Tsinghua Science Park is under the management of Haidian Science Park, which is one of the seven parks in the ZSP. We explain the three parks which are effective in agglomerating firms in the hi-tech industry.

4-1.The Beijing Municipal People’s Government and the Zhongguancun Science Park Management Committee

The leadership of the Beijing Municipal People’s Government plays a large role in promoting the agglomeration in the hi-tech industry in the ZSP. The head of the ZSP Group is a mayor and the members of the group number 18, including the presidents of Peking University and Tsinghua University.

The Zhongguancun Science Park Management Committee manages the Zhongguancun Science Park Group instead of the Beijing Municipal People's Government. The Zhongguancun Science Park Management Committee plays a large role in the industrial agglomeration at the ZSP. It was established in 2000, and started to manage five sub-parks. The ZSP consisted of seven sub-parks in 2005 and 10 sub-parks in 2006, and each sub-park has its own management committee.

There are 39 universities, 700 thousand students, 75 national engineering research institutes, and 71 nationally important laboratories in the ZSP. The 17 thousand firms in the ZSP employ 690 thousand people and earn 480 billion yuan (about 60 billion dollars). The total road length is 130 kilometers. The largest sub-park in the ZSP is Haidian Park and others include the Electronic Zone, Fengtai Park, Changping Park, and so on.

Table 1 shows the seven parks of the ZSP. Haidian Science Park was the largest in area among the seven parks in 2005, covering 217 square kilometers. The other parks are very small in area. Table 2 shows the distribution of human resources in the ZSP. Haidian Science Park has the largest numbers of research institutes and researchers. Table 3 makes clear the rapid growth of the ZSP since 2002, partly due to the establishment of the Zhongguancun Science Park Management Committee in 2000 as described above. The number of firms was about 9,500 in 2002 and increased to 17,000 in 2005. The number of employees was about 400 thousand and increased to 690 thousand in 2005. Other figures for industrial output, foreign currency earned by exports and total tax payments grew very rapidly from 2002 to 2005.

Next we will clarify the roles of the Zhongguancun Science Park Management Committee in the agglomeration of firms in the ZSP.

The Beijing Municipal People's Government enacted a municipal ordinance on the ZSP at the end of 2000. It arranges tours for oversea inspection. Regarding its main development promotion policy, the ZSP ordinance prescribes (1) fund support, (2) to attract human resources, (3) land policy, and (4) tax policy in the following.

(1) The fund supports technological innovation for small and medium scale enterprises by providing funds. The Beijing Municipal People's Government established professional funds such as development funds for the hi-technology and new technology industries and the software industry in the ZSP. It subsidizes the interest rate by 1.5% for credit on items of integrated circuits.

(2) Regarding the invitation of human resources, preferential treatment for a family register is available. Persons whom the Beijing Municipal People's Government identifies as professional technicians and managers required for hi-technology and new firms and the hi-technology and new industry can have temporary proof of residence for employment after the municipality's ratification and are provided the same conditions as residents of Beijing. A person who has worked for three years whom the government recommends can establish a family registers in the Beijing Municipality. New students who graduate from universities and research institutes of science and technology and apply to hi-technology and new firms located in the ZSP in Beijing can establish a permanent family register in the Beijing Municipality. This policy resulted in the invitation of 7,400 persons and the establishment of 3,200 firms in the ZSP up to 2006.

(3) Regarding preferential treatment from the nation as land policy, the charge for use of land in the ZSP is reduced. When joint ventures and

firms with 100% capital ownership obtain land in the form of a transfer, the local municipality charges them 75% of the value of the land transfer and half the rate for the cost of urban infrastructure construction and municipal government administration.

(4) Regarding the policy of reduction and exemption on income taxes, new technology firms in the ZSP must pay income tax at a rate of 15%. They do not need to pay tax for three years from the day of establishment. Firms that the Beijing Municipal People's Government designates must pay income tax at a half rate of 15%, or 7.5%, for three years following the three years at zero tax mentioned above.

Table 4 summarizes the policy measures of the Zhongguancun Science Park Management Committee, which are effective in the industrial agglomeration of the ZSP.

4-2. Haidian Science Park (HSP)

About 10,000 firms have moved into Haidian Science Park (HSP), which is 217 square kilometers in area and a comprehensive science park directed at uniting hi-technologies such as electronics, information technology, optomechatronics, new materials, and so on. It is a place for hi-technology research and development and a business center. In HSP, there are 20 sub-parks including Tsinghua Science Park (THSP) and Peking University Science Park.

The following statistics describe HSP in 2004. There is a high concentration of human resources with 348,300 jobholders. Among them, 32,000 hold master degrees and 6,000 hold Ph.Ds. There are more than 10,000 high-tech enterprises, and 63.3% of them were electronic information enterprises. There are branches of world-class enterprises like IBM and

Microsoft. There were 81 enterprises with a registered capital of over 50 million yuan. Forty-one "Fortune 500" companies have invested in the Park. HSP has the nation's largest trading market for electronic products with a trade value of technology reaching 24,055 billion yuan, which is 18 % of the national figure.

Note:

http://61.49.38.5/docs/investdoc/Haidian%20In%20General/20060126/1138281004656.html

4-3.Tsinghua Science Park (THSP)

THSP, a holding company for Tsinghua University, covers 250 thousand square kilometers. It was established in 1994 and evaluated as first class by the nation in 2003. One of its characteristics comes from the fact that the Chinese returned from Silicon Valley in the United States and established a lot of firms in THSP.

THSP Company is a state-owned holding company jointly initiated by Tsinghua Holdings Company, Beijing Zhongguancun Science & Technology Development, Beijing State-owned Asset Operation, Tsinghua Tongfang, and Tsinghua Unisplendour. Its predecessor was the Tsinghua Science Park Development Center, which was founded in 1994. A Service Platform for Hi-tech companies was established and IC Design Park was put into operation in 2005.

Investment focusing on high-tech enterprises is an important constituent part of the business scope of THSP. The management talent there makes THSP one of the most valuable partners for venture capital organizations, not only in China, but around the world. THSP has advanced its cooperation with other venture capitals around the world and boosted the establishment of venture capital funds.

THSP has more than 400 customers, categorized into four types: (1) Research and development centers of multinational corporations represented by P&G, Sun Microsystems and NEC; (2) research facilities of major domestic technology enterprises represented by Tsinghua Tongfang and Tsinghua Unisplendour; (3) technological small and medium-sized enterprises; (4) agent service companies such as venture capital management, banks and consulting companies.

THSP is independently managed and plays an important role in helping venture capital start ups and inviting human resources to the park from Silicon Valley in the United States.

4-4.Capacity building to foster a science park

Capacity consists of physical infrastructure, institutions, human resources, and living conditions mentioned in Section 2. We explain the physical infrastructure and living conditions of the capacity in Beijing below. Transportation – physical infrastructure to carry passengers – plays an important role in developing the software industry.

We illustrate here a case of the capacity to invite investors to HSP. Regarding transportation in HSP, it is a distance of 150 kilometer from HSP to New Tianjin Port, 45 kilometer from HSP to Beijing Capital International Airport, and the roads in HSP link to the third belt highway around Beijing. In sum, HSP is located in a convenient place for communications.

The living conditions are very convenient since HSP is located in Beijing, the capital of China. HSP has residential housing for foreigners, many restaurants including Japanese restaurants, entertainment facilities, and five-star hotels. The movement of the following firms into HSP helped Beijing build capacity sufficient to invite research institutes of multinational corporations, including IBM, Microsoft, Samsung, HP, Motorola, Bell, Siemens, and others. Japanese firms such as NTT, Canon, Panasonic, Hitachi, and NEC established their research institutes in HSP. A characteristic of the ZSP is that CAS, Peking University and Tsinghua University are in close partnership with Chinese firms such as Lenovo and Red Flag Software. Peking University invests in the Beijing Founder Group and Beijing Beida Jade Bird Group. Tsinghua University invests in Tsinghua Tongfang and Tsinghua Unisplendor. Partnerships between firms, and universities and research institutes help them innovate.

4-5. Innovation by partnerships between firms, and universities and research institutes

This section shows that partnerships between universities and firms in the ZSP play a crucial role in agglomeration of firms in the hi-tech industry. The methods of partnership are firms contracting research to universities, joint research between universities and firms, internships for university students in firms, and university funding for firms.

Table 5 shows well-known companies that are invested in by research institutes and universities. Lenovo Group Ltd. is one of China’s leading firms. As shown in Table 5, Peking University is related to Founder Group Corporation and Beida Jade Bird Group and Tsinghua University is related to Tsinghua Tongfang Co. Ltd., and Tsinghua Unisplendour Co. Ltd. All of the companies have grown very rapidly.

We will explain examples innovated by partnerships between universities and firms, with illustrations from Company A, Company B, Tsinghua Tongfang, and the Chinese Academy of Sciences (CAS) (July 2006).

(1) Company A

Partnerships between Company A and universities take the following three forms. First, Company A entrusts Beijing University and Tsinghua University with research. Second, Company A offers university students internships. Third, Company A conducts joint studies with CAS.

(2) Company B

There are 70 researchers at Cmpany B's research institute in the ZSP, consisting of graduate students from Peking University, Tsinghua University and Peking University of Post and Telecommunications. The institute in ZSP is a base to develop Company B's televisions and it asks Peking University, Tsinghua University and Beijing University of Post and Telecommunications to study televisions development.

(3) Tsinghua Tongfang

Tsinghua Tongfang is one of the holding companies for Tsinghua University. Its president is a researcher at Tsinghua University and one of its vice-presidents is a professor at the university. There are about 100 researchers and professors at Tsinghua Tongfang. Graduate students from Tsinghua University participate in research activities for Tsinghua Tongfang, carry out practical studies and write papers. Tsinghua Tongfang sends some staff to Tsinghua University to obtain master degrees. A lot of the technologies developed at Tsinghua University are used for manufactured goods of Tsinghua Tongfang. Tsinghua Tongfang implemented 863 projects in 2006. Examples are projects on desulphurization equipment and air conditioners. In addition, researchers who returned to Tsinghua Tongfang from Silicon Valley in the United States invented a product for the E-zone platform.

(4) The Chinese Academy of Sciences (CAS)

CAS plays an important role in planning science technology policies. The Institute of Policy Management (IPM) at CAS was established in 1985. It was formed by consolidating four former CAS subsidiaries: Office of Policy Research, Division of Management Science, Journal of Dialectics of Nature, and Section for Optimization and Overall Planning.

IPM encourages students studying abroad to come back to the ZSP. IPM implemented a plan to send back 100 researchers to the ZSP and exceeded the target of 100 researchers. The plan strengthened the network between the ZSP and Silicon Valley.

IPM has mainly engaged in theoretical, methodological, and applied research into strategic, policy and management issues arising from national science and technology (S&T) development. IPM offers a variety of high-level research and consultancy services to the central authorities, local governments, and IPM to help them with their decision-making regarding S&T development, social and economic progress, and S&T administration and management of enterprises. IPM focuses its research on development strategy, S&T policy, management science and engineering, and S&T management.

IPM has masters, doctoral and postdoctoral courses in management science and engineering, and a masters program in technology economics and management. IPM has recruited 192 graduate students including 62 doctoral students since 1995.

5. Stage of innovation

Figure 5 is a summary of our flowchart approach to the hi-tech industry cluster policy. First, the existence of ‘universities and research institutes’ is a precondition of our flowchart approach to industrial cluster policy. Second, the existence of the Zhongguancun Science Park Management Committee is effective in implementing the industrial cluster policy in the ZSP. Third, the science parks in the ZSP are needed for inviting hi-technology firms. Institution building and construction of infrastructure are also needed to build capacity. Preferential treatment to invite human resources to the ZSP is crucial to the success of the industrial cluster policy. One of the treatments is to offer workers a permanent family register which is effective in asking Chinese students who have studied oversea to come back to the ZSP.

In general, Step II: Innovation in Figure 5 is not active in the ZSP in 2006. Enforcement of intellectual property rights is a precondition for innovation for firms in the ZSP. At Step II, firms innovate partly because they agglomerate and produce competitiveness between them. There is no joint action for firms in the ZSP to cooperate on innovation. Figure 8 illustrates the establishment of skill centers and associations, and implementation of joint projects as joint actions. Direct support for innovation by government includes aid for research and development, financial support and technology transfer. Furthermore, it is necessary to remove barriers to innovation. Examples of barriers are organizational thinness, fragmented regional system and lock-in effects. The above is the hypothesis behind Step II: Innovation. But the ZSP is not yet at Step II.

Step I of the flowchart in Figure 5 starts with the existence of universities as a pre-condition. The flow proceeds to the next box in the flowchart if there are human resources at the start of the flowchart. Next an economic agent is needed as a leader for agglomerating hi-technology firms. The Zhongguancun Science Park Management Committee plays the role of leader in the case of the ZSP. THSP is managed on a self-paying basis.

The public sector has built capacity in both preferential treatment and infrastructure construction that are crucial to success in the ZSP. In addition to capacity building, hi-technology firms agglomerate if living conditions are satisfied. The ZSP has satisfactorily reached this stage.

The flow proceeds next to Step II: Innovation. Firms can innovate if they agglomerate and compete with each other. Joint action by firms is needed for innovation when they agglomerate and cooperate with each other. Examples of joint action are skill centers, associations and joint projects as shown in Figure 8. But the ZSP is not at the stage of innovation in which firms cooperate but at the stage of competition in innovation.

6. Conclusions

This paper proposes a flowchart approach to the automobile industry cluster policy and the hi-technology industry cluster policy to prioritize policy measures. First, concerning automobile industry clusters, suppliers of parts and components to anchor firms such as Honda, Nissan and Toyota of Japanese assembly makers in Guangzhou, China, can innovate partly because the suppliers have become independent of their anchor firms in the Japanese Keiretsu system. Second, concerning the hi-technology industry clustering in Beijing, we have shown that the existence of universities is a precondition for industrial cluster policy and that the leadership of the Zhongguancun Science Park Management Committee is crucial to success in industrial cluster policy. We found that the flowchart for high-technology industry cluster policy is different from the one for automobile industry cluster policy as is shown in Figures 1 and 5.

Figure 7 shows methods of linking universities and firms in Beijing as follows: professors and students at universities establish firms; universities and firms conduct joint studies; firms contract universities to invent new products; universities send their graduate students to firms as interns; firms send their staff to universities to obtain degrees; universities provide their research results to firms. Successful firms related to Peking University are the Founder Group and Beijing Beida Jade Bird Corporation while successful firms related to Tsinghua University are Tsinghua Tongfang and Tsinghua Unisplendour.

As Figure 6 sums up, the role of the Zhongguancun Science Park Management Committee is the key to success in the industrial cluster policy for Beijing's hi-tech industry. The Zhongguancun Science Park Management Committee belongs to Beijing Municipal People's Government and is supervising ten science parks in 2006. Each science park has its own management committee. About 17,000 firms are operating in the Zhongguancun Science Park in 2006, and the number of tenants is increasing. Haidian Science Park is the biggest of the seven parks and consists of 20 districts; THSP is one of those districts. THSP Company is a joint venture between Tsinghua University Holdings Company, Beijing Zhongguancun Science & Technology Development, Beijing State-owned Asset Operation, Tsinghua Tongfang, and Tsinghua Unisplendour. About 400 firms including Google, NEC, P&G, and Sun Microsystems have moved in THSP.

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Table 1.Data for Seven Parks

	Park	District	Surface area(㎢)	Number of companies
1	Haidian Park	Haidian District	217(planned)	over 10000
2	Changping Park	Changping District, north outskirts of Beijing	5	over 1300
3	Fengtai Park	Fengtai District, south outskirts of Beijing	5	over 2700
4	Yizhuang Park	Southeast of Beijing, inside the Beijing Economic-Technological Development Area	7.5	over 1000
5	The Electronic Zone	Jiuxianqiao, Chaoyang District, east outskirts of Beijing	10.5	over 440
6	Desheng Science and Technology Park	Xicheng District	6	145
7	Jianxiang Science and Technology Park	Chaoyang District	4.2	-

Source: Zhongguancun Science Park Management Committee, 2006.

Table 2. Human Resources of the Science Parks

Park	Research institutes・Universities	Researchers	Notes
Haidian Park	Research institutes: 232 Universities: 73	Researchers: 378 thousand University students: 300 thousand	
Changping Park	Scientific research institutes: 114 Universities: 14	Researchers: 15 thousand	
Fengtai Park	Scientific research institutes: 60	Researchers: 70 thousand	Located close to Lugu where many affiliated electronics research institutes of the Ministry of Information Industry are concentrated.
Yizhuang Park	–	–	
The Electronic Zone	Electronic research institute: 4 Electronic universities: 5	–	One of the major construction projects in the tenth five-year plan.
Jianxiang Science and Technology Park	CAS Institutes: 12	CAS academic members: 44 CAE academic members: 5 TWAS academic members: 5	
Desheng Science and Technology Park	Research institutes: 6 Universities: 8	–	

Notes: CAS; Chinese Academy of Sciences,
CAE; Chinese Academy of Engineering,
TWAS; Third World Academy of Science,

Source: Zhongguancun Science Park Management Committee, 2006.

Table 3. Zhongguancun Science Park Economic Development

(unit：one hundred million yuan)

Economic index	2002	2003	2004	2005 (Note)
Number of firms	9,567	11,529	13,957	17,000
Total revenue from technology trade	2,394.8	2,886.4	3,692.2	n.a.
Total industrial output（at cost）	1,477.2	1,607.8	1,876.1	n.a.
Foreign currency earned by exports （one hundred million US $）	28.8	32.9	53.6	n.a.
Total tax payment	98.8	120.1	141.7	n.a.
Number of employees （million）	40.4	48.9	55.7	69.0
Gross profit	96.6	161.5	256.6	48.0

Source：The Zhongguancun Science Park Management Committee, *2004 Beijing New Technology & Industry data*, Zhongguancun Science Park, *2004 Economic Development Review*

Note: Interview by the author in 2005.

Table 4. Preferential Policies of Zhongguancun Science Park (1)

	Preferential Policies
Company registration	■ When enterprises to be established in the ZSP apply for registration at the Department for Industry and Commerce Administration, they do not need to specify a category of business. They can choose it for by themselves. ■ High-tech enterprises may determine the proportion of an enterprise's registered capital.
Taxation	■ Beginning from its date of its establishment, a new technology enterprise is exempted from income tax for three years. For the period from the fourth to the sixth year, income tax is collected at a rate of 7.5%. ■ Corporate income tax for new technology enterprises is collected at a reduced rate of 15%. On the output value of export products of an enterprise that account for over 40% of the total output value for the current year, the income tax is collected at a reduced rate of 10%. ■ Factories and bonded warehouses shall be exempted from import tariff on raw materials and value added tax on their products. ■ New and high tech enterprises that obtain land directly in the form of land transfers are exempted from fixed assets investment orientation regulated tax; and the fee for the transfer of the land use right is collected at a rate of 75%; and the urban infrastructure "four-utility" construction fee is charged at half the rate.
Financing	■ New and high tech enterprises may accept priority support from state funding for new and innovative technology, risk investment and guarantee fund. ■ Risk investment institutions may take the form of limited liability of partnerships. ■ Subsidies: Beijing Municipality may provide subsidies for the projects of the state. The amount of each subsidy is equal to the amount of the subsidy of the state with a limit of ten million yuan. ■ Subsidies up to 50% of the interest on loans will be provided. ■ Small loans to enterprises which were established by students returning from overseas are in principle secured with a limit of one million yuan. ■ Incubator Fund: High-tech enterprises, which were established within the past three years, are invested in with a limit of three million yuan. ■ Integrated Circuit Design Enterprise Loans are secured to support IC design enterprises in Beijing to solve the difficulties in financing. ■ Current expenditures on offshore development enterprises are secured. They enjoy the benefit of the state's and the city's preferential policies for export enterprises.

Source: Zhongguancun Science Park Management Committee (December 8, 2002), "Regulations for Zhongguancun Science Park".

Table 4. Preferential Policies of Zhongguancun Science Park (2)

	Preferential Policies
Accounting	■ The period of depreciation of equipment and instruments used for new and high technology industry development may be shortened as defined.
industrial policy	■ For an ordinary value added tax payer who sells software products and IC products , the portion which exceeds the actual tax burden by 3% shall be refunded immediately after collection. ■ For key software enterprises covered by state planning, business income tax is collected at a reduced rate of 10%. ■ Software enterprises whose registered capital exceeds one million yuan can decide to export their software products. ■ Software export enterprises may apply to the Commission of Foreign Trade Economic Relations and Trade for funding support and cost support for certification. ■ Software exports enjoy credit support at preferential interest rates. ■ When software enterprises and IC enterprises establish R&D institutes in Beijing, the charge for land price is collected at 75%.
Human resource	■ High tech enterprises that invite persons studying abroad or technical and managerial talents from other provinces or cities may take procedures on Beijing residency permits. ■ Qualified personnel from other provinces or cities may be registered as permanent residents of Beijing Municipality , and their children will be admitted to schools to receive compulsory education. ■ High tech enterprises that invite newly graduated students from colleges and universities in urgent need, may complete procedures on entering Beijing. ■ Special funds to be arranged in the municipal financial budget will be used for financial subsidies for senior managerial personnel and technical personnel in software enterprises and IC enterprises. ■ Teachers and students may set up new and high technology enterprises in the ZSP.
Company activities	■ The government may provide funding support, interest subsidies for loans and export encouragement to new and high technology projects. ■ In the ZSP organizations and individuals may engage in any activities except those business that are prohibited by laws and regulations. ■ When enterprises purchase real property, contract tax shall be refunded after collection.

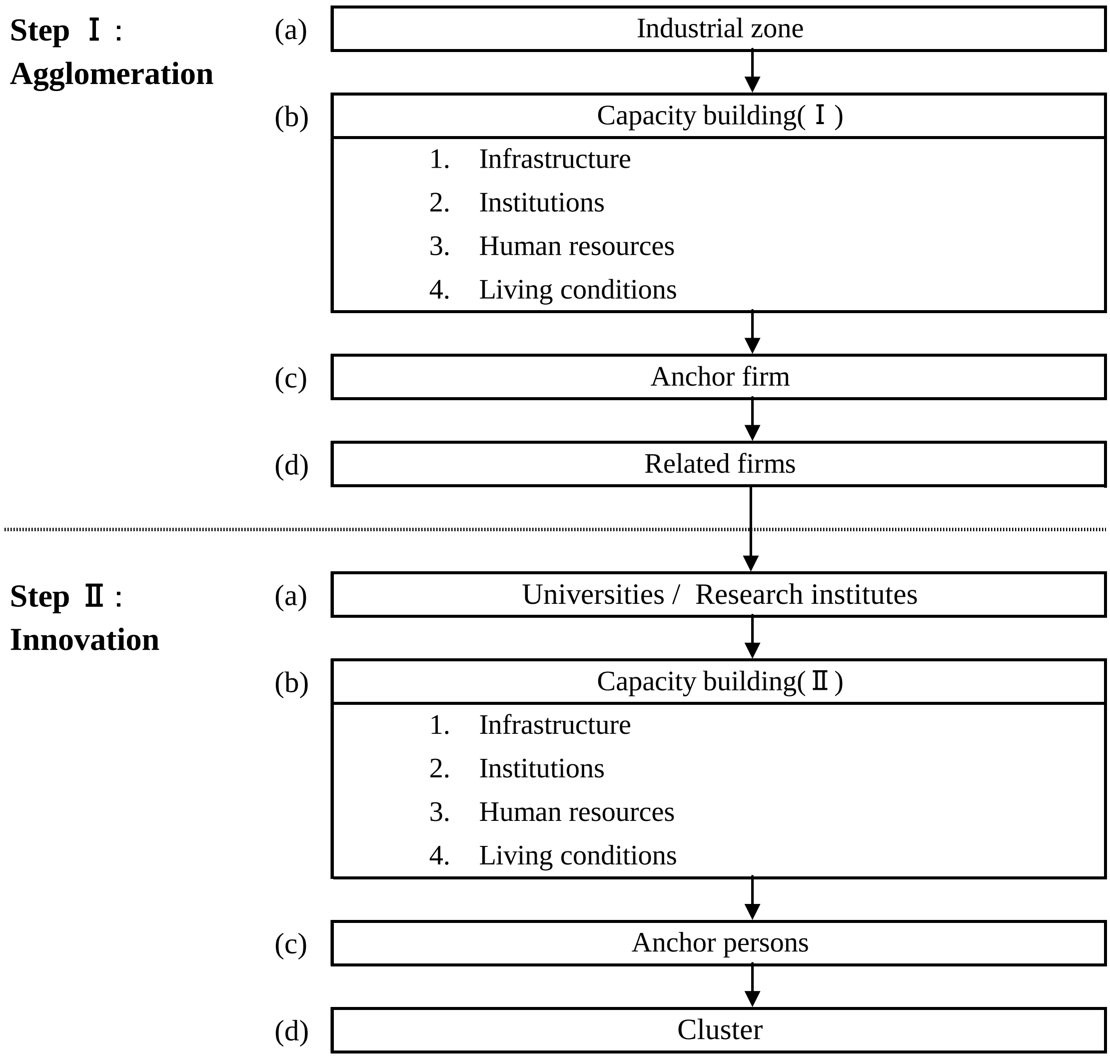
Source: Zhongguancun Science Park Management Committee (December 8, 2002), "Regulations for Zhongguancun Science Park".

Table 5. Enterprises Invested in by Research Institutes/Universities

Research Institutes/Universities	Name of Enterprise	Notes
Institute of Computing Technology, Chinese Academy of Sciences	Lenovo Group Ltd.	Leading enterprise in development, manufacture and sales of computer products.
Software Research Institute of Chinese Academy of Sciences	Red Flag Software Co., Ltd.	The Linux OS developed by the company is at the highest level in China. Ministry of Information Industry invested one hundred million Yuan in CAS Red Flag in 2001.
Chinese Academy of Science	China Sciences Group (Holdings) Corporation	Consists of over 40 enterprises, such as Zhong Ke San Huan, Zhong Ke Hope Software, Shanghai China Science, Dayang and CSCA Technology.
	China Daheng Group Inc.	Manufacturer of optical components. Ranked in China's Top 100 Electronics Enterprises.
Peking University	Peking University Founder Group Corp.	The second largest enterprise for computer and multimedia products (after Lenovo). Leading position in the field of Chinese character laser-typesetting system.
	Beida Jade Bird Group	Software production, mainly software development, system integration and computer security.
Tsinghua University	Tsinghua Tongfang Co. Ltd.,	Computer products (personal computers for home and business, servers and laptops; application information systems; digital television systems, and civil nuclear technologies)
	Tsinghua Unisplendour Co. Ltd.,	Pioneer in Chinese character recognition technology. Leading enterprise in China's environmental protection industry.

Source: JETRO Beijing (2005), *"Outline by JETRO Beijing"*.

Figure 1. Flowchart Approach to Industrial Cluster Policy



Source: A. Kuchiki and Y. Yoshida

1. Find factors.

A, B, C, D, E

2. Select some factors from all factors.
   ⇒Figure 2, Figure 3

3. Apply the flowchart approach to a region and find actors if the answer at a step of the flowchart is 'No'.
   ⇒Figure 4

Figure 2

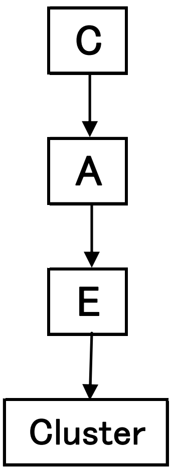


Figure 3

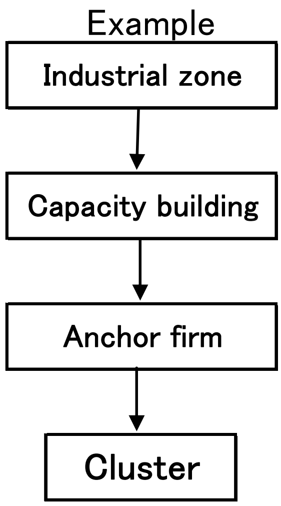
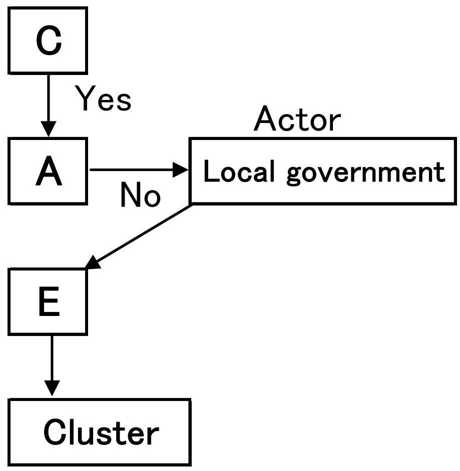
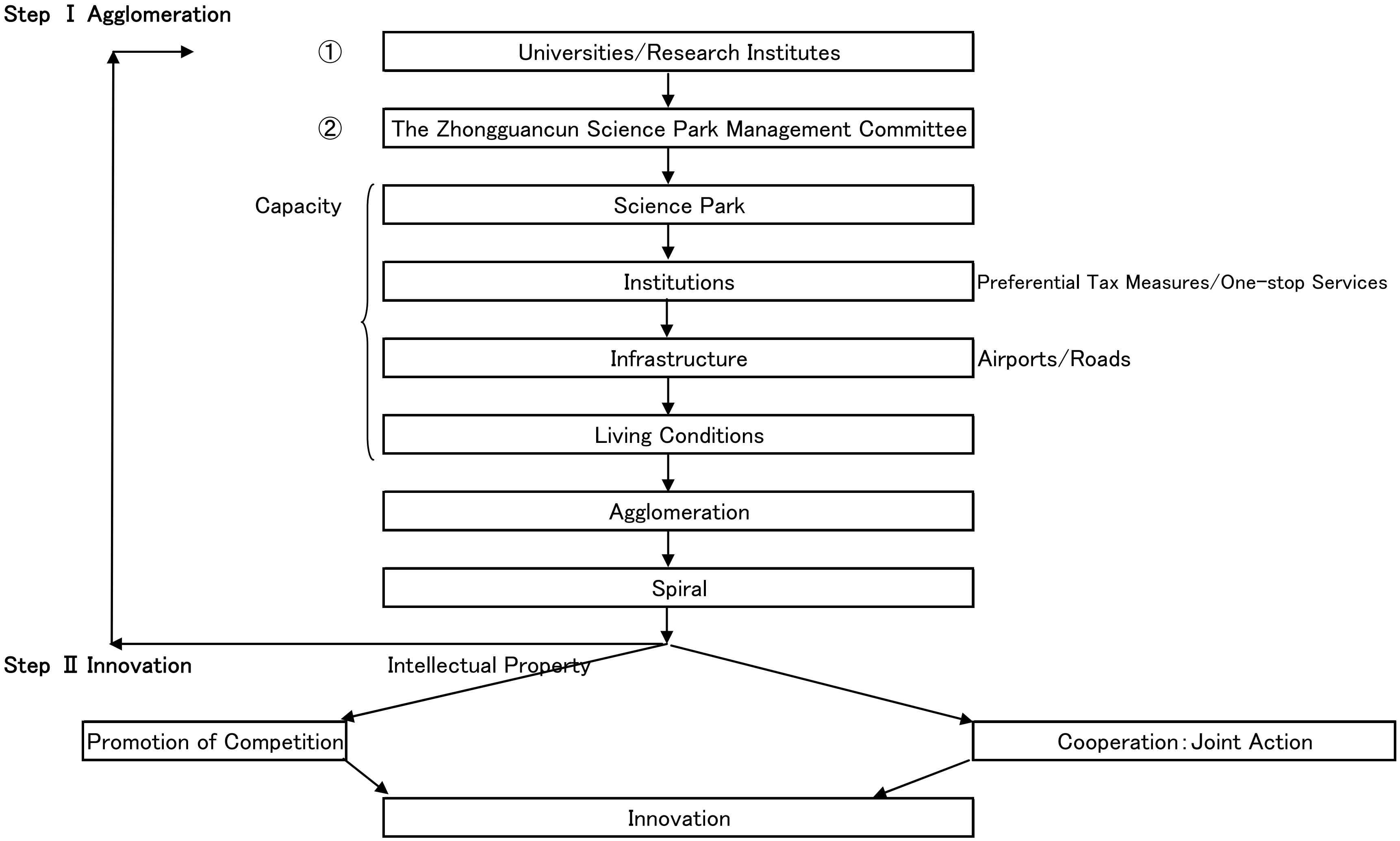


Figure 4



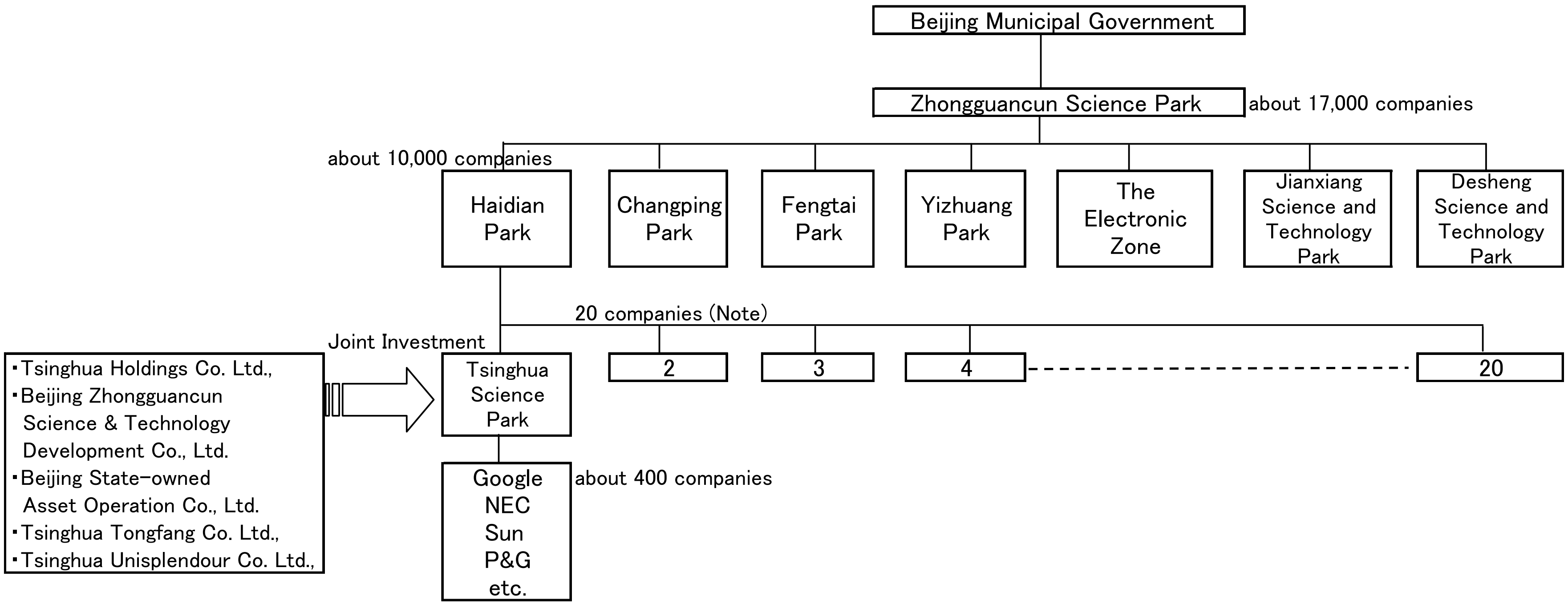
Source: Author.

Figure5. The Industrial Cluster in the ZSP



Source: Author

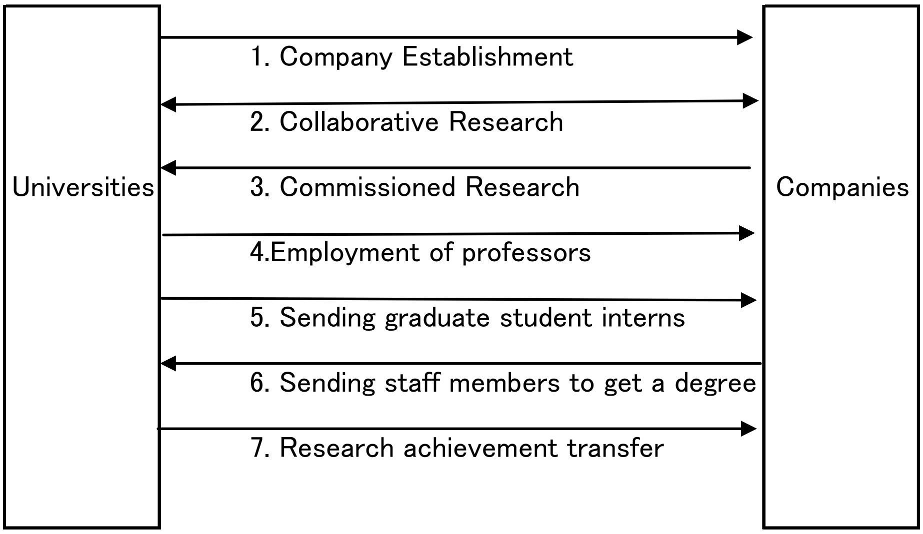
Figure 6. Management Structure of Zhongguancun Science Park



(Note)20 companies: 1.Tsinghua Science Park 2.Zhongguancun Environmental Protection Park 3.Yongfeng high Technology Industrial Base 4.Zhongguancun Life Science Park 5.Space Flight City 6.Zhongguancun Software Park 7.Peking University Biotechnology City 8.Zhongguancun International Commerce and Trade City 9.Shangdi Information Industrial base 10.Xierqi Intelligence Residential Area 11.Peking University Science Park 12.Zhongguancun West Zone 13.Zhongguancun Science City 14.Shangzhuang Town 15.Agriculture and Forestry Science Park 16.Sujiatuo Town 17.Zhongguancun Culture and Education Base 18.Zhongguancun New Medicine Park 19.Wenquan Town 20.Xibeiwang Town

Source: Author.

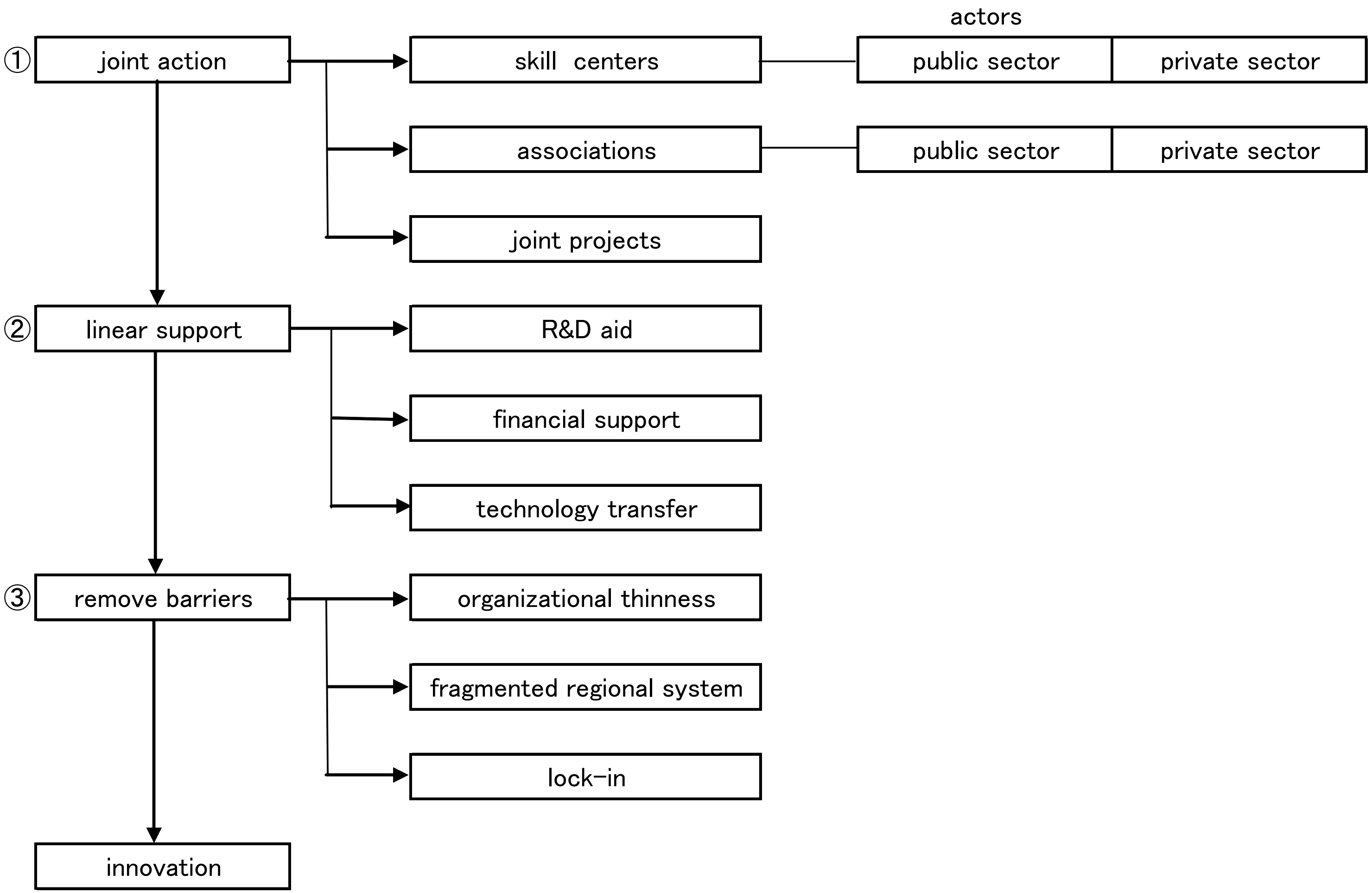
Figure 7. Partnerships between Universities and Companies in the ZSP



Source: Author.

Figure8. The Hypothesis Behind the Flowchart for Innovation

Step Ⅱ Innovation



Source: Author