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THE IMPORTANCE AND ROLES OF SCIENCE PARKS IN THE NATIONAL INNOVATION SYSTEM

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ABSTRACT

The innovation system means the interaction of certain elements by which innovation process becomes stronger and faster. When this subject is studied at the macro level for a country, it is called the National Innovation System (NIS). Science parks and incubators are elements of NIS with impact on the different functions and other elements of NIS. Moreover, the science parks have a special role in the national system. They can complete and compensate failures of the other elements in NIS.

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INTRODUCTION TO NATIONAL INNOVATION SYSTEM (NIS)

The concept ‘innovation system’ was introduced in a booklet on user-producer interaction, in the middle of 1980s (Lundvall 1985), to capture the relationships and interactions between R&D-laboratories and technological institutes, on the one hand, and the production system, on the other hand. The first widely diffused publication that used the concept of a “national system of innovation” was the Technology Policy and Economic Performance: “Lessons from Japan” by Christopher Freeman (1987). The concept was definitely established in the innovation literature, as a result of the collaboration between Freeman (1988), Nelson (1988) and Lundvall (1988) in the collective work on Technology and Economic Theory (Dosi et al., 1988). The NIS approach recieved a boost with the publication of the book "National System of Innovation" by Lundvall (1992). Based on observations that firms normally collaborated when innovating, the book presented an agenda for research and policy for much of the 1990's. The refocusing from a sequential to a systems oriented view of the innovation process was also a part of a reapraisal. The concept has been further developed analytically and empirically in Nelson (ed.)(1993).

National innovation systems are defined in several ways by theorists. Some of these definitions are represented below.

Definitions of the NIS:

Chris Freeman (1987)- "the network of institutions in the public and private sectors whose interactions initiate, import, modify and diffuse new technologies" in Technology Policy and Economic Performance: Lessons from Japan, Pinter, London

B.A. Lundvall (1992) - "elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge . . . a national system encompasses elements and relationships located within or rooted inside the borders of the nation state" in National systems of innovation: Towards a theory of innovation and interactive learning. London: Pinter.

Stan Metcalfe (1995) - "that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provide the framework within which governments form and implement policies to influence the innovation process. As such, it is a system of interconnected institutions to create, store, and transfer the knowledge, skills and artifacts which define new technologies", in Stoneman P. (ed), Handbook of the Economics of Innovation and Technological Change, Oxford, pp. 409-512.

R. R. Nelson (1993) - "The main emphasis of this framework is to analyze the impact of national technology policies on a firm’s innovative behavior. Innovative behavior or activity is measured in terms of formal activities related to the R&D system and the science base. The narrow definition of NSI includes organizations and institutions involved in searching and exploring such as R&D departments, technological institutes and universities", in National Innovation Systems: a comparative study, Oxford: Oxford University Press Bo Carlsson (1995) - Carlsson used technological Systems term, which are similar to NIS. The basic concept of Carlsson’s Technological Systems (TS) is similar to NIS. TS have been defined as ‘network(s) of agents interacting in each Specific technology area under a particular institutional infrastructure for the purpose of generating, diffusing, and utilising technology. The concept tends to place more emphasis on the microeconomic aspects of technology diffusion and utilisation; in "On the nature, functions and composition of technological systems"

Mian functions of NIS:

For further recognition of NIS, the functions and activities are expalined.

Xielin Liu and Steven White(2000) focused on the functions in an NIS. These functions are relative to creation, diffusion and use of technologic innovation in an NIS. They focused on the organizing, distributing and coordination of the innovation process functions. Liu and White defined 5 basic functions in innovation systems:

1. Research(basic, developing and engineering)
2. Implementation
3. End-use
4. Linkage
5. Education

Johnson and Jacobsson(2001) defined 5 activities for an innovation system:

1. Creating new knowledge
2. Guide for the research process
3. Providing resources such as capital and etc.
4. Facilitating the generation of foreign economies
5. Disseminating market information

Rickne(2000) explained that the functionality leads to activate the new technology-based firms (NTBFs). Incubation of these technology-based firms can also be used as an index of the completeness of innovation system. Rickne prepared a long list of activities for national system of innovation:

1. Human resource creation
2. Creating and distributing technological opportunities
3. Creating and distributing products
4. Incubation (providing facilities, equipment and official services)
5. Facilitating some rules for the market development of technologies
6. Regulations for technology and firms
7. Market development and knowledge diffusion
8. Reinforcing networks
9. Leading technologies, market and joint researches
10. Facilitating capital providing
11. Providing a man-pool for new technology-based companies.

OECD(1999) defines functions for a national system of innovation as below:

1. Leading
2. R&D
3. Financing R&D
4. Human resource development
5. Technology diffusion
6. Upgrading technology entrepreneurship

as well as the below activities:

1. Technology and innovatin policy making, coordination, supervision and evaluation
2. Basic research
3. Applied research
4. Developing research
5. Supporting non-profit R&D organizations
6. Supporting R&D activities
7. Supporting special researches
8. Human resource development and facilitating their mobility
9. Upgrading capabilities for technology localization
10. Upgrading capabilities for technology absorpsion
11. Creating innovation capacities in the firms
12. Financing technology-based companies
13. Others.

NIS IN THE DEVELOPING COUNTRIES

In developing countries, the innovation process due to some reasons is not necessarily started from an idea to science and research (basic and applied research). In such countries, university is not a place for research; it is mostly a place of education and the more or less research done there is used and commercialized in developed country. The infrastructures of doing research and commercializing their results are lacked and so the companies and government when programming in technology development, they mainly pay attention to transferring technologies from other countries. Moreover, there is no attention to the innovation system in national level, therefore one of the functions of NIS, namely policy making, is not working in most developing countries.

THE MANAGERS OF SCIENCE PARKS NEED TO STUDY NIS

Why a manager of a science park needs to know about such a topic? If the manager does not care about the competition situation of the global market or of the country, he or she can not be sure about the success of the park. Where in a country there are no roles for intellectual properties, managing a science park or a technology is not as easy as where these roles have been examined and experienced for years.

The industrial clusters existing in the region where a park is located, will highly impact on the fields that a science park can work successfully. The explained items are some elements of a national innovation system that influence on the functions of science parks. Other elements such as the existence of the innovation culture, the financial tools and facilities and existence of enough high-educational institutions in the area are also important regarding managing a science park. These close relation and high influence of the elements in a NIS and science parks show that a manager of a park can not forget about NIS and run the park successfully.

ANALYZING MODELS OF NIS

Two different types of categories of the elements involved in NIS, which are assumed as two different models to analyze the elements of NIS, are mainly believed by different authors. The first model is to divide the elements into the organizations and the institutions. For organizations, one can find the

organizations responsible for innovation in the society and analyze the strength and weaknesses of their roles in NIS. In the second model nine different elements are focused by which an NIS is shaped and influenced. Below we explain these 2 models.

As we mentioned above the first model divide the elements of national system of innovation into 2 categories: institutions and organizations. Organizations are formal structures those are established with specified purposes. Organizations are the players or actors of the innovation systems. Some of the important organizations in innovation systems are companies (such as consumers, suppliers or competitors), universities, financing organizations, government organizations related to innovation policy. Institutions such as common habits, routins, rules and regulations and etc determine the relations and interactions between individuals, groups and organization and those are game rules. We can also add other institutions of innovation systems such as patents, norms in university-industry relationship and laws to the above list.

All of the theorists believe in these two categories: institutions and organizations. But they don't have a common definition about institutions. Some of them like Nelson and Rosenberg know the institutions as a part and subset of organizations. While Lundvall say the institutions are game rules. By now the disagreement still exists and nobody could be able to solve it.

The second model divide the elements of a national innovation system into 9 categories such as:

1. Structural elements
2. Legal and regularity framework
3. Innovative/Entrepreneurial Culture
4. Innovation drivers
5. Innovation infrastructure
6. Finance
7. Information dissemination
8. Technology transfer/diffusion mechanisms
9. Commercialization support

The structural elements consist of: industry composition, expenditure, competition, cost structure, access to market, natural resources, foreign ownership, globalization, comparative advantage, size of firms, networks, national linkage program, industry clusters, export orientation.

Legal and regularity framework consists of: taxation regims, regularity climate and intelectual property protection (e.g. patent processes, copyright laws, etc.)

Innovative/Entrepreneurial Culture consists of: human resources (management and workforce skills), education/training systems, technology incubators/parks, technology diffusion programs, management development programs, external factors.

Innovation drivers consist of: government policy and programs, venture capital funds, industry (technology incubators, market leaders, etc.), research centers, cooperation and coordination mechanisms.

Innovation infrastructure consists of: higher education institutions, centers of excellence, public innovation agencies, private innovative organizations, embassies and business networks abroad,incubator services, technology parks.

Finance consists of: government programs, private sector, venture capital, foreign investment.

Information dissemination consists of: industry associations, universities, networking, websites, patent databases.

Technology transfer/diffusion mechanisms consist of: governmet programs, incubators, industry clusters,

R&D organizations, networks/business-research linkages.

Commercialization support consists of: government programs/agancies, mentoring, technology incubators, spin-offs.

In this model an analyzer searches for these elements and their sub-elements in an NIS. After that he can make scence of the strength and weakness of the national innovation system of a country, causes for the failures in this system that leads to entrupt the innovation process, lack of some elements such as some organizations or linkages and relations and institutions. Then policy makers and strategists have an insight of the realities about national system of innovation and probably failures in it. So they can plan and implement suitabale strategies and policies to get rid of the system failures and finally the innovation process in national level becomes faster and stronger.

THE SCIENCE PARKS

Science parks were established in the 1960s as a social institution and a branch of economic development based on technology. Today, there are more than 800 science parks in more than 55 countries around the world, and more are under construction, depicting the importance of such social institutions. These parks are also a type of business parks where the major activities of the involved organizations deal with research and development targeted at industrial applications, thus usually these parks are not engaged with mass production or basic research. Special laws have been adopted in order to promote smaller companies next to the large and established companies, and special services are offered which facilitate the activities of the organizations working in such parks. It is also expected that these parks would help establish new companies based on the developed technologies whether within the development section of a larger company or through other investment means. Other objectives of these science parks include promoting high-technologies and economic developments, as well as attracting specialists, scientists, and companies dealing with high-technologies at international levels. Thus, many of these parks can work as part of a coordinated strategy for national and regional development. In addition, governments have put effort to provide a suitable condition for the activities of small and medium sized companies to speed up the process of technology exchange, employment of educated work force, and commercializing research results. As a result, these parks have turned into one of the most active technologic centers in the world with a remarkable growth both in numbers and volume. The International Association of Science Parks (IASP) has defined the science parks as:

"A Science Park is an organization managed by specialized professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high quality space and facilities." (IASP International Board, 6 February 2002). The IASP definition of “Science Park” encompasses other terms and expressions such as “Technology Park”, “Technopolis”, “Technopole”, “Technology Precinct”, “Research Park” etc.

THE FUNCTIONS OF SCIENCE PARKS AND INCUBATORS IN NIS

Some functions of NIS are made by several organizations and vise versa, some organizations making more than one functions of NIS. Performing R&D activities especially applied and developing research are being done in science parks and incubators. Comparing with universities and research institutes, science parks and incubators have more applied and specified researches.

Another function of NIS is technology diffusion which is done by science parks and public technology (transfer and innovation) agencies. In this regard, in a science park, interacting between different

companies and their activities to attract new technologies make technology be more diffused among companies.

Nowadays, one of the main goals in establishing science parks and especially incubators is to promote the technological entrepreneurship which is one the main functions of NIS. This function is also done by some other elements of NIS, such as universities, research institutes and public technology agencies but they are not as important as parks and incubators in this regard. Incubators are, as a part of their mission, developers of entrepreneurship start-ups. Commercializing the results of researches as a function of NIS is done by business parks.

THE INTERACTION OF SCIENCE PARKS AND OTHER ELEMNTS OF NIS, FIRST MODEL

As mentioned before, in this model the elements of NIS are divided into two categories, institutions and organizations. As institutions, routines, rules and laws and intellectual property regulations are more important. Some rules make easy for establishing interactive relation between universities and science parks or incubators, for example in Taiwan a university staff can still keep his/her position in university even until 3 years working in a company and leaving the educational job. This will highly improve the entrepreneurship behaviour of university staffs. Establishing incubators or science parks close to the universities makes easier for a researcher to be able to use such regulations.

Two of the organizations in NIS are incubators and science or business parks. These both are related to financial elements from one side; and universities and research institutes from another side. As companies in science parks and incubators are commercializing the results of researches they have to establish certain relations with university staffs. This is, of course, not the case in developing country where transferring technologies may be more applicable than producing technologies. Instead, in these countries, companies in science parks and incubators are related with international companies.

In NIS science parks are also in close relation with commercial banks, venture capitals, etc. Incubators need seed capitals. From one hand science parks and incubators need to attract money from their habitants to be developed and on the other hand the financial units can be active and profitable by investing in innovative ideas or technological projects running inside incubators or science parks.

THE INTERACTION OF SCIENCE PARKS AND OTHER ELEMNTS OF NIS, SECOND MODEL

The structural elements of the second model include fourteen different factors. Expense structure is one of these factors. When in an innovation system the expense of R8D is high, companies like to transfer foreign technologies instead of developing new technologies. Science parks and incubators facilitate R&D activities and make these activities be possible in lower expense. Therefore they have a role of adjusting the expense structure in the system. The measure of access to the market is another factor of the structural elements of the NIS in this model. The more local, national and international cooperation contracts among companies, local authorities, governments and multinational companies, the more access to the market. The management of a science park tries to use networks and different contracts for the companies located in the park. A manager can even try establishing relation through formal and political contracts between the government and other countries through embassies inside or outside the country. Science parks in a way are enlarging the market and making easier the access to it. Networking, technology clusters and international cooperation among companies inside and outside the science parks are the other topics in structural elements that are under attention in science parks.

The third element of this model is the innovation and entrepreneurship culture and activities. In a country the educational system helps diffusing of technologies. Science parks and especially incubators have also the role of educating the transfer technology, even though it happens practically and not in classrooms, and so are important in technology diffusion and improving the innovation culture. When companies were

educated in an incubator it means that they have already used to work, more or less, in an innovative culture space.

Incubators strengthen entrepreneurs by consulting, interacting with successful companies, working in cooperation with universities and having stylish space of work. In science parks, as far as the companies are upgrading to be able to extend their exports or act internationally, they have to increase their entrepreneurship. This can also impact on the society outside the science park or incubators as a side-effect.

Innovation drivers are other elements of NIS, for example Industry has the ability to become in some cases an innovation driver. The companies inside incubators who are working in front line of science and technology, and the R&D centers or hi-tech companies located inside science parks are the best potentials to be the innovation drivers inside NIS. A new technology may be started in an incubator and be come widespread very fast and activate many other elements of NIS.

Some of the organizations of the innovation infrastructure as the fifth element of NIS are scientific poles, government's innovation agencies and innovative organizations in private sector. A science park helps innovation agencies in private or governmental sector and a science park, it is assumed as a scientific pole. Incubator services and science parks, not only affects positively on other organizations of the innovation infrastructure, but also they themselves are organizations of the infrastructure of NIS. Science parks provide venture capitals and facilitate the foreign investment via cooperation with the companies located inside the park. This improves another element of NIS which is providing the financial investments.

The mechanism of technology transfer and diffusion is 8th element of NIS. Incubation is among these mechanisms. Industrial clusters, R&D organizations and the networks in research and business are other mechanisms that are paid enough attention to them by the managers of science parks.

Supports for commercializing the ideas and results of researches is the ninth element of NIS in the model we are discussing. Technology incubators are among the most important ways to support for commercializing.

THE COMPLETING ROLE OF THE SCIENCE PARKS IN NIS

In addition to the importance and roles of incubators and science parks in NIS, they can also have an extraordinary impact on strengthening other elements of NIS. If and if in incubators and science parks some of the companies or part of the R&D institutions related to technology management or technology assessment come into studying the NIS of the country and determine the strengths and weaknesses of the system, then those elements, which has not yet come existence or have not enough capability comparing to the other elements of the NIS, will become under consideration and can be improved in a way or another, directly by science park or indirectly by emphasizing on the problem through different governmental organizations.
Moreover, where there is no care about the NIS in a country as it is in some developing countries, a science park due to its loss of such a situation can play this extra ordinary role in NIS. Without having a powerful NIS of all elements defined in any of the two said models, science parks cannot work easily and successfully. Therefore this extra role is benefiting science parks, too.

CONCLUSIONS

In this paper the NIS, science parks and incubators, and their interactions have been studied. Science parks and incubators are assumed as organizations functioning among the element of NIS. Different aspects of the said interaction have been discussed and some other suggestions are summarized as below:

1. In feasibility study of a science park or an incubator, the situation of elements of NIS that has influence on the functioning of science parks or incubators has to be studied.
2. A manager of a science park or incubator should always remain informed about the situation of

the elements of NIS in order to be able to move successfully.

3. Science parks are in relation with, from one side to universities and from the other side to the financial institutes. Therefore, the opportunities or treats from these two sides have to be monitored and reactioned in time.
4. Science parks and incubators have impact on 7 elements of 9 in NIS. This show that they are highly influencing NIS and if be improved and widespread through the country, they can improve NIS.
5. Science Parks can play an extra role as an organization monitoring the NIS and guiding the failures of the system.

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