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The Role of Governmental Policies in Improving National Innovation System: A Case Study of Iran

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Abstract: Economic development is impossible without considering research activities and their application in economy and industry. Governments' political power is in a close relationship with its scientific and economic power. In every country, the key point for national development is the existence of close and redoubtable relations among the university, industry and government, which are the most effective institutions. Recent global evolutions in different areas have signified the importance of technology and knowledge for the government and have heightened the notability of innovation. According to the review of national innovative systems, new institutions and approaches are suggested in the governments' policies of science and technology. In this study, the importance of the relationship between university and industry are explored as economical growth indexes. Then, the two existing approaches (Triple Helix and New Economics of Science) in the literature are discussed and a number of countries' policies for improving the national innovation systems are explained. After all, the role of Iranian government in this area will be explored.

Key words: University-industry interactions · Government · National innovation system

INTRODUCTION

University knowledge, which includes tacit and explicit knowledge, is an important source of industrial innovativeness. Positive impacts of university research on firms' innovative performance have been confirmed by most academics and industrialists. Also, economists have recognized the contribution of the university knowledge to the economic growth of countries [1-5]. In today's world, knowledge is considered a key source of economic growth and the firms' competitiveness. Since universities are the sources of new knowledge, the university-industry relationship has become an important issue and has attracted special interests [6].

Since the late 1960s, universities have undertaken research in addition to education and they have created and diffused knowledge into society [7]. By the emergence of knowledge-based economy during 1990s [8], universities have performed a key role for countries' scientific and economic growth under their third mission for "economic development" [7, 9-10].

Knowledge is the strategic source for creating innovative capacities in companies in order to maintain viable competitive advantages. The productivity of firms having partnerships with universities is higher than those with no partnerships and the firms involved in the cooperation with universities in particular earn substantial benefits of increased productivity, profitability and innovation [11].

Bishop *et al*. [3] suggested that firms can benefit from journal articles and technical reports generated by the scientific research at universities and education. Also, the highly trained and qualified individuals, direct personal contacts between industrialists and members of the scientific communities, advice and assistance provided by university scientists in the innovation process of companies are all advantageous factors for the firms. Generally, knowledge transfer mechanisms proposed in literature include: 1) using university faculties as consultants in industry, 2) conducting joint research projects, 3) hiring students by the industry, 4) publishing scientific papers and holding technical meetings, 5) patenting, licensing and forming start-up companies, 6) mobilizing academic personnel and 7) jointly supervising Masters and PhD theses [1, 4-5, 10, 12-14].

Due to the increased international competition and fiscal constraints of universities, change of economic circumstances, success of R&D efforts during the World War II and processes of globalization, the relationship between university and industry was altered in the last

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quarter of the century and close relationships were developed in response to these challenges [2, 9, 15- 17]. Many governments have been strengthening universities' roles in their countries' national innovative systems by encouraging more interactions between universities and industries [2].

Review of the literature in the field of university-industry interactions shows that, since 1970, many governments have also paid attention to their importance and have adopted policies for facilitating and improving these interactions [7, 15, 18]. The government's role in appropriate university-industry relations is an integral element for the success of innovation and productivity endeavors and for meeting future challenges [12, 19].

Iran is a developing country; thus the importance of university's contribution to the economic growth has been recognized and the relationship between university and industry has been seriously addressed in the scientific and technological atmospheres during the last decade. According to Islamic World Science Citation Centre [20], Iran ranks 22 in the world for knowledge production. Because of increasing growth of science production in Iranian universities, the importance of using university knowledge for local industries is revealed. Therefore, the Iranian government has planned several policies and strategies in science and technology for improving the interaction between university and industry. The question this paper tries to answer it is: what policies have the Iranian government used for improving university-industry interactions? This paper also explores the government's policies of some countries such as Korea, Japan and China; then, it conducts a case study in Iran.

The National Innovation System (NIS): The entrepreneurial university, introduced by Etzkowitz [21], encompasses the third mission of economic development in addition to research and teaching [21, 22] and emerges as a key component of the NIS [23].

NIS is a set of knowledge institutions and the interactions of them, which determine the innovative performance of national firms [8]. University-industry interactions are discussed within the theoretical framework of NIS. This concept is based on the interactive models of innovation which emphasize the importance of cooperation between innovative firms and partner organizations such as universities, banks or business service providers. Close linkage allows firms to access knowledge from partner organizations and to utilize it in the innovation process [24, 25].

According to Freeman [23], NIS is "a network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies". The origins of the concept of NIS in East Asia can be traced back to Freeman's studies, who drew "lessons from Japan" after visiting the country [18]. Lundvall [18, 23] defined the concept of NIS by proposing a coordination system based on the interactions between knowledge users and producers and said "it is obvious that any model of a national system of innovations must take into account the interaction between universities and industry" and "government may intervene, directly or indirectly, in relation to the establishment and restructuring patterns of user-producer relations" [18]. In a book comparing the NIS of 15 countries, Nelson [23] pointed out that the performance differences among the countries reflect different institutional arrangements. In the NIS-related literature, one of the roles of universities and research institutes is to channel their knowledge toward firms; also universities follow the process of diffusing knowledge by producing qualified students and interacting with firms through cooperative programs [23]. With regard to the role of a university, two contrasting views exist: the Triple Helix (TH) thesis and the New Economics of Science [21, 23, 26].

Etzkowitz and Leydesdorff [27] proposed the Triple Helix (TH) model, which affirms the existence of a spiral pattern of relations and links the three institutional actors of industry, university and government, among which university tends to have a critical part in the context of a knowledge-based economy [26, 28]. The TH model of university-industry-government relations privileges previous models of institutional relationships, such as laissez-faire and socialist, in which either the economy or the policy predominated, with the knowledge sector playing a subsidiary role. It also attempts to account for a new configuration of institutional forces emerging within innovation systems, whether through the decline of the total state or the opening of the insular corporation [21]. This model has the capability of explaining dynamics within three strands and new developments at network level, which are created as a result of mutual information exchanges among the strands [18, 27].

The TH model emphasizes the importance of interactions among these institutions in order to facilitate the conditions for innovation. This approach argues that universities should form direct links with the industry to maximize "capitalization of knowledge" and,

in this regard, social and economic roles of universities contribute significantly to the innovation in increasingly knowledge-based societies [6, 23, 27].

Another thesis about the relationships of university and industry is "New Economics of Science" which was introduced by Dasgupta and David [6, 23]. This approach emphasizes education as an innate function of a university and is concerned with the relationship between university and industry which is becoming too close and argues that this process may seriously endanger a nation's capacity to benefit from scientific advances. Dasgupta and David stated that "Open Science" (academia) and "Proprietary Technology" (industry) are distinctively-organized and functionally-differentiated spheres and that a proper division of labor between the two should be maintained in order to maximize the scientific benefit [6, 23].

The contrasting views on the ideal university-industry relations and the specific role of university have often confused policy makers and practitioners in the related fields. This is even more so from the point of view of those in developing countries because both views seem to have a common drawback in terms of applicability to developing countries [6]. Many developing countries are trying to transform their economy from resource-based/low technology towards technology-based economic growth. Innovation is, however, specific to each country; hence the process which governs the dynamics of innovation in a developing country is inherently different from the one in a developed one [29]. The TH or New Economics of science supports a particular type of university-industry relation (integration or division).

Governments' Policy for Developing National Innovation Systems: Since 1970s and 1980s, governments in the US and UK have devoted governmental appropriations of universities to their performance in education and research; thus the importance of knowledge commercialization is increasingly emerging. The aim of this movement was to improve the link between the research activities of the national higher education system and the needs of the national economy. In order to force universities to interact with companies, many governments have cut public funding and encouraged universities to obtain money from knowledge commercialization, e.g. through contract research [24].

The policy of the governments on research and development (R&D) is emphasized as crucial for the technology transfer from public research organizations to industry [23]. Governments usually restructure the national research system by allocating funding and modifying evaluation indicators [18]. Dzisah and Etzkowitz [18] pointed out that coordinating the role of government in both developing and developed societies is a key for improving the conditions of active collaboration among institutional spheres. Governmental support for R&D is helpful for firms which need external partnerships but face financial or networking problems. The government may provide these firms with capital for acquiring basic or core technology from university or with opportunities for collaborating with them in research projects [23]. Another governmental policy is to encourage universities to establish technology transfer offices, incubators, entrepreneurship centers, science parks, university seed- and venture capital funds [30].

The Korean government decided to bolster the Korean national system of innovations, building on the tradition of attention to science and technology (S&T) policies, which goes back to the dictatorship of the 1970s. The Korean government's policies are important for shaping and continuously reconstructing the system. For example, in response to the structural problems regarding the national research and development (R&D) administration, President Lee Myung-Bak (2008) formulated a grand strategy for reforming the Korean R&D system by reorganizing governmental agencies. The new government launched the Ministry of Education, Science and Technology (MEST) and the Ministry of Knowledge Economy (MKE). While MEST is intended to play a role as the key coordinator for incorporating human resources of education, science and technology for the purpose of national development, MKE has a mission in fostering knowledge-based innovation capacities across the country [18].

When Korean universities and public research institutes were producing innovative research in the emerging technologies during the 1970s and 1980s, university-industry-government collaborations were popular among academic scientists [18].

By the 1970s, Japan had become a top-runner in technology development and its success led to increases in its trade surplus. Therefore, it was asked to make substantial contributions to the basic research that matched its economic strength. In the 1980s, the Japanese government promoted its basic research and developed fundamental technologies as the major focus of its scientific and technological policy. The Japanese government recognized that basic research was essential

for the country's future prosperity. This recognition was reflected in recommendation report no. 11 of the Council for Science and Technology (CST) in 1984, which stated that Japan cannot advance without enough stock of basic research and technological bases. Based on this recognition, the report set the reinforcement of basic research and technology bases as the first main activity in the S&T policy over the next decade. In this context, several R&D programs were founded for the basic research and encouraged basic and fundamental research not only in universities but also in public research institutes and industries. In particular, biotechnology, materials science and information and electronics technologies were recognized as priority areas, which is reflected in the CST's recommendation reports of the R&D national plan for each field. In these "science-based technology" fields, inter-sectoral collaboration was considered as an important factor in research implementation [31].

In China, a shift occurred from the planned economy to the market economy. Since mid-1980s (following this shift), several reforms have occurred in science policy. The most significant change was cutting the government research fund in order to push research units toward the market. From 1986 to 1993, governmental research funding decreased at an annual rate of 5%. So, universities began to establish their own enterprises, a practice officially approved by the central government in 1991. Another wave of reform on Chinese universities began in December 1994 when a national forum encouraged institutional merge and decentralization in jurisdiction for efficiency purposes. The decentralization reform implied promoting collaborations between universities and local industries [2].

In order to join to the World Trade Organization (WTO), China has been trying to improve its legal environment for intellectual properties. In April 1999, the Ministry of Education issued a Chinese version of Bayh-Dole Act that allowed universities to retain titles for inventions derived from governmental funding and emphasized the protection and commercialization of the university's intellectual properties [2].

The Iranian Government Policies for the Development of Innovation System: The history of the Iranian government to develop the interaction between university and industry until 2002 can be divided to four periods as follows: 1) From the establishment of Tehran University in 1934 as the first Iranian university until 1961 during which the university- industry interaction was based on education. 2) From 1962 until 1982 during which, in addition to education, apprentices were sent from universities to governmental industrial corporations to get acquainted with new imported technologies. 3) From 1983 until 1995, research tasks were undertaken by universities as well and offices for relation with industry were established in universities. 4) From 1995 until 2002 a new basis for university-industry interaction was provided, according to which, the government launched the establishment of research and scientific towns and parks in various provinces [32, 33].

The government started its policy-making in the areas of science, technology and innovation vigorously and more speedily in 2000. Since, according to Iran's constitutional law, the government is responsible for economic, social and cultural development, the legislation of the country's third program for economic, social and cultural development" is regarded as a turning point in Iran's history of higher education.

Since the beginning of the third program (2000-2004), the government has paid increasing attention to university-industry interaction. The salient feature of the third developmental program was to provide the necessities for a sustainable development. The 11th chapter of the program is devoted to the development of sciences and technologies.

The third program's clause number 99 states since the beginning of the program, "the Ministry of Culture and Higher Education" will be renamed as "the Ministry of Sciences, Researches and Technology" in order to integrate the country's administrative affairs and its scientific system's policy-making; furthermore, the following tasks of planning, supporting, supervising and evaluating, the legislation of policies and strategic priorities in the areas of research and technology will be added to the ministry's responsibilities:

The program's clause number 102 maintains the government is warranted to finance projects -through its yearly budget programs- that are offered by ministries and other administrative bodies to universities, governmental and non-governmental research centers; on the condition that at least 40% of the costs be provided and committed by the employer [34].

After the renaming of the Ministry of Culture and Higher Education to the Ministry of Sciences, Researches and Technology, the ministry's law of objectives, tasks and structure was revised. According to the law's clause number 3&4, the High Council of

Sciences, Researches and Technology was announced to harmonize and integrate macro-administrative policies in science, research and technology's areas.

The council's tasks and permissions, according to the aforementioned law, are as follows: 1) Prioritizing and selecting long-term executive programs for large investment in educational, research and technological sectors. 2) Investigating and offering required financial resources in science, research and technology's areas [35].

The government also paid attention to the importance of knowledge- technology- university-industry relations for the development of the country in the next developmental program (2005-2009). The 4th developmental program's chapter 4- entitled knowledge-based development- states, due to the important role of knowledge, technology and skill as the main factors in generating value added in modern economics, the government is obliged to take the following steps: 1) Streamlining and reconstructing research, technological and educational policies and strategies in order to enable the country's scientific, research and educational centers to answer social, cultural and industrial demands and to operate in the world's increasingly competitive sphere during the 4th program's first year. 2) Providing the country's comprehensive scientific and technological development program, especially technologies ranked on par with the day's high level technologies and sciences, in different sectors during the first year of the program.

The program's clause 45 states the government is obliged to fulfill the following requirements in order to expand knowledge-based commodities' market, commercialize research achievements, innovate and increase the role of private and cooperative sectors in this area.

- Designing and establishing the comprehensive regime of intellectual, national and international property rights and anticipating necessary executive structures.
- Supplying and paying some portions of costs for registering patents at the international level and for buying producers' domestic registered patents [36, 37].

In line with the execution of the 4th developmental program, a need was felt to build a competent regime of science, technology and innovation to design related policies and strategies, evolve and coordinate structures, redefine missions, synergize activities, reform regulations and procedures, relativize the country's resources and financial facilities to the opportunities of science, technology and innovation. For this purpose, the president's Deputy for Science and Technology was announced in February 04, 2007, according to the constitutional law's clause 124 and with the president's verdict, to operate cross- sectionally. The main tasks of this office are as follows [38]:

- Managing the allocation of 1% of governmental organizations' operating revenue to research: coordinating applied research plans that resulted in the conclusion of contracts and agreements worth almost 5000 billion rials[1] in 2008 between companies and banks, on one hand and universities and scientific and research centers, on the other hand, as the country's greatest university-industry corporation [38, 39].
- Establishing canons for coordinating university and industry: the act of compiling a local model for the development and the improvement of university-industry collaborations began in 2007, using national and international experiences and consulting massively with experts. The university-industry coordination canons are aimed to have science and technology penetrated in commodities and services produced in the country through the active participation of all agents involved in scientific, research, technological, producing and commercial procedures of every commodity or service.

The canons have been organized to coordinate innovation cycle's all main role- players to expedite and guide their activities so as to make optimal use of the country's resources. The coordination canons for educational-research centers' cooperation and compound industries are among the main role-players of the innovation cycle in one specific product or service [38, 40].

- Programming and supporting national technological macro-plans: designing, programming and organizing national macro-plans is a pivotal realm for the activity of the president's deputy for science and technology, paving the way for the long-term activity of different sectors, the sustainable progress and

[1]The standard unit of money in Iran

development of the country. These activities are purposed to remove the country's internal needs, participate at global competitions and create wealth, science, human capital, financial synergy at very principal areas of the country like the national supercomputer network, the national speeder and observatory in conjunction with universities and industries.

The most important objectives of national technological macro-plans are:

- Assisting the development of knowledge-based technologies so as to benefit from their results.
- Participation in the development of new technologies and removing the society's technical and specialized needs.
- Participation in the commercialization of research plans.
- Assisting the scientific and technical enabling of the country's private sector.
- Contribution in transferring emerging and upcoming technologies.
- Furnishing the required infrastructures for the implementation of low level technological and innovative plans or applied researches at the international scale [38, 40-41].
- Assisting scientific and technological parks and incubators: for instance, the deputy's total aid to scientific and technological parks and incubators, subjected to the Ministry of Sciences, Technology and Research and the Ministry of Health and Medical Education, has exceeded 125 billion rials in 2008.
- Removing barriers and facilitating the commercialization of innovations: the government legislated the bill of "supporting knowledge-based companies and the commercialization of inventions and innovations", according to which, large facilities would be at these companies' disposal.

According to the text of the bill of supporting knowledge-based companies, legal personalities like companies, private and cooperative institutions whose main axis of activities is to create and exercise knowledge and technology are dubbed knowledge-based companies and are subject to this law's supports. The aim of these entities is to expand and apply inventions, innovations and the commercialization of development and research results. The operation area of these entities includes designing and producing commodities and services in the area of higher technologies or high value added technologies with the aim of wealth and science synergy, developing knowledge-based economy and realizing the country's scientific and economic objectives.

- Improving the position of science and technology in the government: establishing the government's Science, Research and Technology Commission suggested by the deputy. The commission setting up its own secretariat launched its activity as one of the government's main commissions, involving the scientific and economic ministers with the major intention of wealth and science synergy [38].

S&T as effective factors in all social affairs, moving force of all economic, social and cultural activities and the source of economic growth, value added and cultural transformations have been the subject of special emphasis under two titles of the country's twenty-year perspective document as follows: 1) A society enjoying advanced knowledge, capable of producing science and technology and dependent on human resources' premier shares and social capital in national production (the perspective document's article 2). 2) Achieving the first scientific and technological position in the region of Western South Asia with an emphasis on the software movement, science production, highly accelerated and sustained economic growth, the relative improvement of per capita income and the achievement of full employment (the perspective document's article 6) [42].

S&T sectors have key and central roles in realizing the perspective document's objectives and so necessitates the preparation of some essential mechanisms for the expansion of knowledge borders, facilitating research, producing and transferring technology, establishing the regime for the commercialization of research achievements, policy-making, managing and supervising for the development of S&T. In line with this, the country's comprehensive scientific map was compiled by some experts in the field of management and science and technology policy-making. Technological development plays a very significant role in realizing the perspective document's objectives to which should be attended in all fields. The main three entities of government, industry and university have parts in this regard.

An attempt has been made in the preparation of the country's comprehensive scientific map to make use of all scientific and administrative references and experts; in the meantime, "the High Council of Cultural Revolution" has played a cooperating and decision-making role. General policies for the development of science, technology and innovation have been drawn in this map are: 1) The development of science, technology and innovation with the purpose of strengthening the national authority, achieving the first position in the region and a distinguished position in the world through institutional reforms in science, technology and innovation regimes aimed to complement the innovation cycle. 2) Strengthening the country's infrastructures, scientific, cultural and technological capacities, encouraging and improving a knowledge-based entrepreneurships' position (Technopreneurship). 3) Improving synergized collaborations between universities, governmental and non-governmental research, economic and cultural centers with the establishment and the development of joint centers. 4) Promoting the country's scientific, cultural and economic centers' innovation level and supporting intellectual property [43].

For a better and swifter transferring of research to technology, it is obligatory to have a systematic structure, dependent on accurate and comprehensive information in different fields of science, technology and appropriate knowledge management. For this, the High Council of Science, Research and Technology decided to design and launch the National System of Science and Technology.

This system is a junction for scientific and research data produced in the country. This information network is a place for integrating the country's individuals, organizations, institutions and scientific journals' data. This network, in fact, is a first-hand source and a center link that receives and saves only meta- data like author's name and journal's title, etc. emphasizing the final information presented in other internet websites [44, 45].

CONCLUSION

The world's current technological movement has changed university-industry relation status from an advantage for societies into a necessity. The role of governments and states as policy and ground makers are very significant in establishing targeted and constant relations b etween higher education centers and industries. The country's programmers have paid attention to this major issue for many years. Today, the necessity of coordination and relation is being felt more than ever, due to the massive activities of universities and industries- as the two important pillars of sustainable development- in the country and the entrance of new and higher technologies to the industry sector.

Societies' progress and development are the products of joining the chains of scientific, industrial and economic developments. Joining universities and industries as responsibles, respectively, for scientific and industrial development would result in very positive outcomes in the area of economic development moving the country constantly toward progress and mobility. Generally, the role of the Iranian government in university-industry interactions could be summarized along the following lines:

- Coordinating, supervising and evaluating role: the creation of "the National System for Managing Science and Technology data" reveals the government's coordinating role. This information network is a place for integrating the country's individuals, organizations, institutions and scientific journals' data.
- Supportive and resource-providing role: the bill of "supporting knowledge-based companies and the commercialization of inventions and innovations", the allocation of 1% of governmental organizations' operating revenue to research and the government's capital assistances to science and technology parks and incubators are among the indicators of the government's supportive and resource-providing role.
- Policy-making and macro-programming role: the chapters related to science and technology development in the third and the fourth economic development program and the country's comprehensive scientific map show the government's policy-makings and macro-programmings with regard to university-industry interactions.

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