

Exploring of the Role and Position of Institutional Actors in the University-industry Interactions

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Abstract: Knowledge has become the strategic source of generating innovation capacities for firms to maintain sustainable competitive advantages in the fast changing business environment. Although the firms perform in-house R&D activities, but it is not enough for developing their capability in modern technology and innovation and requires them to look for out-source knowledge. Due to huge knowledge storage, universities are a very excellent source for providing the firms' knowledge needs. University-industry knowledge transfer is a key research subject in management and economic studies. The effective use of academic knowledge is that universities and industries have appropriate interactions. In this regard, not only university and industry, but also government has a crucial role in providing a suitable basis for the efficient university-industry interaction. The present study is an attempt to explain the role of these institutional actors in the process of knowledge transfer from university to industry.

Key words: Knowledge transfer • University • Industry • Government

INTRODUCTION

The present society is a knowledge-based society. An important aspect of this society is the close relationship between science and industry and the rise of science-based technologies [1]. Due to an increasing recognition of the fundamental role of knowledge and innovation in fostering economic growth, technological performance and international competitiveness [2], the interactions between universities and industries have become a major concern for policy makers, researchers and industrial managers over the last two decades [3- 5].

Knowledge is essential for improving the economy of a nation, especially in the developing countries where industrial growth is assigned a very important role [6]. It is apparent that the development of knowledge and technology provides much of the basis for future industrial development [7].

Since the late 1960s, the university has been considered as an institution that generates and disseminates knowledge mainly through education and research, so it has played a critical role in scientific and economical growth of countries. Nowadays economic

development is presented as the third mission of universities [7- 9]. Etzkowitz [10, 11] refers this as universities' "second revolution", with the "first revolution" being adding research to teaching. In addition, direct relationship between university and industry can bring important competitive benefits through increased productivity, profitability and innovation to firms [6, 12]. Thus university research represents a potentially important source of industrial innovation [6, 13-15].

Regarding to this important sector of innovation, it is needed to understand which institutional actors are involved in this innovation system and what is the role of each one in this context.

The Triple Helix: Triple helix model is among the major methods of studying the university-industry interactions. Etzkowitz and Leydesdorff [7, 16] have proposed the Triple Helix model that affirms the existence of a spiral pattern of relations and links between the three institutional actors: Industry, University and Government, in which the university tends to have a critical part to play in the context of a knowledge-based economy [7].

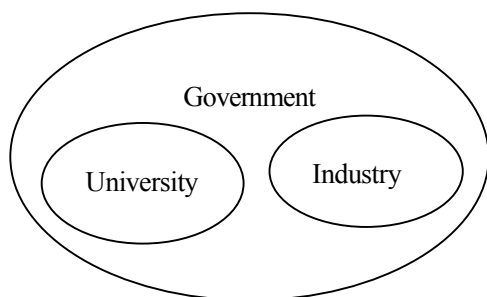


Fig. 1: An etatistic model of university-industry-government relations [7].

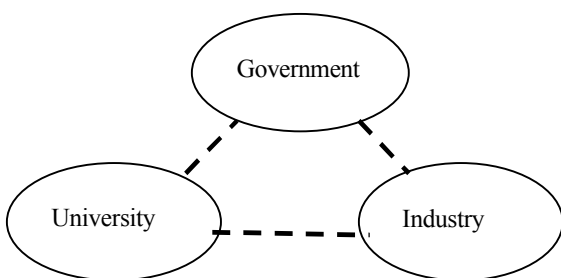


Fig. 2: A laissez-faire model of university-industry-government relations [7].

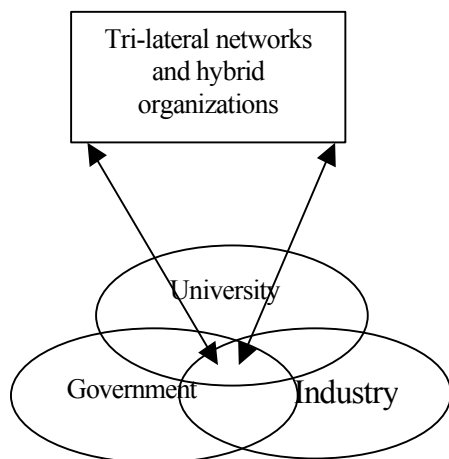


Fig. 3: A triple helix model of university-industry-government relations [7].

The evolution of innovation systems are reflected in the varying institutional arrangements of university-industry-government relations. In the first configuration, named etatistic model, government encompasses university and industry and directs the relations between them (Figure 1). The strong version of this model could be found in the former Soviet Union and in the Eastern European countries under the name of “Existing Socialism”. The second model, named laissez-faire (Figure 2) consists of separate institutional spheres with strong borders dividing them and highly circumscribed

relations among the spheres. Finally, Triple Helix III generates a knowledge infrastructure in terms of overlapping institutional spheres, with each taking the role of the other and with hybrid organizations emerging at the interfaces (Figure 3) [4, 7, 16]. A Triple Helix III, in which each strand may relate to the other two, can be expected to develop an emerging overlay of communications, networks and organizations among the helices [7, 9].

The triple helix model has the capability to explain the dynamics within the strands and also the new developments at network level that are created as a result of mutual information exchanges among the strands.

Government: In recent years, many governments have implemented policies for concomitant rise in university-industry partnerships [17]. Governments’ policies have further encouraged firms and universities to develop partnerships with each other (e.g. by providing funding programs that require firms to work with universities as a condition of the funding) [11]. Government reforms in national research systems aiming to increase knowledge transfer and commercialization of research have become a global trend [18]. Some of these reforms in various countries are as follows:

The US government has taken steady steps to improve knowledge transfer within US institutions. These include the Patent and Trademark Amendments of 1980, the National Co-operative Research Act of 1984, the Federal Technology Transfer Act of 1986 and directing the federal departments and agencies to improve the transfer of knowledge [19].

China initiated the economic reform in the early 1980s, by emphasizing that scientific research should meet the needs of national economic development. The reform of the science and technology management system started in 1986 that covered many areas such as changing the funding system, opening up the technology market, promoting the integration of science and technology with production, enhancing the ability of enterprises to absorb new technology and reforming the personnel management system [19].

The government instruments play a key role in the development of commercialization infrastructures at Canadian universities [18]. Rasmussen [18] reveals that government instruments are implemented including 1) to provide resources for use in commercialization projects, either directly or through the development of professional expertise in the university sector, 2) to encourage innovation in program design by

encouraging institutions to attempt new initiatives or by encouraging the broader adoption of good practice and 3) to create networks between the commercializing organizations.

University: Insofar as knowledge is becoming an increasingly important. Indeed, the university as the crucial part of innovation that produces and disseminates scientific and technological knowledge, is getting much more important to industrial innovation. This innovation function has been mainly the exclusive preserve of either industry or the government [16].

University-industry linkages have evolved over the past twenty years due to environmental changes affecting the actions by universities, firms and government. Universities are more cognizant of the commercial value of their work and researches are showing more interest in product commercialization [11].

In the late 19th century, a revolution occurred in the university, in which research was introduced into the university mission and made more or less compatible with teaching, at least at the graduate level. The increased salience of knowledge and research to economic development has opened up a third mission as economic development. In the USA in the 1970s and in various Western European countries during the 1980s, this transition has led to a reevaluation of the mission and role of university in society. Similar controversies have taken place in Latin America, Asia and elsewhere in Europe [7]. Then economic development is considered as third mission of universities [7- 9].

The stock of knowledge held by university, which creates value to the society, is defined as intellectual capital of a university. Intellectual capital is an important part of universities' endowment of intangibles. An important part of this capital is the research-development-transfer capital (R&D&T capital), that is the intellectual capital due to the process of creation of scientific and technical knowledge and the transfer of that knowledge to the social environment (companies, institutions and other social agents) [20]. Castellanos *et al* [20] suggested intellectual capital as "the set of knowledge that creates or can create value for an organization in the future". They declared that when addressing R&D capital in universities, one cannot consider research and development in an isolated manner, without the transfer of the scientific and technical knowledge generated in university to organizations. Indeed, such valuation is critically based on an adequate transfer of the knowledge to organizations.

Researchers are more concerned about the relationship of university and industry because universities whose links with industry are too intensive become interested in more industry-driven, short-term, problem-solving research. That might undermine the researchers' intellectual freedom in the definition of research agendas and the way that research results are used. Some authors have also highlighted that the alternative sources of funds for universities based on their relationships with industry, could reduce government responsibility to support university research, which may penalize basic science or may bias research agendas toward more profitable applied research activities [21].

Industry: Faster technological development, shorter product life-cycles and more intense global competition have transformed the current competitive environment for most firms. This new competitive landscape forces organizations to actively acquire knowledge since a firm's competitive advantage is now more dependent on continuous knowledge development and enhancement [22].

Many authors argued that resources like knowledge and technology capabilities are important for the development of competitive advantage as they are often unique and difficult to imitate by competitors. Extending the resource-based view, the dynamic capabilities perspective emphasizes the ongoing development of capabilities underlying the firm resources. It is not only the resources that matter, but also how the managers coordinate and integrate their activities within the firm to best utilize and enhance these resources over. Consistent with this evolutionary perspective of building and extending the firm's capabilities, the knowledge-based view of the firm emphasizes the firm's ability to integrate external sources of explicit and tacit knowledge [23].

Innovation is increasingly related with the firm's ability to absorb information, knowledge and technology. Many of the new products can be traced to the interactions and partnerships between the firms and various institutional actors (such as universities and R&D institutions) which are becoming the engines of innovation [4].

Exchange theories suggest that collaboration between the firms and universities can provide the firms with skills, knowledge and access to facilities needed to effectively evolve the firm's capabilities by exchanging complementary resources and growing competencies to generate value-added synergies. Beyond the building of

dynamic capabilities, university-industry collaboration can sometimes generate lower transaction costs with less risk than alliances between the industrial firms [23].

There is a large and growing interest in the organization of the transfer of scientific knowledge created by universities to the private sector. Many highly innovative sectors such as robotics, electronics and life sciences benefit from the results of university research [24]. For example, Cockburn and Henderson [24] calculated that research carried out in public institutions was used in 16 out of 21 medicines that, according to the experts, have enjoyed the greatest therapeutic impact between 1965 and 1992.

Major products in a wide variety of industries have been developed through university-industry interactions, such as the Boyer-Cohen “gene-splicing” technique that launched the biotechnology industry, diagnostic tests for breast cancer and osteoporosis, internet search engines, music synthesizers, computer-aided design (CAD) and environmentally-friendly technologies. Success in university-industry knowledge transfer could be as a critical factor in sustaining the global competitiveness of US firms [25, 26].

Hellman [5] developed an interesting theory of the search and matching process between scientists and firms. At the core of the model is the problem that scientists rarely know what industrial applications may exist for their scientific discoveries. At the same time, firms are often unaware what scientific discoveries might help them with their needs. The author calls this the “science to market gap” which can be bridged when scientists and firms engage in a process of search and communication.

Knowledge Transfer Mechanisms: Firms that operate in different industrial sectors seem to make use of diverse types of technological and market knowledge. They also seem to attribute different levels of importance to interact and access the knowledge developed by universities. Given the different forms of technological developments observed in each sector category, the relative efficiency of a set of channels may differ across different industries [14]. The increased emphasis on knowledge and technology transfer across university-industry institutional boundaries has led to the creation and implementation of a variety of transfer-oriented mechanisms [2].

Different mechanisms can be applied in knowledge and technology transfer between university research

centers and industry according to their motivations and available resources. These mechanisms include collegial interchange, conference, publication, consultancy and technical services provision, exchange program, joint venture of R&D, cooperative R&D agreement, licensing, contract research, science park, research park, technology park or incubator [6].

Technology transfer offices (TTOs) facilitate technological diffusion through the licensing to industry of inventions or intellectual property resulting from university research. The key ‘suppliers’ in this process are faculty members who must disclose their inventions to the TTO in order for the university to generate an economic rent from the transfer of the technology [17]. Jensen *et al* [17] claimed that many TTO directors report that less than half of the potentially viable commercial faculty inventions are actually disclosed to the TTO. In recent years, universities have attempted to formalize knowledge transfer and capture a larger share of the economic rents associated with technological innovation by establishing TTOs [26].

Siegel *et al* [25, 26] identified three key stakeholders in the transfer of technology and knowledge from university to the private sector: 1) university scientist, who discovers new knowledge; 2) technology transfer office, which works with faculty members and firms/entrepreneurs to structure deals and 3) firm/entrepreneur, which/who commercializes new technology.

Knowledge transfer from university can take place through many different channels. One important channel is the formation of new firms, based on research, knowledge or skills generated at universities [27]. Bercovitz and Feldmann [27] identified the establishment of such firms, known as academic spin-offs, as one of the core mechanisms of technology transfer [27]. University’s capabilities that facilitate the creation of spin-offs are related to their ability to initiate and promote the venture-creation process. Therefore, a key element of university capabilities for fostering spin-offs is related to their ability to enable the initiation of entrepreneurial activities [28, 29].

Science parks and incubators are the intermediate organizations that provide the social environment, technological and organizational resources and managerial expertise for transformation of a technology-based business idea into an efficient economic organization. Science parks and business incubators are property-based organizations with identifiable

administrative centers focused on the mission of business acceleration through knowledge agglomeration and resource sharing. A recent global increase in the level of activity of these institutions has stimulated an important academic debate concerning whether such property-based initiatives enhance the performance of corporations, universities and economic regions [30].

Bekkers and Freitas [14] examined the relative importance of different channels as a result of four factors including industry sectors effects, basic characteristics of the knowledge in question, scientific disciplines and characteristics of the organizations and individuals involved. They selected 14 distinct scientific disciplines (or groups of disciplines) for their field of work: biology, medical science, medical engineering, chemistry, chemical engineering, physics, material science, mathematics, computer science, electrical engineering, mechanical engineering, economics and business studies, psychology and cognitive studies and (other) social sciences.

According to their finding, it was specified that the difference in the importance of knowledge transfer channels is expressed by the basic characteristics of the knowledge (tacit, systemic and expected breakthroughs), disciplinary origin of the knowledge involved and the individual and organizational characteristics of those involved in the knowledge transfer process (seniority, publication record, patent record, entrepreneurship and research environment) [14].

DISCUSSION

The creation of productive infrastructure to connect the universities, firms and government in a country is considered as a competitive advantage in economic development. On the other hand, at present, the performance of innovation systems relies on the intensity and efficiency of the interactions between the chief actors involved in the generation and dissemination of knowledge. It also considers a critical role for healthy and adaptable relations between university and industry leading to the rapid development in the growth and shaping of new industries.

The triple helix model, in addition to paying due attention to the position of university and industry, focuses on the importance of government's role in the knowledge transfer process as well. This approach argues that each engaged institutional factor in knowledge transfer has its own role and function, which

evolves in the result of mutual relationships during the time. The government, as a facilitator and regulator institute, designs and executes a wide range of policies encouraging for the involvement of universities and industries in knowledge transfer activities in order to facilitate and improve knowledge transfer.

The direct use of academic knowledge is not possible due to its specific features of its nature such as complexity, context-related and tacit and also due to the differences between environment and purpose in universities and industries is not possible. Therefore, the effective usage of knowledge requires a transformation process that translates the developed knowledge into the technology needed in the companies.

University, as a producer and disseminator of knowledge, should diminish cultural and organizational barriers that prevent the knowledge transfer process. It also should devote more facilities to knowledge transfer process, encourage entrepreneurial activities, increase the rewards for engaging in knowledge transfer and try to identify the knowledge and technology required for industry.

On the other hand, industry, as a consumer and user of knowledge, should have the ability to comprehend, interpret, evaluate and attract academic knowledge according to its requirements. The engineers and company staff should be aware of the academic researchers and the professors' language.

Technology transfer offices within the university or spin-offs are structures to facilitate the flows of knowledge, information and innovation into the different parts of knowledge transfer process. Such structures need special management skills and unique organization designing capabilities in order to balance and encourage knowledge flows among the members.

Knowledge transfer process requires different forms of intra-organizational collaboration between universities and industries to create more effective transfer and dissemination of knowledge and technology. Thus, in different industrial sectors, the diverse channels for knowledge transfer from university to industry should be examined by systematic methods with respect to learning pattern and various technology levels. These examinations are to identify the best channels for knowledge and technology transfer process. Using various kinds of interactions, instead of unique mechanism, more likely prepares required capabilities for bridging the gap between scientific research and its application in industry.

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