American Journal of Geophysics, Geochemistry and Geosystems
Vol. 1, No. 3, 2015, pp. 124-132
http://www.aiscience.org/journal/aj3g
ISSN: 2381-7143 (Print); ISSN: 2381-7151 (Online)

Innovation Diffusion and Regional Development: A Geographical Analysis

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Abstract

This paper provides a review of existing research on the effect of technology transfer on regional development. Process approaches have received not much attention in innovation field of research. To fill this literature gap, we apply a process lens to a well-established field of technology transfer and diffusion. A review of existing literature is realized to provide an analytical framework able to identify all the phases of technology transfer and diffusion process.

Keywords

Economic-Geography, Innovation, Europe

Received: July 1, 2015 / Accepted: July 24, 2015 / Published online: August 2, 2015

1. Introduction

A considerable body of literature on technology creation, transfer, diffusion and adoption has accumulated during the last decades.

After many years of research, there is widespread consensus that technology creation and innovation diffusion is a multifaceted process that occurs over time, rather than consisting of a single set of actions or discrete events.

To take the two most commonly cited definitions used in the literature, technology transfer is a process of transmission, reception, interpretation and absorption of both innovation protected by intellectual protection (IP) and scientific knowledge without any measures for protection; and innovation diffusion is a process through which new products, values, policies or processes spread from their first worldwide implementation to different consumers, countries, regions, sectors, markets, and firms (Stoneman, 1983; Rogers, 2003 Zahra and Nielsen, 2002).

Combining these perspectives it is possible to identify the whole process of technology transfer and diffusion.

We assume that the process view has always played a minor role in the literature on innovation diffusion as compared to the static perspective analyzing single events or actions. Our aim in this paper is, thus, to use a review of the existing literature to provide a process oriented perspective already advocated by many scholars but never realized. In this paper, we apply a process lens to our review of research on innovation diffusion.

The contribution of this paper is several-fold. First, we provide what is the most comprehensive literature review on innovation diffusion process. Previous reviews of the topic have been more confined in scope and have not applied a process lens.

This process-oriented analysis enables us to identify a new theoretical perspective in analyzing innovation diffusion and practical implications for managers and policy makers.

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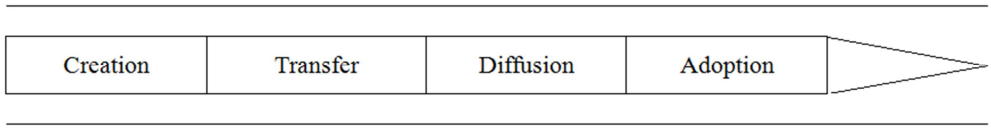

Figure 1. Technology transfer and diffusion process.

2. Analytical Approach

Based on studies of Brocke and Sinnl (2011), Gogan et al. (2013), Soni and Kodali (2011) we conducted a structured literature review aimed to divide technology transfer and innovation diffusion process in phases evidencing for each of them specific aspects and future development of researches. The design of the literature review was thus realized considering the scope of Business Process Management research. We explored the state-of-the-art research using ABI Inform, EBSCO, PubMed, Google Scholar and other online services. This review covered studies published in journals whose authors explicitly stated that they sought to address the technology transfer and innovation diffusion topic.

The review was conducted as a series of keyword searches of major electronic databases, supplemented by snowballing. To cover articles dealing with innovation diffusion process, we searched for 'technology transfer' and 'innovation diffusion' in the abstract of the papers. Through this research we found 100 articles that contained more than 80,000 citations. The next step was to decide on an analytical approach. As well as classifying articles, we asked of each one: What is its contribute to innovation diffusion process? Studies considered relevant were categorized according their contribute to our research question.

3. Technology Transfer

Technology is a set of knowledge in technical ideas, information or data, personal skills, know-how and equipment, prototypes, drawings or computer codes. Transfer is a process of transmission, reception, interpretation and absorption of both innovation protected by intellectual protection (IP) and scientific knowledge without any measures for protection (Schumpeter, 1939).

The process of technology transfer from public research institutions (PRI) to private firms can take place through a variety of informal and formal channels. Informal channels include knowledge transfer through publications, conferences and meetings between scientists. Formal channels include the recruitment of researchers in companies and professional consulting in PRI, sharing of equipment and instrumentation, research collaborations, patents, licenses and spin-off. This transfer from public research institutions (PRI) generates profits, economic growth and social prosperity (Keller, 2002; Branstetter, 2001; Peri, 2002). Consequently, policy-makers have to support research, technology and entrepreneurship in the interest of PRI, private firms and whole economic system.

Search profits are maximized when multiple channels are used for bi-directional transfer between and PRI and businesses. Encourage two-way exchange is a challenge for developed countries, but even more for the rapidly developing economies. It follows that it is in the interest of policy makers to support research, knowledge transfer, technology and enterprise development of new companies born from public research bodies. A considerable amount of research identifies as factors affecting the process of technology transfer the institutional system in which the PRI operate, the presence of innovative companies and venture capital, the size and type of PRI, the portfolio of more or less prone to patenting, the quality of the Institute's research and reputation, the extent of collaboration with other organizations and the business climate, an institutional culture that encourages technology transfer, the implementation of institutional strategies for the transfer and commercialization of technology, incentives to disclose inventions, the characteristics of the technology transfer Office. The procedure to be applied to the transfer of research results of a PRI depends also on the specific national legislation regulating the public property and the specific regulations of the institution (Covin et al., 1999).

The spread of technology transfer practices has led to the need to define specific policies to regulate these processes in order to develop this activity and allow PRI to defend their interests. For this purpose, fall within the technology transfer mode any agreement that allows a plaintiff to obtain rights over knowledge, inventions and works created by others. Studies on the transfer of knowledge from the PRI companies reported positive effects of interactions between the two actors on scientific production (Harman, 1999; Lebeau et al., 2008). The authors provide as possible explanations of this increased productivity on the one hand the fact that industry tends to fund researchers who are already highly productive and secondly the fact that the relationship with the industry extends the ability to study and provides new perspectives of researchers of PRI analysis (Gulbrandsen and Smeby 2005; Zucker and Darby, 1996). In this perspective contrasts with that of scholars, however, argue that relations with companies

create a scattering of interests and the expulsion of PRI from basic research (Gluck et al., 1987; Goldfarb, 2008; Senker and Senker, 1997). The authors believe that the industrial support, conveys to research projects that require greater applicability and favors special interests at the expense of the community. Other studies provide a mixed perspective of the effects of the PRI-undertaking over scientific production (Blumenthal et al., 1986a and b; Geuna and Nesta, 2006). Seashore-Luis et al. (2001) conclude that researchers engaged in entrepreneurial activities are very productive due to the availability of funds and of importance inside the RPE. Meyer (2006) comparing the publication and citation of scientific researchers with industry-related ones that are not a time-saver. Researchers-inventors are most prolific in terms of publications due to their position of centrality in national networks of innovative development (Meyer, 2006; Azagra-Dear et al., 2006).

Cooperation agreements between PRI and companies allow PRI to get funding for research projects involving private operators since the early stages of project development. On the other hand, private operators participating in the project can be involved from an early stage and participate in the definition of strategies to follow. This way of working allows the public research institutions to obtain funding for their activities, to increase knowledge and investing in high-yield projects and public authorities to promote research and development. The procedures to be followed in defining these arrangements depend on the legal framework in force in each centre (Bozeman et al., 1978). Cooperation agreements include, generally, the definition of the research project and the results to be achieved. The contributions of the PRI are represented by activities of researchers and from the sale of the right to use the technology, while private companies provide funding and operational support (Brown et al., 1990). In the case of activities carried out jointly by various bodies is necessary to define in advance the allocation of property rights on results generated by the collaboration. Finally, if the cooperation between the parties is extended to the marketing of the results generated by the creation of a new company, you must define the transfer of rights of economic exploitation to the new entity (Blundell et al., 1995).

More structured forms for the transfer of knowledge to use patents. A patent is a right granted by a State monopoly on technology in Exchange for sharing by the inventor. In the absence of complete information on formal and informal relationships between universities and businesses, the patent data are used as main indicators of knowledge transfer is to evaluate the temporal evolution and to make international comparisons. Since the 80's, the number of international patent applications made by PRI was steadily increasing, except for a decline in 2009 due to general economic conditions. Most innovations have been made by developed economies as the United States, Japan, Germany, France and United Kingdom. Among the countries with rapid development, China has been the leading innovator, followed by Brazil and India. The positive trend of China can be explained by significant investments in University of the last decade. In the case of India, the national public research body, Council of Scientific and Industrial Research (CSIR), is the main responsible for most of the innovations. In patent law, much attention should be paid to specific technology-based inventions subject of studies published earlier by the same public research body (Williams and Gibson, 1990). In fact, technology to be patented must offer innovations that aren't obvious to an expert in the field and which cannot be inferred from a combination of previously published information.

The application of industrial technology implies that it must be implemented in a product or used in an economic activity and does not remain purely theoretical (Danneels 2002, David and Foray 1995, Fagerberg et al., 1997, Freel, 2005, Georghiou, 2007, Geroski, 1990).

The patent is probably the most appropriate mechanism to protect a particular technology in a market. The obtaining of a patent provides the right to exclusive use for a limited time within a specific geographic area. It prevents a third the use and exploitation of the protected technology and offers the owner the time needed to introduce the technology in the market and exploit it for economic ends. Giving to the inventor the exclusive right to the exploitation of the technology invented, the patent represents an incentive to innovation and like any other titles of property can be sold or licensed (Bresnahan et al., 2001). The patent is granted by the State, and it is therefore necessary to extend the patents in the various countries where they want to protect the technology developed. The European patent was born from the desire to extend the protection of an invention in different European countries, giving each of them the competence to resolve any issue. The European patent offers protection in approximately 20 countries at the same time. If you select the European path, the European Patent Office (EPO) relationship with the public opinion within 18 months from the date of initiation of the procedure and subsequently opens a six-month period to pay the taxes in the countries covered by the European patent. The transfer of technology to third parties through sale of patents and licenses is a mechanism through which the Research Institute takes a passive role in the exploitation of research results, because its activity is limited to the functions of control and protection of his interests (Arnold, 2004).

With the creation of a new entity through spin-off process the

PRI may take a more active role in the process of commercialization of the technology. The researchers who developed the technology in a public research body promote the creation of a start-up in order to handle the direct marketing of the technology. The creation of a spin-off from an PRI is a mode that receives support from the Government because it encourages the development and generation of new businesses in the field of innovation. However, the fact that the researchers combine their activities in the Center with that in the new company can lead to a potential conflict of interest between the activity (Cavaye, 1995). Therefore, research institutes tend to develop internal protocols for creating companies by researchers, enabling them, within the existing legal framework, to manage participation in spin-off compatibly with activities for the Research Institute. The creation of the company requires the transfer of rights of use and exploitation of research results. As a mechanism of compensation for such transfer, it can be agreed that the institution participates in the company's capital and its profits. The research institution can participate in the new company to exploit the technology developed within his organization (Gopalakrishnan and Damanpour, 1997, Gosselin, 1997, Grant, 2003, Greer and Liao 1986, Griliches, 1957, Gupta and Govindarajan, 1984, Russell and Russell, 1992, Santos and Alvarez-Gonzalez, 2007, Coe et al., 2008). The literature shows that the spin-off of PRI tend most likely to commercialize radical innovations. The ability of RPE to create businesses depends on transfer strategy and the marketing channels of technology. The creation of businesses requires not only the participation of researchers, but also the involvement of entrepreneurs (Daft 1978, Damanpour 1991, 1996, 2010, Damanpour and Gopalakrishnan, 2001). Several large companies have arisen as a spin-off facilitated by academic technology transfer offices (Bozeman and Crow, 1991).

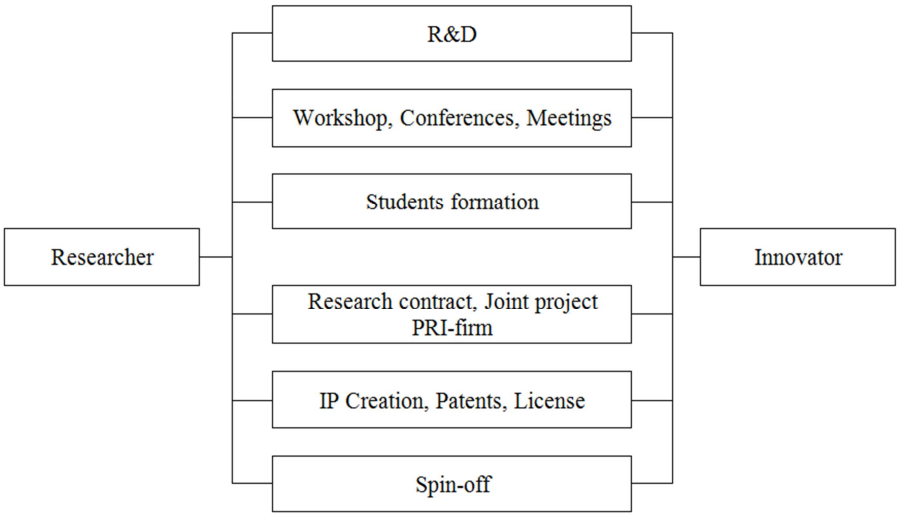

Figure 2. Technology creation and transfer.

4. Innovation Diffusion

When a new technology is implemented in a new or significantly improved product, process, marketing or organizational method in business practices, workplace organization or external relations we can identify an innovation. Product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses (Chen and Puttitanun, 2005). This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Marketing innovation is the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing. Organizational innovation is the implementation of a new organizational method in the firm's business practices, workplace organization or external relations. Innovation diffusion is a process by which an innovation is transferred within and across economies (Stoneman, 1989, Karshenas and Stoneman, 1995). Diffusion is, thus, the process through which innovations spread, through market or non-market channels, from their first worldwide implementation to different consumers, countries, regions, sectors, markets, and firms. Without diffusion, an innovation will have no economic impact. The minimum entry for a change in a firm's products or functions to be considered as an innovation is that it must be new to the firm. This process is composed of many activities (Leonard-Barton and Rogers, 1981).

Innovation activities are all scientific, technological, organizational, financial and commercial steps which lead to the implementation of innovations. Some innovation activities are themselves innovative; others are not novel activities but are necessary for the implementation of innovations. Innovation activities also include R&D that is not directly related to the development of a specific innovation. The innovative activities of a firm partly depend on the variety and structure of its links to sources of information, knowledge, technologies, practices, and human and financial resources. Each linkage connects the innovating firm to other actors in the innovation system: government laboratories, universities, policy departments, regulators, competitors, suppliers, and customers. Innovation surveys can obtain information on the prevalence and importance of different types of linkages, plus the factors that influence the use of specific linkages.

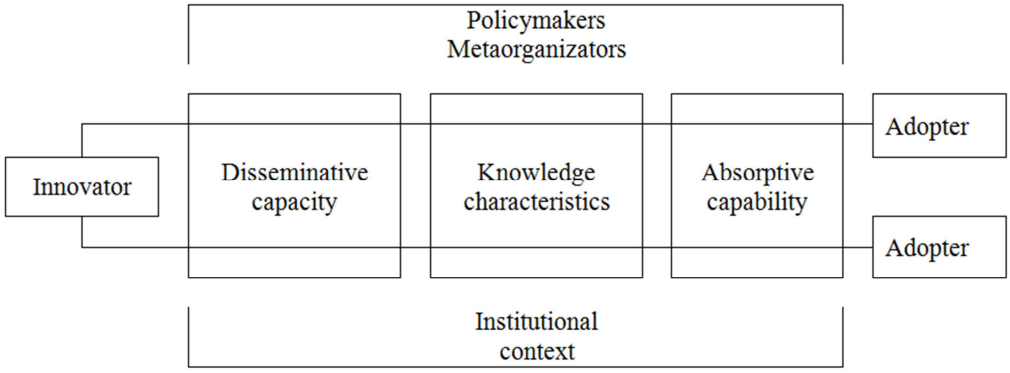

Figure 3. Innovation diffusion and adoption.

Innovation diffusion process is impacted by legal, physical, technological as well as socio-economic and cultural factors related to the contest. It is also impacted by individual determinants such as psychological aspects of innovators and adopters that are uncontrollable by the marketer and by controllable factors which are in the hands of the marketer (Brouwer and Kleinknecht, 1997). Apart from these, researchers have identified characteristics of new technology that can act as triggers to the diffusion and adoption process. Relative advantage, compatibility, complexity, trialability, and observability of innovation affect the diffusion process and influence adopters' acceptance of it (Izsak and Edler, 2011; Karagozoglu, 1993; Kollmer and Dowling, 2004). First of all, the relative advantage of the innovation over already existing products or services, and its perception by potential adopters accelerates its rate of adoption by the target market. Secondly, the compatibility of the innovative product and service with the existing structures of adopters also affects its adoption (Buchko, 1994). An innovation would be diffused more quickly if it does not require adopters to change their previous structure and system of production. Another factors that affect innovation diffusion is the level of complexity in a product and its usage. An innovation would be easily diffused when there is ease of understanding, purchase and use. Moreover, the higher the degree of trialability and observability, the greater would be the rate of diffusion (Rolfstam, 2005; Rosenberg, 1972; Ozsomer et al., 1997).

This is because the prospects get an opportunity to try the product/service benefits and decide to accept or reject it. There are also certain factors that negatively affect diffusion of innovation and subsequently the adoption process (Chenhall, 2003). These barriers could range at the micro level from product characteristics, to the more macro, socio-cultural, economic, situational and technological forces. While product characteristics like relative advantage, compatibility, trialability, and observability, do boost the rate of diffusion and adoption, perceived complexity in purchase and usage of innovative offerings, retard the process. Innovations could also meet resistance from socio-cultural, economic, situational and technological forces. The innovative offering may not with compatible with social norms, values and lifestyle or may not go well with the economic strata or be technologically complex, leading to fear to usage, obsolescence and risk. Several barriers are likely to affect process of innovation diffusion (Stoneman, 2002, Rogers, 2003, 1995, 1976; Zahra and Nielsen, 2002; Hall and Khan, 2003). To overcome these barriers, policy-makers pursue a wide variety of policy measures to promote or accelerate technology diffusion (Scott, 1999; Fagerberg 1994, Fagerberg et al., 1997). Specifically, Government plays an important role in the process of innovation diffusion in defining general policies, in applying measures to support supply and demand of innovation and becoming itself the main acquirer of an innovation (Lundvall and Johnson 1994; Rothwell and Zegveld, 1988, von Hippel, 1976; Mowery and Rosenberg, 1979; Edquist et al., 2000; Edler and Georghiou, 2007).

5. Conclusion

Technology transfer and diffusion process directly increases the productivity of actors involved in the process and indirectly raises economy-wide productivity through its diffusion and adoption (OECD, 2013). Diffusion leads innovation to be available for use in relevant applications through adoption by firms who in turn improve their profitability leading the whole system to a higher level of efficiency.

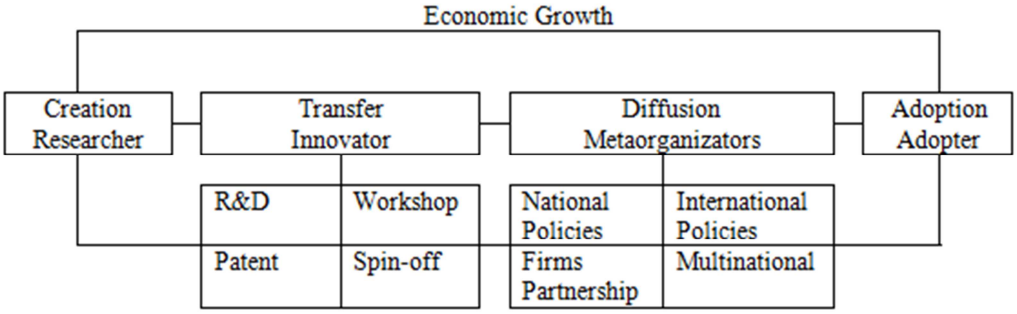

Figure 4. Factors affecting technology transfer and diffusion process.

Researchers provide some empirical evidences of this relationship between innovation process and economic success at both the macro (country) and micro (firm) level. Given the relevance of innovation diffusion process for the economic success, at both country and firm level, policy-makers intervention in supporting innovation diffusion is a task of high interest for researchers and policy makers.

The realization of these potential productivity gains can be helped by policies that either directly encourage technology development and diffusion or seek to remove general, demand and supply-side barriers to such activities.

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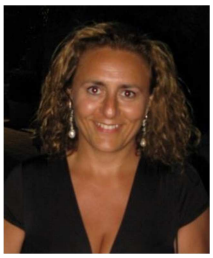
Biography



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