A COMPLEX SCIENTIFIC ATTEMPT ON INNOVATION FROM A MULTILEVEL PERSPECTIVE

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Abstract
Innovation is a concept adopted in so many domains and in such different forms that it became increasingly more difficult to understand and apply. The number of performers involved in the innovation process and the number of forms in which they can manifest their involvement is growing. This article aims to identify the main levels and types of performers involved in the innovation system and so to create 'a bigger picture'. Innovation becomes "everyone's job" in the entire society, and the current research provides an instrument to zoom in on a certain level of innovation to simplify its understanding. Innovation is not limited to new technology or new products and is not only a company's activity, but rather includes several interrelated parts from micro level – as the important role of each individual to a macro level – as the intergovernmental organizations or continental unions. Realizing an integrative study of the research literature and using a multi-level perspective, the paper identifies more clearly the role that different performers have in the innovation system and provides further insight on this phenomenon.

Keywords: innovation system, multi-level perspective, business innovation, policy innovation, social innovation

JEL Classification: O30, O35, O38, M10

Introduction

From 1967, Jack Morton, vice-president at Bell Telephone Laboratories, referred to innovation as 'not a simple action, but a total process with several interrelated parts'. This fact is obviously at the organizational level as highlighted by Michael Schrage, once with the increasing importance that organizational knowledge and employees skills have in the innovation process of a company. Thus, there is more emphasis put on 'who' than on 'how' (Scharge, 2016), innovation becoming a responsibility for each employee. The entire process is transformed from an activity to an attitude that employees must manifest by creating value and improving their working environment.

If at the company level things are obvious, when it comes to other performers involved in innovation system, things are not so clear anymore. In practice, the innovation attitude has many ways of expression depending on the level at which it is addressed. The research question that this paper aims to answer is: *Which are the main performers in innovation and which are the roles for each of them?*

Literature review

Gupta et al. (2007) distinguish between five different levels of innovation and specific activities performed at each of these levels: individual, group/team, organization, industries and geographic regions. A different multi-level perspective is the one according to which the evaluation of innovation performance is based on the level at which the activity is developed. This approach would have a significant impact on formulation and implementation of innovation policies at different stages and moments of the innovation process, distinguishing between two different classifications: national, regional, sectorial level or macro, meso, micro level (Carayannis et al., 2016). The evaluation of innovation performance is a difficult task considering the limited number of variables that are available and that can be used in studies on this topic. Often, specific activities that are considered innovation can be hardly or not at all quantified. In most studies, as summarized by Carayannis et al. (2016), the level of innovation performance at national or regional level is analysed using variables such as R&D expenditure and patents. The representativeness of these variables is reduced considering the following two aspects: (1) are limited to identify technological innovation that involves R&D activities or product innovation, without having the capacity to reflect other forms of innovation such as business model innovation, organizational innovation, marketing innovation or process innovation; (2) the number of patents shows rather the ability of companies or individuals to register their inventions than the degree and their ability to innovate.

Innovation can occur in many forms, for example as in the case of a new business model which cannot be patented and not necessarily supposes R&D. At the same time the new business model creates value and is a form of innovation, as in the case of marketing or organizational innovation that are in the same situation. Moreover, innovation sometimes may suppose especially process innovation as happens in the petroleum refining industry or especially product innovation in the pharmaceutical industry (Cohen & Klepper, 1996). Not only the industry in which they operate impacts the development of particularly forms of innovation, but also the firm size represents an important determinant, on this subject being conducted several studies. Among the most recent ones, the one made by Lee & Kim (2016) points out that small firms are more flexible and more oriented towards market-driven innovation, while larger firms are more rigid, sometimes with some routine elements installed between departments, being more oriented towards technological innovation.

Research Methodology

It is well known among innovation researchers that product innovation is the most visible form of innovation, generating emotional effects and also influencing customers' perception on the value of innovation (Rindova & Petkova, 2007). Most often product innovation is the result of a company, which manages to create value and to sale a new technology. This is the main reason why the central role in innovation system is assigned to companies (Etzkowitz & Leydesdorff, 2000). Using the iceberg theory, product innovation

in the entire innovation activity of a firm represents only the visible part. Thus, it captures most of the attention and interest both in practice and among researchers.
The current paper aims to bring a complementary perspective to the research carried out so far in the innovation field, contributing through an integration of several concepts and dimensions to a better understanding of the innovation process in its entirety.
Starting from the multi-level research conducted by Gupta et al. (2007) and Carayannis et al. (2016), there were established four levels of interest, considered representative for this research: (1) individual; (2) organization – research institution, company, public agencies, NGO's; (3) regional/national; (4) international. This hierarchy provides a broad perspective on innovation from a micro to a macro level, aiming to identify the main performers and to highlight their different roles.
The research method used was a comprehensive literature review, which involved selecting a number of relevant articles, necessary to understand the main forms of innovation at each level mentioned above. Articles selection was done using the Web of Science database provided by Thomson Reuters, using at the same time citation metrics criteria and also specific periods of publication. In this way there were ensured both the representativeness of the scientific discoveries and their evolution in time.
Summarizing a number of different perspectives, focusing on each part of the innovation system, this paper brings a more comprehensive and a clearer perspective on 'the bigger picture' just to have a proper understanding of innovation and of all its parts.

An integrative perspective on innovation

It is important to properly understand innovation, considering all these issues and to use specific actions depending on the level at which it is addressed. If a small company understand by innovation, especially technological innovation, product innovation and R&D activities, it may conclude that it doesn't have the capacity to innovate. In this case, the problem could be an inappropriate positioning in relation with its level, that leads to a misunderstanding of the innovation activity. The solution for such situations would be a correct positioning and a proper understanding of the role that each performer has in the innovation system.
For instance, at national level, innovation may refer to the improvement of the competitiveness level, in an university or a research institute innovation may suppose discovering a new theory, creating knowledge, inventing a new technology or new materials, while in a company it could be more useful borrowing or adopting new practices or technologies than inventing new ones (Cohen & Levinthal, 1990). Thus, is necessary to develop a multi-level perspective in understanding the innovation phenomenon as summarized below.

Table no. 1: Understanding innovation at the appropriate level – performers and their roles in the innovation system

Level/performer	Innovation methods/roles/understanding	Study
Individual	At this level innovation refers to creating or improving specific **skills**, as:	*Individual innovation*
	problem-solving	Von Hippel, 1994

	learning-by-doing, innovating-by-doing,	Nilsson, 1995
	learning orientation	Calantone et. al, 2002
	divergent thinking, critical thinking	Scott et al., 2004
	creativity, design thinking	Gupta et al., 2007
	attitude - create value or improve processes	Scharge, 2016
Organization		
Research institutions (Universities, Research institutes, etc.)	At this level innovation refers especially to **knowledge production**:	*Innovation in science*
	Research & Development - practice of scientific discoveries, isolation of gaps in fundamental knowledge	Zvegintzov, 1968
	Extra-industry technological knowledge (complements and therefore leverages the firm's own knowledge)	Cohen & Klepper,1996
	Develop human capital (researchers, younger generations' competences and mind-set), creating new theories or developing existent ones, newly created disciplines, incorporating knowledge in patents, inventions	Etzkowitz & Leydesdorff, 2000
	Develop critical technology science (materials science, nanotechnology, etc.)	Etzkowitz & Leydesdorff, 2000
	Universities will become hubs of knowledge and innovation	Schaeffer, V. & Matt, M., 2016.
Companies	At this level innovation refers particularly to **knowledge commercialization**:	*Innovation in business*
	integrating knowledge, knowledge application	Grant, 1996
	increasing the absorptive capacity	Cohen & Klepper,1996
	transforming technological innovations into business opportunities, using technological change to create new processes, new products, new markets, new ways of organizing	Shane, 2000
	value creation, applying new business models, creating a competitive advantage, improving dynamic capabilities	Amit & Zott, 2001
	open innovation - use external source of knowledge and R&D, sale of know-how (patenting, licensing, etc.), collaborate in innovation	Chesbrough, 2003; Ghisetti et al., 2015
particularities for **Start-ups, SME's**	focusing on market-driven innovation, with a simple structure and an increased flexibility they can more easily adapt to their consumers' needs	Lee & Kim, 2016

Big companies	better able to develop their own R&D - background knowledge that would permit them to exploit rapidly useful scientific and technological knowledge, deeper understanding useful for exploiting new technical developments	Cohen & Klepper,1996
	better able to develop technological innovation	Lee & Kim, 2016
Public agencies - Patent Offices	At this level innovation refers especially to **knowledge protection**:	
	Protecting intellectual property rights – patents, trademarks, etc.	Picard de la Potterie, 2013
NGOs	At this level innovation refers especially to **fulfilling social needs**:	*Social innovation*
	promoting partnerships and participation, advocating for certain principles in society	Fyvie, C. & Ager, A. 1999
	social entrepreneurship - meeting emerging social demands, helping people in need and developing non-profit activities, helping people to adapt trends	Defourny & Nyssens, 2013
	civic entrepreneurs working in collaborative arenas to improve the resilience of specific communities, assuring equity in society	Defourny & Nyssens, 2013
National level	At this level innovation refers especially to improving the **legal framework** and **financing innovation**:	*Public innovation*
	National System of Innovation (frame for government interventions), Triple Helix (university-industry-government relations)	Etzkowitz & Leydesdorff, 2000
	financing innovation - support of national governments for the development of a new technological trajectory, support with founds academic research, stimulating the procurement of advanced technologies	Etzkowitz & Leydesdorff, 2000
	industrial competitiveness and economic growth, trade performance and specialization patterns, increase productivity	Castellacci, F. 2008;
	'policy mix' for innovation, appropriate government policy intervention for encouraging innovation	Castellacci, F. 2008; Flanagan et al., 2011
Regional level	involvement in clusters, linking industries and building collaboration networks and strategic alliance	Porter, 1998
	decision-making process for the various domain	Țarțavulea (Dieaconescu et al., 2016

	developing a systemic innovation policy mix	Iosif & Tăchiciu, 2016
International level **Intergovernmental organization** (e.g. ONU, OCDE, NATO) and **Continental unions / supranational unions** (e.g. EU, African Union)	At this level innovation is refereeing especially to assuring the **international cooperation** and **responsible innovation**: economic growth, the development of a new technological trajectory invokes the support of international levels promoting sustainable development - responsible innovation, democratic governance of emerging science, ensuring political/military stability transformative change cross-border knowledge transfer and innovation through partnerships, cooperation and international ties, globalization, intellectual property rights protection	*Responsible innovation* Etzkowitz & Leydesdorff, 2000 Owen et al., 2012 Weber & Rohracher, 2012 Jandhyala & Phene, 2015

Progress requires a good cooperation between all these performers and appropriate understanding of their activities. Furthermore, each entity should assume its role and make all the efforts to achieve the best performance through specific methods for its level as a contribution to the functioning of the innovation system.

Conclusions

Innovation is not anymore a simple action, there are more and more performers involved in this process and in many different ways. Recently is put more emphasis on attracting as many people as possible in the innovation process, given that innovation is directly related to knowledge.

Innovation is not only a result of companies and is not just knowledge commercialization, R&D, new technologies and patents. Everyone can innovate in many ways and at different levels: (1) at the individual level through learning orientation, creativity and attitude; (2) research institutions by creating new knowledge, developing human capital; (3) firms by developing new business models, improving process and involving in collaborative networks; (4) NGOs through social entrepreneurship and civic initiatives; (5) at regional or national level by adopting appropriate governmental policies, financing innovation and increasing competitiveness; (6) intergovernmental organizations and continental unions by responsible innovation, cross-border knowledge transfer and economic growth.

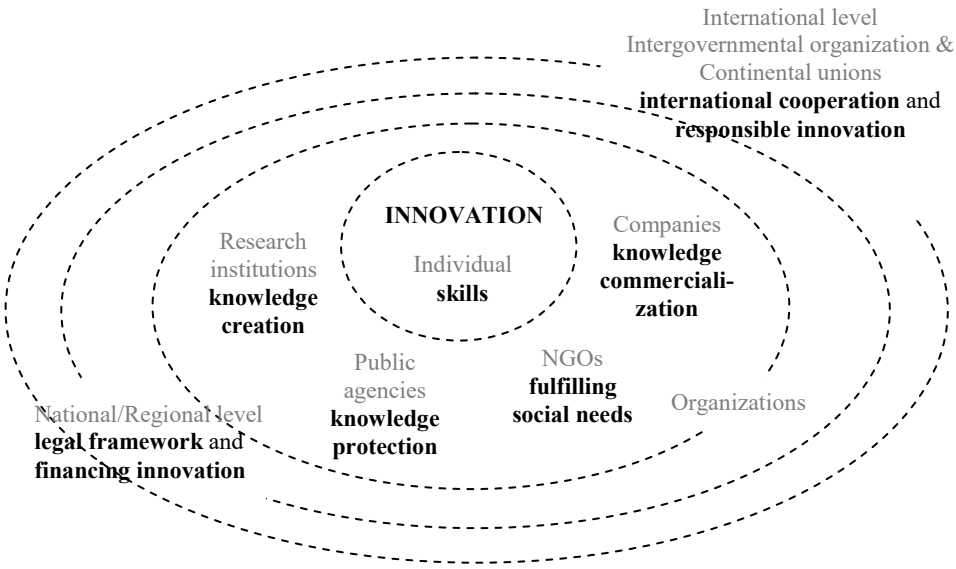

Figure no. 1: Roles of innovation performers

Improving performance at each of these levels is the only way in which innovation may lead to further sustainable development. This paper contributes to clearly define the role of each innovation performer, making it easier to see innovation as <everyone's job> and not only in a company, but in the entire society. Another role of this paper was to 'increase the level of understanding of the innovation complexity, offering the possibility to zoom in and out', by focusing on a specific level of innovation and by understanding different innovation forms.

This study can be further developed and may be useful in providing a new perspective on the dimensions of innovation and how to assess its performance, taking into account different results recorded at each of these levels.

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