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University-Industry interaction for a sustainable energy system:

The case of smart grid technologies

Introduction

The sustainability challenge that our society is facing associated with the increase of electric demand require a radical transformation of the electric sector. The change of paradigm that is required is toward a Smart Grid, defined as "an electricity network that can intelligently integrate the actions of all users connected to it - generators, consumers and those that do both - in order to efficiently deliver sustainable, economic and secure electricity supplies" (European Technology Platform SmartGrids, 2006). The development process of smart grid paradigm could be investigated from different, yet intertwined, perspectives (i.e. institutional, technological, managerial). In our paper we'll go in depth about the technological perspective, and in particular we will focus on the role of different actors (academic/research institutions and industry sector) involved in the development of smart grid technologies. In this context, the theme of interaction university and industry is, in our opinion, an interesting analysis perspective and it could shed light on the evolution dynamic of related technologies.

Collaboration between universities and industry, aimed at the transfer of technical and scientific knowledge to the economic system, is now considered a crucial factor for the competitiveness and Economic Development (Etzkowitz, Leyde-sdorff 2000; Cooke et al., 2004; Bonaccorsi, Daraio 2007). Starting from the literature that higligthts he role of University-Industry collaborations in the development of new technology and innovation processes, objective of the paper is to analyze the dynamics and determinants of interaction between University and industry in the smart grid technologies sectors. Using data from European Patent Office, we analyze U-I interactions in terms of co-generated patents and test an econometic model to measure the impact on collaborations of the three following

variables: the reputation of academic researchers; the openess of industry; the technological distance between University and Industry.

Our study contributes to the existing literature on university-industry relationship, and could have relevant implications for policy makers and university management in order to adopot adeguate policies aimed to stimulate collaborations to support the emerging paradimg of smart grid energy system.

Theoretical framework

Smart grid: the emerging paradigm in the electric sector

The Smart Grid is a difficult challenge to realize, that requires a global effort: all stakeholders must play a proactive role to achieve the ultimate goal. In particular Smart Grid development requires significant new investments and commitment mainly from the technological point of wiew. Many of technologies needed for smart grid are today available as separate elements and at differente maturiry stage. Further investments in R&D are required with the objective to reach the development level necessary to be used at a large scale. Then, the analysis of the interaction among the two main sources of technological development could, in our opinion shed light on the reasons why the new energy paradigm develops or fails to develop over time.

University Industry Collaborations

There is a general consensus in the literature (e.g. Hamel and Prahalad, 1994) that the development of innovation is strongly related to the organizations' capability to collect and manage knowledge, since its use and combination provide the creativity and the novelty necessary to move outside existing paradigms. In this perspective, the innovation process can be wieved as an open process, where complementary and heterogeneous inputs (pieces of knowledge) are transformed into outputs (results of innovations) (Katz and Khan, 1996).

It is also commonly accepted that universities are important sources of new knowledge, especially in the areas of science and technology (Rosenberg and Nelson, 1994; Nelson and Rosenberg, 1998; Etzkowitz and Leydesdorff, 2000). Other studies show the limited cacapcity of university to translate the excellent results from European research into innovations that are successfully destined for the marketplace (Abramo et al., 2009). Several studies have empirically showed the superior ability of industry actor in the applications of knowledge to economic sector and in the esploitain processes of new knowledges and technologies (Cohen and Levinthal 1989, 1990). Thus, researchers have devoted a great attention to investigate the nature and the importance of the relationships between university and industry, trying to build a clear picture of which mechanisms may favour universities and firms interaction, thus promoting knowledge transfer and acquisition (Etzkowitz, Leyde-sdorff 2000; Cooke et al., 2004; Bonaccorsi, Daraio 2007; Shane 2004; Thursby and Thursby, 2003; Mowery et al., 2001). A better comprehension of university-industry links has assumed a great importance also at policy level, as shown by the several initiative launched by the European Commission to proactively enhance the transfer of technological knowledge from university to industry and identify effective and efficient innovation policies. The importance for both parties, University and Industry has been well documented (Owen-Smith and Powell, 2003) as well as the role of collaboration for both parties ((Meyer-Krahmer and Schmoch, 1998), the differents forms of collaboration (Cohen et al. 2002; D'Este and Patel, 2007; Faulkner 1994) and the factors leading universities and firms to fruitful collaborate (Debackere and Veugelers, 2005; Veugelers and Cassiman, 2005; Rothaermel et al., 2007).

Research methodology

Starting from these premises, the objective of the paper is to analyze the dynamics and determinants of interaction between University and industry in the European Smart Grid

sectors. Using data from European Patent Office, we analyze U-I interactions in terms of co-generated patents between scientific research and industry (Lissoni et al., 2008) and test an econometic model to measure the impact on collaborations of the three following variables: the reputation of academic researchers; the openess of industry; the technological distance between University and Industry. Co-generated patents see university researchers as the inventors and firms as owners of commercial exploitation rights, often representing the outcome of joint research projects. Investigations of university initellectual property have ranged from textual exegesis of matched scientific publication and patents (Myers, 1995) to sophisticated economietric analyses of the total factor productivity of university licensing endeavors (Thursby and Thursby, 2002). There are numerous advantages to the use of patent indicators (Pavitt, 1985; Basberg, 1987; Griliches, 1990; Hall et al., 2005): patent documents contain highly detailed information on content and ownership of patented technology; they cover a broad range of technologies; patent data are 'objective' in the sense that they have been processed and validated by patent examiners; and patent data are publicly available. European patent data are preferred to the more commonly used data from the United States Patent and Trademark Office (USPTO): the cost of patenting is two to five times higher at the EPO than at the USPTO; and the EPO has a 20–30% lower patent-granting rate than the USPTO (Van Pottelsberghe de la Potterie and Francois, 2006; Quillen and Webster, 2001; Jaffe and Lerner, 2004). The use of co-generated patents as a proxy to evaluate innovation is well documented in the literature (Cerrato et. al., 2012; Belderbos et al., 2014; Messeni Petruzzelli et al., 2014). In a second step of the resarch, we investigates the effect of 3 types of factors on the co-generation of patents between research and industry in the european smart grid energy system: the quality of basic research of teachers-inventors measured on the basis of the number of citations for each of them; the degree of open-innovation of firms, measured by the number of collaborations; the technological relatedness. This is evaluated by means of

the degree of overlapping between the organizations' technological bases, in terms of technological fields in which they patent. In particular, in this research the technological similarity is measured using the patent technological class (Jaffe, 1986). Then we test the following hypotesis:

Hp 1: the probability to co-generate a patent is positive linked to the quality of base research.

Hp 2: *the probability to co-generate a patent is positively linked to the degree of openess of firm.*

Hp 3: *the probability to co-generate a patent is positively linked to the technological relatedness between university and firm.*

Conclusions and implications

Even if there is no impact on the incentive to produce knowledge per se, patents may usefully facilitate the commercialization of that knowledge and help to bridge the university-industry divide. Patents may contribute to the effective functioning of the market for ideas (Merges and Nelson, 1990, 1994; Arora et al., 2001; Gans and Stern, 2000), as well as enhance the incentives and efficiency of the process by which academic researchers search and match with potential downstream partners (Kitch, 1977; Jensen and Thursby, 2001; Hellman, 2007).

We believe that our findings will inspire academic scholars and policy makers to further examine the value-creation opportunities of co-patenting and collaboration arrangements. In addition, we trust that our insights will help practitioners to further optimize their collaborative IP strategies with different types of partner.

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