



Tracing the flows of knowledge transfer: Latent dimensions and determinants of university–industry interactions in peripheral innovation systems



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ABSTRACT

Firms interact with universities through a variety of channels, ranging from collaborative research projects, patents, spin-off creation, consultancy and specialized training, to informal relationships. This article explores the combination of mechanisms used by firms in Andalusia, a peripheral region in Spain and Europe, when interacting with universities. Using information from a survey of 737 innovative firms, the empirical study found evidence that university–industry links can be grouped into five latent dimensions (knowledge generation and adaptation, involvement in new organisations, training and exchange of human resources, intellectual property rights, and facilities and equipment) which are mainly based on exploitation or exploration activities. A typology of firms was created, highlighting the large number of firms with no interactions, and six clusters that specialize in specific mechanisms (IPR exploiters, Institutionalized interactors, University facility users, Training and education beneficiaries, Tacit knowledge users, and R&D interactors). The study also presents the determinants for engaging in each type of channel, concluding that whilst firms developing exploitation activities also develop parallel exploration activities, the reverse is not significant. The absorptive capacity of firms is important in determining the type of interaction, but is not fully conclusive about the range of exploration and exploitation activities. The article ends by discussing the policy implications associated with incentives to adapt knowledge transfer mechanisms to the industrial fabric of peripheral innovation systems.

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1. Introduction

Peripheral innovation systems¹ have greater difficulty in transforming R&D and higher education endeavours into economic benefits. Even though this problem is not uncommon in many innovation systems, less developed regions and countries fall behind both in terms of business innovation and absorptive capacity (Cooke and Piccaluga, 2004). Their industrial structure is often concentrated in low or medium-technology sectors and services. Low and medium-technology industries play a relevant role in innovation, particularly in terms of employment and production (Hirsch-Kreinsen, 2008). Consisting mainly of small firms and with few large technology users in the local markets, R&D investment in these systems is dominated by the public sector. The research personnel and scientific facilities are also concentrated in the public sector,

especially in universities. Although it is more acute in peripheral systems, this difficulty in translating scientific results into the market in the form of innovation is well recognised in the European context, leading some to consider it a European paradox (although the extent to which this difficulty is linked to leadership in science, thus creating the so-called paradox, is disputed; cf. Dosi et al., 2006). As a result, governments are rethinking how to maximize benefits from higher education and public research organisations for skills and development (OECD, 2007).

In the innovation systems which are lagging behind, it is particularly important to understand how universities can contribute more effectively to the innovation process in firms. It is also important to establish evidence to support appropriate knowledge transfer policies. A body of literature has emerged on the factors and motivations that lead firms to draw on knowledge from external sources. Several studies have addressed the propensity of firms to establish links with universities and how such links are related to innovation (Belderbos et al., 2004; Laursen and Salter, 2004; Mora-Valentín et al., 2004). Although it is important to note that universities are ranked low as a source of innovation in comparison with other actors, such as suppliers and business partners (Perkmann et al., 2013), it has been found that knowledge transfers from regional universities may enhance the capacity to

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¹ In this article the notion of peripheral region is related to the absence of industrial agglomeration, implying the existence of an industrial fabric composed of many SMEs with low absorptive capacity.

innovate (Cohen et al., 2002; Uyarra, 2010; Larsen, 2011). Some studies have explored the influence of structural and behavioural factors on the probability of firms seeking out and applying knowledge from universities (Carayol, 2003; Arundel and Geuna, 2004), although, in general, they fail to differentiate between types of knowledge flows and consider university–industry interactions as a homogeneous whole (Jaffe, 1989; Laursen and Salter, 2004).

Another body of literature has dealt with the nature and mix of links through which collaboration takes place (Gulbrandsen et al., 2011). In comparison with the general motives and barriers to university–industry collaboration, forms of engagement have been investigated to a lesser extent. These studies show that knowledge transfer occurs through different channels, pathways or mechanisms (Schartinger et al., 2002; Bekkers and Freitas, 2008) which differ in terms of the level of formality and capacity to transmit codified or tacit knowledge (Bruneel et al., 2010). Nevertheless, much of the attention has focussed on describing channels and exploring conditioning factors. One gap in this field is the fact that there are few studies on the recombination of specific forms of collaboration by firms with different profiles, despite the acknowledgement that mechanisms should not be studied or promoted in isolation (D'Este and Patel, 2007; Perkmann and Walsh, 2007). Technological cooperation and other types of research links are beginning to be studied as “alliance portfolios”, as firms combine strategically different but often complementary horizontal and vertical types of mechanisms to broaden their pool of competitive opportunities (Duysters and Lokshin, 2007). Focussing on comparing discrete channels may thus be misleading, as collaboration may entail the use of several channels simultaneously (Levy et al., 2009). The recombination of different channels may provide useful insights into specific forms of knowledge transfer. Nevertheless, it is difficult to systematically observe all the forms of relationships and, at the same time, study the impact of firms' characteristics on their inclination to collaborate.

This article contributes to studies on knowledge transfer between universities and firms by analysing the mix of transfer mechanisms in a peripheral innovation system. By observing the role of specific channels used by firms when collaborating with universities, the study creates a typology of firms according to the combination of channels, and explores the characteristics that shape specific modes of knowledge transfer. The study is based on a survey of 737 innovative firms in Andalusia, a Spanish region with an extensive public higher education sector and a diversified industrial fabric characterized by a predominance of SMEs, an important service sector and a low and medium-tech manufacturing presence. A questionnaire, administered in 2009 to a sample of firms reflecting the variety of sectors, size and innovative profiles in the region, contains a set of questions that deal with various forms of interaction with universities, thus addressing the research gap identified above.

The article is organised into five sections. Following this introduction, Section 2 presents the theoretical and empirical background. Section 3 sets out the study's strategy and presents the hypotheses on the combination of different knowledge transfer channels between universities and industry. Section 4 describes the data source, fieldwork, sample characteristics, and variables used in the survey. The results are presented in Section 5. Using a descriptive analysis, the study follows three analytical steps. Firstly, a factor analysis is developed to identify the patterns underlying the variety of relations. Secondly, a typology of firms is proposed through cluster analysis. Thirdly, the profile of each cluster is analysed through an econometric estimation of the determinants of the channels used by firms. The conclusions section highlights the implications for the literature on industry–university interactions and presents policy options for peripheral innovation systems.

2. Theoretical and empirical background

Universities have often been described as “the driving force behind growth”, as they generate educational capacities, skills and knowledge that are central to innovation, particularly in certain industrial sectors

(Mansfield, 1998). Comparative studies have highlighted the relationship between industrial investment in R&D, innovation and university–industry collaboration, with micro-level research finding that university–industry collaboration is central to this process (Fritsch and Schwirten, 1999; Löf and Heshmati, 2002; Belderbos et al., 2004). Governments and research agencies have been supporting the development of university–industry relationships, with the aim of promoting the economic impact of university research (OECD, 2002; Mowery and Sampat, 2005).

Nonetheless, two important issues need to be taken into account: a) the impact of these interactions on economic development occurs through specific mechanisms, b) the propensity of firms to engage with universities depends largely on the composition of the surrounding industrial fabric. These are key points in the development of evidence-based innovation policies adapted to their specific contexts.

2.1. The diversity of university–industry relationships

Knowledge is embedded in different forms and circulates through multiple channels. Codified academic science is not easily transferred to other non-academic organisations (Pavitt, 2001). Many of the economic benefits of academic research are indirect rather than direct outputs of research, and are often unequally distributed amongst firms. The effects are not linear, but are often based on iterative processes within different types of mutually reinforcing relations, through the circulation of people, instruments and problems where tacit knowledge is of particular importance, in addition to formal knowledge (Salter and Martin, 2001). In this context some firms may find in local universities offer easier access to the pool of knowledge accumulated by academia due to their proximity and flourishing personal relationships (D'Este and Iammarino, 2010). As such, whereas public policies often focus on formal processes, relations between universities and firms are often informal and linked to personal interactions (Perkmann and Walsh, 2007). They emerge from common and overlapping interests and frequently develop through informally negotiated exchanges. Some studies reveal that the most science-intensive collaborative relations, such as patent exploitation, cooperative research and the creation of spin-offs, account for only a small share of the process (Agrawal and Henderson, 2002), especially amongst firms working on services and low or medium-tech manufacturing, which are central to peripheral innovation systems. It has been suggested that more open forms of interaction, such as occupational mobility or workshops, are important channels used by some firms (Cohen et al., 2002). Others use universities as providers of technical services or infrastructures in regions where these services are scarce and expensive. Moreover, universities provide the human resources and specialized training required to upgrade the technological capacities of local firms (Hall et al., 2000; Bonnacorsi and Daraio, 2007).

One useful distinction that has long been made in the literature highlights the difference between “knowledge exploration” and “knowledge exploitation” (March, 1991). The first usually refers to monitoring procedures aimed at detecting useful external knowledge. The second concerns the active use of a more specific knowledge source that can be directly appropriated by a firm. This distinction can be linked to university–company relationships. For instance, patent licensing and participation in spin-offs are more akin to exploitation activities. Personnel flows and subsidised joint R&D projects are closer to exploration activities, although contract R&D and collaborative research centres can be used for both purposes. However, both of these scenarios entail different activities. Firms that lack well-defined innovation needs for their production processes, as well as firms with an insufficient capacity to obtain knowledge internally, are usually expected to develop exploration strategies involving links with universities that differ from those occurring in a knowledge exploitation context. It is widely accepted that knowledge exploitation is related to certain firms that have the ability to understand and recombine knowledge with a high R&D content. In other words, knowledge exploitation and the generation of new knowledge can operate hand in hand (Zahra and George, 2002).

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