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Dynamic interactions between university–industry knowledge transfer channels: A case study of the most highly cited academic patent

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ABSTRACT

This paper examines the succession of formal and informal channels of university–industry knowledge transfer, and the local economic impact of their dynamic interaction. To do so, we investigate a highly cited university patent over an extended period of time through a case study methodology. Our work provides three fundamental insights. First, local economic impact can be achieved only after a complex, temporally unfolding sequence of interactions between formal and informal channels of knowledge transfer. Second, in the course of this dynamic interaction, knowledge generated during formal transfer activities may be transferred via informal channels. Third, the method developed can provide information on the variety of knowledge transfer channels related to highly cited patents.

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1. Introduction

Knowledge transfer in university–industry interactions can be either ‘formal’ or ‘informal’, depending on the presence or absence of a contract (Vedovello, 1997). Informal channels involve access to the pool of knowledge embodied in the expertise and equipment, and as well as the technical and scientific capabilities and needs, training, recruitment and/or allocation of qualified manpower in universities or firms in the absence of a contract. Formal channels imply contractually regulated exploitation of the knowledge, expertise and equipment available in universities and firms.

The study of formal and informal channels of knowledge transfer between university and industry has a long intellectual history in the field of Economics of Innovation (see Mowery and Ziedonis, 2015, for a recent literature review). Since the US Bayh–Dole act, which allowed US universities to register and license patents from public research, numerous studies have examined the licensing of university patents as a formal mechanism of knowledge transfer

between universities and industry (Mowery and Sampat, 2005; Grimaldi et al., 2011). Other formal channels, such as consulting (Roessner, 1993), have also been analysed. Informal channels studied include personal contacts between academic and industry researchers (Cohen et al., 2002; D’Este and Patel, 2007; Bekkers and Freitas, 2008; Ramos-Vielba and Fernández-Esquinas, 2012).

Nonetheless, less attention has been paid to the temporally unfolding, dynamic relationship among channels of knowledge transfer. One partial exception is the work by Faulkner and Senker (1994), who acknowledge the existence of temporal continuity among formal and informal channels, reporting that ‘informal linkage is often both precursor and successor of formal linkage’ (p. 680). Similarly, D’Este and Patel (2007) show that researchers with previous experience of one knowledge transfer channel are more likely to be involved in transferring knowledge through other types of channels in the future. Rappert et al. (1999) find that informal contacts among university and industry actors can create the trust necessary for formal engagement. However, this was not the focus of their work and was not further developed. Most of these works recognize a dynamic interaction among transfer channels without providing more detail, and they do not address the relationships in a temporal sequence of channels, i.e. whether the knowledge trans-

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ferred by one channel is related to the knowledge transferred using other channels.

Moreover, almost no empirical research deals with the relationship between the dynamic interactions of formal and informal channels and the localization of their economic impact. The assumption of these studies is that knowledge transferred through one channel has no relationship with knowledge transferred through other channels. A corollary of this assumption is that the study of local economic impact can be limited to only one transfer channel. However, this does not mean that the localization of formal or informal channels has not been studied in the literature. For example, there is some consensus that informal knowledge transfer from universities has a more pronounced impact on the local industry since it often depends on personal communication and social connections among inventors which are more sensitive to distance (Breschi and Lissoni, 2001; Singh, 2005). There is less unanimity regarding formal channels. Some studies show the importance of proximity in formal transfer channels such as licensing (Agrawal, 2006) and R&D contracts (Rosa and Mohnen, 2008). Others, such as Audretsch and Stephan (1996, p. 651), find that 'when knowledge is transmitted through formal ties between researchers and firms, geographic proximity is not necessary, since face-to-face contact [...] is carefully planned'. Nevertheless, few studies compare the localization of formal and informal channels. Mowery and Ziedonis (2015) compare the local impact of university patent licences and citations to university patents among three top US universities and find that formal knowledge transfer (patent licensing) is more geographically localized than knowledge transfer based on patent citations, but the authors do not disentangle the channels underlying patent citations. Survey-based studies find opposite results: either formal knowledge transfer channels can be more localized than informal channels (Arundel and Geuna, 2004), or the other way round (De Fuentes and Dutrénit, 2014). Nonetheless, they use cross-sectional data and do not account for a temporally unfolding, dynamic interaction among channels which would require a longitudinal analysis. To our knowledge, longitudinal studies addressing the localization of knowledge transfer are reserved for work on the evolution of patent citations, which show a decline in localization over time (Jaffe et al., 1993). Meanwhile, the localization of economic impact of a temporal sequence of knowledge transfer channels is left unexplored. In this paper we are interested in capturing the moment in a temporal sequence of knowledge transfer channels when the economic impact becomes local.

To address these gaps, we exploit a little used but promising case study methodology to examine the channels of knowledge transfer related to a highly cited university patent, being our research questions: Is the knowledge transferred by one channel related in any way to the knowledge transferred by previously used channels? At which moment in a temporal sequence of channels does economic impact become local?

2. Case studies of highly cited university patents

The economic and technological importance of highly cited patents has been recognized following the pioneering work of Trajtenberg (1990) (see Barberá-Tomás et al., 2011 for a recent discussion). Jaffe et al. (1993, p. 597) highlight that case studies of highly cited patents can provide a more profound understanding of knowledge transfer:

In future work we plan to identify a small number of patents that are extremely highly cited. It is likely that such patents are both technologically and economically important. Case studies of such patents and their citations could prove highly informative about [...] the mechanisms of knowledge transfer.

There is one highly cited university patent which has attracted the attention of researchers: the Cohen-Boyer 'Process for producing biologically functional molecular chimeras' (US4237224) based on recombinant DNA. The patent was applied for in 1974 by Stanford University and granted by the US Patent and Trademark Office (USPTO) in 1980. Feldman et al. (2007) provide a qualitative case study analysing the licensing strategy in the Cohen-Boyer patent and stressing the role of Stanford's Office of Technology and Licensing in flexibly managing this formal knowledge transfer channel. Feldman and Yoon (2012) study knowledge transfer, based on quantitative analysis of citations to this patent, and conclude that it has been used as a 'general purpose technology' by citing inventors who have built on the general recombinant process with applications in several domains. The richness of these findings suggests the variety of formal (notably licensing) and informal channels underlying knowledge transfer measured via patent citations.

Even more interesting in our context is a study of the Cohen-Bayer patent by Hughes (2001) in the discipline of the History of Science (Martin, 2012). Hughes demonstrates that in-depth, qualitative study of a highly cited patent could provide information on licensing and citations and also on other knowledge transfer channels. Although her main interest was not in temporally unfolding dynamic interactions and the localization of knowledge transfer channels, her narrative shows that the start of the patent application process in 1974 was followed in 1975 by a highly localized knowledge transfer channel: Cohen's consulting activity with the Cetus Corporation, a Bay Area company. Hughes (2001, p. 562) discusses the importance of the relationship between the knowledge transferred through the two channels of patenting and consulting:

What raised concern in Cohen's case was the fact that he was an inventor on a Stanford patent application and at the same time a paid consultant for a company seeking a license on the invention being patented. He tried to reassure critics by arguing that he expected to be able 'to effectively separate my relationship with Stanford as the Inventor, from my relationship with Cetus as a scientific consultant', it was a fine—if not impossible—line that Cohen attempted to draw between Cohen the scientist, Cohen the inventor and Cohen the corporate consultant. . . Attempts to draw boundaries between the three interlocking realms were artificial and ultimately futile.

We extend Hughes' (2001) insights on the relationship between the knowledge transferred through the dynamic interactions among various channels and their localization, with a case study of a highly cited university patent over a long period of time. Case study research is used to examine the complex, context-dependent nature of processes, such as university-industry knowledge transfer, through in-depth examination of specific examples (Eisenhardt, 1989; Patton, 2005). Case studies are appropriate for exploratory research on previous unexamined phenomena (Eisenhardt, 1989) and, especially, phenomena which unfold over a prolonged period of time (Yin, 2013).

3. Methodology

Although the Cohen-Boyer patent has been identified as the most highly cited biomedical patent granted between 1976 and 1980 (Feldman and Yoon, 2012), the original interest of the qualitative case studies conducted by Feldman et al. (2007) and Hughes (2001) seems not to be its citation record, but the public importance of the patent in the history of biotechnology. In our case, we started by identifying the most cited patent in university patenting history (we had some hope that the methodology would not identify the Cohen-Boyer patent, since it had already been the subject of sev-

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