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The process of transformation of scientific and technological knowledge into economic value conducted by biotechnology spin-offs

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Abstract

This paper addresses the role played by academic spin-offs in the process of transformation of scientific and technological knowledge originating from research organisations (ROs) into viable technologies, products or services. It first discusses the need for such transformation, the reasons why, in some circumstances, spin-offs firms are particularly well positioned to conduct or orchestrate it, and subsequently looks in detail at the transformation process as it occurs in practice, in the biotechnology field. Three types of transformation functions are identified and described in detail, emphasising the outcomes that might not have taken place without the entrepreneurs' intervention. It is concluded that, in performing these functions, biotechnology spin-offs play a valuable agency role in the access, application and dissemination of knowledge produced by ROs, emerging as an alternative to 'technology transfer' organisations and mechanisms.

Keywords: Knowledge transformation; Academic spin-offs; Biotechnology

1. Introduction

The economic impact of scientific and technological knowledge developed in public research organisations is one major concern of current technology and innovation policies. Underlying the debates on 'how to improve the industrial use of public research', there is frequently the assumption that knowledge is something that can be easily transferred between different contexts. But the nature of knowledge—complex, systemic, context-related, tacit and person-embodied (Pavitt, 1991)—and the differences in scope and purpose between academic and business research (Dasgupta and David, 1994), make 'knowledge transfer' from public research to the productive sector a complex undertaking.

In fields where a substantial part of knowledge production takes place in universities and other research organisations, the productive use of such knowledge requires the performance of *a transformation process*, that involves devising applications for new scientific concepts and turning these applications into viable technologies, products or services. On the other hand, given the different objectives and languages prevalent in academic and industrial contexts, there is also a need for translators between these groups (Chiesa and Piccaluga, 1998). Therefore, more than simple transfer, what needs to be conducted is a transformation of knowledge into technologies, products or services and/or a translation that make the knowledge accessible to different cognitive contexts.

Our argument is that, in some conditions, these roles can be efficiently performed by new organisations, intensive in technology, created by people who have both the competencies and the linkages to match the knowledge available in research organisations and the needs they identify in the market, as well as to conduct the necessary transformation and/or translation processes. Academic spin-offs appear to be well positioned for this task. Thus, the objective of this paper is to look in more detail at the role of academic spin-offs in the transformation of scientific knowledge into productive knowledge. The biotechnology field, characterised by a close proximity between scientific research and application (Orsenigo, 1989), is a particularly interesting setting to address this question.

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2. Knowledge transfer and the role of academic spin-offs

2.1. The nature of knowledge and transfer problems

The contribution of academic research to technological development in the industrial sector has been the subject of extensive research (e.g. David et al., 1992; Faulkner and Senker, 1994; Gibbons and Johnston, 1974; Pavitt, 1991; Salter and Martin, 2001). One important conclusion from this debate is that there are a variety of channels and mechanisms through which academic knowledge can be transformed into productive knowledge—ranging from direct use of knowledge inputs, to instruments, tools, techniques and background knowledge, to highly qualified human resources—and that these channels appear to have a different relevance in different research fields and industrial sectors. On the other hand, empirical research has shown that, on the whole, the direct contribution of academic research is relatively less important than contributions taking place through indirect mechanisms, with the possible exception of science-based industries, such as those associated with biological sciences (Klevorick et al., 1995).

There appear to be some inherent difficulties to the direct industrial use of knowledge inputs generated in research organisations. Research on the nature of knowledge and of knowledge production systems can contribute to explain these difficulties. Knowledge can be complex, systemic, tacit, person embodied and context-related (Pavitt, 1991; Dosi, 1988), which makes disembodied 'transfer' more difficult and absorption in different contexts dependent on the level of prior related knowledge (Cohen and Levinthal, 1990; Sheen, 1992). Even when knowledge is codified in publications or patents, its full exploitation will require the transfer of a component of tacit knowledge that is only possessed by the producer(s) of such knowledge (Dasgupta and David, 1994). Moreover, the effective translation of knowledge into products and processes often requires a number of complementary scientific and technological activities. This implies both the presence of enough competencies in the user organisation and intensive interactions with the knowledge source (David et al., 1992).

The above discussion suggests that knowledge originating from academic research cannot always be made directly useful to industrial activities. Even when it can, informational asymmetries between knowledge producer and user can be an obstacle for its effective exploitation and considerable development efforts (and therefore a degree of familiarity with the knowledge) may be required to turn such knowledge into products or services.

2.2. The need for a transformation process

Thus, the productive use of knowledge developed in research organisations requires a transformation process (Autio, 1997), which involves devising applications for new scientific concepts and/or turning technologies and prototypes into viable products or services. It also entails an uncertainty-reducing element (critical from the adopter point of view), since the uncertainty inherent in the use of new technologies is likely to diminish as control upon them increases through trial and error processes. Finally, it often involves the integration between knowledge coming from different areas—both scientific and functional. Thus this transformation is a complex process, where issues such as personal mobility, shared contexts, integration of knowledge, trial and error experiments are key elements. Moreover, it may also require a component of translation between the different objectives and languages prevalent in academia and industry (Chiesa and Piccaluga, 1998).

Research organisations (ROs) are hardly prepared to conduct this process, given their specific objectives and governance systems (Dasgupta and David, 1994). But it may neither be performed by the (potential) user organisation, particularly in the case of emerging technologies, where informational asymmetries between knowledge producer and user are higher. This may cause industrial organisations to be unaware of the potential advantages of the new knowledge for their innovative activities, or to lack information about the availability of suitable results. Or, even if they are interested, to lack the capacities necessary to evaluate, absorb and further develop the relevant knowledge.

On the other hand, this process will not necessarily be amenable to 'technology transfer' organisations and instruments, which tend to be more appropriate for the transfer of more stabilised technologies (Mason and Wagner, 1999). This may be particularly detrimental for technology diffusion in contexts where the technological level of incumbent firms is relatively lower and 'lead users', able to directly access new knowledge, are less frequent (Fontes and Novais, 1998). Therefore, other instruments are necessary to replace or complement the so-called 'transfer infrastructure'.

Recent research has called the attention to the role performed, in the dissemination of new technological knowledge, by some organisational forms, which are emerging as alternative agents of diffusion. Research on the growing importance of knowledge intensive activities have revealed a new type of actors—knowledge intensive business service firms—that not only perform many of the functions previously located in the 'traditional' S&T infrastructure, but have also devised new forms of knowledge supply and intermediation (den Hertog, 2000). Research on the roles of new technology-based firms, uncovered their contribution as agents of technology acquisition, transformation and diffusion within innovation networks (Autio, 1997; Fontes, 2001a). More specifically research on academic spin-off firms has shown that in some fields, particularly science based fields such as biotechnology, they are an important vehicle in the transfer of public research results to the market (e.g. Kenney, 1986; Dodgson,