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R&D service firms: The hidden engine of the high-tech economy?

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ABSTRACT

R&D service firms are highly innovative knowledge-intensive businesses. They constitute an important component of the knowledge economy, but one that is often in the shadow of the role normally attributed to universities and other public research organisations in the growth of high tech clusters and, more broadly, innovation systems. In this paper we present evidence from an in-depth analysis of the strategy, practice and impact of a sample of R&D service providers long active in the Cambridge area, the leading science and technology cluster in the UK. Based on an extensive programme of interviews with companies' CEOs and managers, we analyse: the main features of the R&D contract and the way in which this allows firms to de-risk the uncertain process of early technology development and to meet customer's needs; the services' typical organisational features and development stages; the variety of observed growth paths. We provide evidence of the significant direct and indirect contribution to innovation of these service firms and conclude by discussing the implications of this original model of technology development in relation to the early-stage financing and university-led growth debates.

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1. Introduction

In the background of this study are two macro shifts observed in the recent growth patterns of advanced economies. The first is the increasingly important role of information and knowledge as sources of innovation-driven competitive advantage (Foray, 2004; Antonelli, 2008). This has fostered greater recognition of the economic role of those organisations whose main objective is the generation and diffusion of new knowledge and skills (Lundvall, 1992; Nelson, 1993). The second structural shift is the increased weight of the service sector in both total value added and employment relative to manufacturing (Rubalcaba and Kox, 2007; EC, 2009; Gallouj and Djellal, 2010; Jorgenson and Timmer, 2011).

Since innovation has increasingly been identified as a key determinant of growth,¹ the need has emerged to gain a better

understanding of the extent to and the way in which services contribute to innovation (Miles, 2005). The transition to knowledge-based economies with a substantial service component is associated with a complex division of labour between users and producers of innovation and with combinations of different kinds of know-how (Metcalf and Miles, 2000; Gadrey and Gallouj, 2002). The rising role of business services, and especially of those involved in the generation, absorption and diffusion of new knowledge, is an integral part of this process. Such businesses are usually referred to as Knowledge-Intensive Business Services (KIBS) in the innovation literature (Miles et al., 1995).

Within the broader class of business services, KIBS have displayed above-average growth rates and accounted for an increasing share of the total proportion of business services (Rubalcaba and Kox, 2007). The core activity of these firms has been identified as the provision of intermediate inputs, in the form of labour services with a predominant high-skill bias, to other businesses (Miles et al., 1995). They include research and development (R&D), design and technology services, management consulting, information and communication services, human resource management and employment services, legal services (including those relating to intellectual property rights), accounting, financing, and market related service activities.

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¹ This is a fundamental principle of Neo-Schumpeterian economics in both its evolutionary (Nelson and Winter, 1982; Metcalfe, 1998) and endogenous growth (Grossman and Helpman, 1991; Aghion and Howitt, 1992) variants.

This paper focuses on R&D services and their contribution to the high-tech economy. The research context is the science and technology cluster that developed from the late 1970s onwards around Cambridge and is regarded today as one of the most important of its type in Europe.² Known as the Cambridge 'Phenomenon', the cluster first achieved prominence in the early 1980s and its growth has been extensively documented since (see e.g. Segal Quince & Partners, 1985; Segal Quince Wickstead, 2000; Herriot and Minshall, 2006; Kirk and Cotton, 2012).³ The role played by the University of Cambridge in the growth of high-tech business in the region has been repeatedly acknowledged, to the extent that Cambridge is now regarded as one of the few truly successful examples of an entrepreneurial business cluster forming around a major European university (*ibidem*).

From early on observers noted that many of the companies in Cambridge had adopted a business model based on carrying out R&D contracts for customers, rather than developing standard products (Segal Quince & Partners, 1985). While, however, the role of the venture capital sector has been highlighted – Cambridge has one of the highest concentrations of venture backed companies in the world (Library House, 2007) – the role played in this process by the private R&D service sector has been quite significantly underestimated. We argue that that provision of R&D services has grown over time into a fundamental mechanism to develop new technologies directly and through spin-out. The primary motivation of this paper, therefore, is to remedy the gap in understanding of the hidden contribution of R&D service firms to the development of innovation systems through an in-depth analysis of the strategy, practice and impact of the R&D service providers active in the Cambridge cluster.

The paper is organised as follows. In Section 2 we set the paper in the research framework of knowledge-intensive business services and their role in innovation systems. Section 3 presents the methodology and sample of firms, while in Section 4 we describe the key characteristics and operative patterns of the subset of KIBS firms we refer to as technology development consultancies (TDCs). Section 5 includes three case studies illustrative of different paths to growth of businesses developed through an R&D service provider. The economic impact of technology development consultancies in the Cambridge region is documented in Section 6. In the final sections of the paper we discuss the contribution of these firms to the high tech economy and its managerial and policy implications.

2. Literature review and analytical setting

The growth of markets for technology (Arora et al., 2001) and the diffusion of more 'open' models of innovation (Chesbrough, 2003, 2006) have implied the externalisation of some activities, including R&D, that had previously been performed mainly in-house. This has implied a growing demand not only for discrete and codified technological know-how in the form, for example, of patents and licences, but also a growing demand for services designed to supply external knowledge to other businesses. In one of the earliest systematic attempts to conceptualise the activity of these specialist service providers, Miles et al. (1995) defined knowledge-intensive business services as businesses characterised by: heavy reliance upon *professional knowledge*; intensive (and often pioneering) use

of *information technology*; and a business focus on the supply of combinations of codified and tacit knowledge (e.g. measurements, reports, training, consultancy) as a contribution to their clients' own knowledge-generating and information-processing activities. KIBS essentially perform *problem-solving* activities and tend to do so through direct user-producer *interaction* and *mutual learning* with clients (Antonelli, 1998; Muller and Zenker, 2001; Den Hertog, 2002; Wood, 2002).

KIBS are a rather heterogeneous class of businesses encompassing on the one hand traditional professional services (i.e. training, management consultancy and legal services) and on the other technology based-services (i.e. IT, technical engineering and R&D services).⁴ Taken altogether as a component of the service economy, KIBS are intensive buyers, providers and users of innovative inputs and outputs (Metcalf and Miles, 2000; Den Hertog and Bilderbeek, 2000; Czarnitzki and Spielkamp, 2000; Strambach, 2001; Gallouj, 2002). They perform a dual function in innovation: they are claimed to exert both direct and indirect effects on the rate and direction of technical change in innovation systems (Miles, 1999; Toivonen, 2004). Direct effects include the output of their own R&D activities and human capital formation. Indirect effects include, on the one hand, their role as adopters of new technologies and, on the other, the ability to gather and diffuse new knowledge in science and technology networks and the potential to augment the system-level capacity to elaborate and adapt new and economically valuable knowledge (Miozzo and Grimshaw, 2005).

KIBS make a significant contribution to the productivity of client sectors (Oulton, 2001; Baker, 2007; Camacho and Rodríguez, 2007; Kox and Rubalcaba, 2007). Analyses of Community Innovation Survey data confirm that KIBS are among the most innovative businesses (Tether and Tajar, 2008; Tether and Massini, 2007) but they also play a role in innovation of wider and systemic significance. Firstly, they operate at the leading edge of innovation practices that will later diffuse, at least to some extent, to other parts of the economy. Secondly, they support innovation in other sectors of the economy. Thirdly, they play key intermediary, bridging or brokering roles, connecting innovative ideas developed in different parts of the economy (Bessant and Rush, 1995; Hargadon and Sutton, 1997; Hargadon, 1998; Howells, 2006) and helping to 'translate' ideas produced by the science base into practical and commercialisable knowledge that can be exploited by firms (Tether and Tajar, 2008).

With respect to their connection within innovation networks, KIBS have not been reported to maintain strong connections with universities (Leiponen, 2001) with the exception of R&D consultancies (Tether and Hipp, 2002; Czarnitzki and Spielkamp, 2003). When, instead, they are compared to universities as sources of best practice knowledge for firms, private service providers seem to be the preferred choice (Hughes and Wood, 2000). Tether and Tajar (2008) and Tether and Massini (2007) also find that private sector (and not-for-profit) consultants and research organisations tend to be more widely used by firms as sources of information and as collaborative partners for innovation than are universities and the wider public science base. Yet, in contrast with direct industry-university interactions, the role of these organisations as a 'second knowledge infrastructure' (Den Hertog and Bilderbeek, 2000) is often overlooked.

² In Cambridgeshire, high-tech business accounted for 14.5% of all jobs in 2006, with Cambridge City at 17.2% and South Cambridgeshire at 25.4%. See Cambridgeshire County Council Research Group (2006) Employment in the Hi-tech "Community". Available from: <http://www.cambridgeshire.gov.uk/NR/rdonlyres/E394F26D-3925-4B75-AF95-BE041B1BE82/0/HiTech06.pdf>.

³ For detailed case studies of firm growth in the Cambridge cluster, Garnsey and Heffernan (2005), Maine and Garnsey (2006), and Garnsey et al. (2008) provide excellent examples.

⁴ Muller and Doloreux (2009) provide a broad overview of this part of the literature (2009) while a more recent contribution by von Nordenflycht (2010) focuses on 'professional services'. There is an overlap between what the innovation literature defines as KIBS and what the management literature refers to as professional services; the identifying characteristics are very similar. For a discussion of KIBS in relation to Pavitt's taxonomy (1984), see instead Miozzo and Soete (2001), who identify a category for 'Science-based services and specialised technology suppliers'.

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