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Firm collaboration and modes of innovation in Norway

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ABSTRACT

This paper examines the sources of firm product and process innovation in Norway. It uses a purpose-built survey of 1604 firms in the five largest Norwegian city-regions to test, by means of a logit regression analysis, Jensen et al.'s (2007) contention that firm innovation is both the result of 'Science, Technology and Innovation' (STI) and 'Doing, Using and Interacting' (DUI) modes of firm learning. The paper classifies different types of firm interaction into STI-mode interaction (with consultants, universities, and research centres) and DUI-mode interaction, distinguishing between DUI interaction within the supply-chain (i.e. with suppliers and customers) or not (with competitors). It further controls for the geographical locations of partners. The analysis demonstrates that engagement with external agents is closely related to firm innovation and that both STI and DUI-modes of interaction matter. However, it also shows that DUI modes of interaction outside the supply-chain tend to be irrelevant for innovation, with frequent exchanges with competitors being associated with lower levels of innovation. Collaboration with extra-regional agents is much more conducive to innovation than collaboration with local partners, especially within the DUI mode.

1. Introduction

There has traditionally been a strong dividing line in the research looking at the sources of innovation. This dividing line has been fundamentally determined by the value different strands of research award to science and technology as the key element for the generation, diffusion, and assimilation of innovation. Researchers on innovation have, over the years, tended to place themselves on either side of the dividing line. On one side of the line, the linear model of innovation (Bush, 1945; Maclaurin, 1953), and research on knowledge spillovers (Audretsch and Feldman, 1996; Cantwell and Iammarino, 1998; Sonn and Storper, 2008) have looked at innovation from a scientific and technical perspective. This has led to the use of research and development (R&D), patenting, information and communications technology (ICT) expenditures, and the level of education and training of the labour force as the main proxies of, as well as the key factors behind, the development and assimilation of innovation. Other researchers have, by contrast, been profoundly sceptical about the relevance of R&D, patenting and ICT expenditure as sources of innovation relevant to the firm (Cooke, 2001). These researchers on the other side of the dividing line have tended to place the greatest emphasis on institutions, interactions, networks and informal relationships that facilitate the generation and exchange of knowledge (Lundvall, 1992). This strand has given rise to a blooming literature which, under different definitions and names – e.g. 'neo-Marshallian industrial districts' (Becattini, 1987), 'innovative milieux' (Aydalot, 1986), 'learning regions' (Morgan, 1997), or 'regional innovation systems' (Cooke et al., 1997; Cooke and Morgan, 1998) – regards innovation as a territorially embedded phenomenon, determined by the social and institutional conditions in a given territory (Iammarino, 2005).

A number of scholars have tried to bridge the gap between linear approaches to innovation and those more concerned with institutions and interactions, often putting the capacity to assimilate external knowledge at the heart of the process of innovation. von Hippel (1976), for example, focused on how user–supplier relationships shaped innovation in the production of scientific instruments. Cohen and Levinthal (1990) introduced the concept of absorptive capacity in the firm, making it not only dependent on the firm's

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prior related knowledge and R&D expenditure, but also on a firm's interdependence with rivals and history – and path-dependent. Chesbrough (2003) has put forward the idea of open innovation, which has propelled to the fore the view that innovation – in contrast to prior paradigms which emphasised the benefits of in-house innovation, closed to external influences – is increasingly the result of a combination of ideas from both internal and external sources. Other attempts have adopted a more macro-approach, using regions and metropolitan areas as their unit of analysis (e.g. Crescenzi et al., 2007; Rodríguez-Pose and Crescenzi, 2008).

One of the most prominent recent attempts to connect internal R&D-based and external, institutional- and interaction-based innovation has been that of Jensen et al. (2007). These authors identify two fundamental modes of firm learning: 'Science, Technology and Innovation' (STI) and 'Doing, Using and Interacting' (DUI). The STI-mode of innovation refers to the use of scientific knowledge in the development of new technologies that form the basis of new products or processes within the firm. The DUI-mode refers to on-the-job problem-solving based on the exchange of experiences and know-how, through which firms find solutions to various problems that arise. These processes typically involve a large component of tacit knowledge (Jensen et al., 2007, pp. 62–64). According to Jensen et al. (2007), the STI and DUI-modes of innovation have used different approaches, techniques, and proxies to explain and measure how innovation at the level of the firm is generated. The STI-mode has generally relied on deductive approaches and quantitative techniques, employing R&D, patenting, ICT and the formal education of the workforce as the key indicators. The DUI-mode of innovation is somewhat more diverse, although inductive and qualitative approaches have tended to prevail. Despite the increasing importance of quantitative analyses focusing on Community Innovation Surveys (CIS), these authors consider that quantitative methods based on survey data have still played a relatively small role in DUI-mode approaches: "The vast majority of quantitative survey-based studies of innovation simply had little to say about the relation of DUI-mode learning to innovative performance" (Jensen et al., 2007, p. 681). This is partly a result of the difficulty in operationalising the complex institutional and relational factors at the base of DUI-mode approaches to innovation, but also a consequence of a general belief that processes such as learning by doing and using are best analysed through in-depth case studies. Jensen et al. apply latent class analysis to data from 1643 Danish firms and uncover that the two modes of innovation are complementary. Firms which combine STI and DUI-innovation are more likely to introduce new products and services than those specialised in either of the modes (Jensen et al., 2007).

While making a pioneering and important contribution to our knowledge, one of the potential downsides of Jensen et al.'s analysis is that the classification of firms into four clusters according to the intensity of use of STI and DUI-modes of innovation by each firm creates a rather crude division which represents the variables of interest in the logistic regression analysis on which the key conclusions are based. This implies a significant loss of information about STI and DUI-modes of learning at the level of each firm.

In this paper we aim to make a contribution to this debate by analysing to what extent STI and DUI-modes of innovation are related to firm level innovation in Norway. We use a specifically tailor-made survey of 1604 firms with more than ten employees in the five major Norwegian city-regions. The survey measures the different types of interactions that these firms engage in. We classify the interactions with different partner types into STI-interaction types and DUI-interaction types. STI-interaction types include connections with universities, research institutes, and consultancy firms. DUI-interaction types encompass linkages with other firms in the conglomerate, suppliers, customers, and competitors. DUI-type interactions are, in turn, divided into those that fall within the regular supply-chain (interactions with suppliers and customers), and those which do not (interactions with competitors).

The main contributions of this paper lie in four areas. First of all, in the use of different measures of innovation. In contrast to previous work, which tends to differentiate between product and service innovation (Jensen et al., 2007; Kirner et al., 2009), we distinguish, on the one hand, between product and process innovation, defined as the introduction of new products or processes in the firm over the last three years, and, on the other, between incremental and radical innovation. This gives us a classification of four types of innovation which may be affected by different patterns of collaboration at the level of the firm. The fourfold classification allows for much greater nuance in the explanation of how different forms of firm partnerships may affect different types of innovation. Secondly, rather than classifying firms according to their innovation practices, we use the different interaction linkages of each firm individually as our independent variables of interest, dividing, in turn, DUI-type interactions according to whether they are conducted within the supply-chain or not. Thirdly, we pay specific attention to the often neglected topic of the geographical dimension of the different partnerships of the firm and how they influence innovation. STI and DUI-mode interaction are frequently conducted at different geographical scales and this may significantly affect the capacity of firms to produce different types of innovation. We therefore distinguish between interactions conducted in close geographical proximity, i.e. at the level of a locality or region, and those that are conducted with partners located in distant cities or abroad. Last, but not least, we apply the analysis to a broad sample of firms across different industries in the five largest city-regions of Norway, using a tailored survey specially designed for the purpose of this research. By contrast, earlier studies of the DUI and STI modes in Norway have focused on individual industries in smaller regions (e.g. Isaksen and Karlsen, 2010).

The paper is structured into five further sections. In the theoretical section following this introduction, we briefly look at the role of the sources of knowledge and innovation, focusing later on the geography of STI and DUI-modes of innovation. We then present the case and describe the data in Section 3. The following section deals with the empirical analysis linking partner types with innovation outcomes. Section 5 examines the geographical dimension of partnerships and how it is related to innovation. The conclusions and some indications for future research are presented in Section 6.

2. The role of sources of knowledge in innovation

The scholarly literature about where firms get the knowledge to generate and implement innovation has tended to be divided between two camps: (a) a larger camp, which posits that firm-level innovation is the consequence of advances in science and technology (S&T), driven by investment in R&D and by human capital (the STI-mode of innovation) and (b) a smaller, but growing camp putting the emphasis on learning-by-doing and using (the DUI-mode of innovation) (Jensen et al., 2007).

For those placed in the STI camp, innovation in firms is the result of investments in R&D and S&T and interaction with centres producing new knowledge – mainly research centres and universities, but also consultancies, scientific brokers and foundations for the diffusion of scientific research – which generate the codified and explicit knowledge which can be used by the firm to produce new innovations. The capacity to generate and adopt new innovations will also be largely dependent on the human capital available in the firm and on the level of training of employees. As pointed out by Jensen et al. (2007, p. 681), in STI-type analyses "there is a tendency to expect that the increasing reliance on science and technology