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University–industry collaboration and firms' R&D effort☆

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ABSTRACT

This paper investigates the impact of publicly funded university–industry collaboration on UK firms' R&D effort. We test the hypotheses that project participation has a positive effect on firms' R&D expenditure per employee and on their share of R&D employment. The paper exploits a novel source of data made up of a set of U–I projects funded by the UK Engineering and Physical Sciences Research Council between 1997 and 2007 and firm-level data available through the UK Office for National Statistics. We employ propensity score matching to select an appropriate control group of untreated firms on the basis of the probability that they participate to U–I partnerships. We then estimate the impact of participation on firms' R&D effort in two points in time via ordinary least squares regression. The results show a positive and significant impact on the share of R&D employment two years after the end of projects. This is also confirmed by a robustness check. A positive effect on R&D expenditure per employee is found both at the end of the project and two years later. These findings are highly relevant for policy, given that U–I collaboration is among the most frequent policy instruments put in place by local and national policy-makers to foster pre-competitive research and firms' R&D activities.

1. Introduction

Innovative firms are embedded in networks of strategic alliances throughout which they gain competitive advantage from continuous scientific and technical interactions (Owen-Smith and Powell, 2004). In today's fast changing knowledge economies, firms need to find and exploit new sources of knowledge in order to innovate and grow. Universities are often the main repository of such knowledge. The exchange of knowledge between academia and industry is therefore an essential mechanism to bring science to the market and foster innovation and economic growth (OECD, 1998, 2002a).

University–industry knowledge transfer is a broad concept identifying a wide set of interactions between firms and universities. In particular, university–industry research collaboration is a specific channel of inter-organisational knowledge flows and potential spillovers from (and to) academic research aimed at carrying out specific R&D projects, particularly involving pre-competitive and basic research (OECD, 1998, 2002a; D'Este and Fontana, 2007; D'Este and Iammarino, 2010; D'Este et al., 2013). Cooperative research partnerships are among the most typical forms of U–I research collaborations, followed by contract research, research consortia, consulting and founding of co-operative research centres (OECD, 1998; Fontana et al., 2006). The relevance of this typology of interaction channel is mirrored by the fact that it represents one of the most frequent policy instruments put in place by local and national policy-makers to foster pre-competitive research and firms' innovation activities (OECD, 1998, 2002a; Fisher et al., 2009; D'Este and Iammarino, 2010).

U–I cooperative R&D projects can be seen as a voluntary (or intended) and reciprocal information mechanism that enhances learning processes and performance of the partnering organisations (Feldman and Kelley, 2006). For this reason, U–I R&D cooperation is considered a valid proxy for explaining knowledge generation associated with knowledge spillovers (see e.g. Cincera et al., 2003). However, the innovation literature has been, so far, only partly conclusive with regards to the impact that these activities have on firms' performance. Following the perspective that R&D cooperation can be seen as a vehicle for voluntary knowledge transfer, the present study intends to fill this gap by assessing the effect of publicly funded U–I R&D projects on firms' R&D effort. This paper investigates the impact of U–I R&D projects on firms' R&D expenditure per employee and share of R&D employment, relying on a novel dataset of U–I partnerships combined with firm-level data. We employ propensity score matching to select a control

☆ This work contains statistical data from Office for National Statistics (ONS) which is Crown Copyright. The use of the ONS statistical data in this work does not imply the endorsement of the ONS in relation to the interpretation or analysis of the statistical data. This work uses research datasets which may not exactly reproduce National Statistics aggregates.

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group of untreated firms, and OLS regression to estimate the effect of U–I projects on firms' R&D effort.

This paper intends to contribute to the literature on university–industry knowledge transfer by bringing new evidence on the impact that the publicly funded voluntary exchange of knowledge between university and firms has on firms' internal effort on R&D. We do so by analysing the case of U–I partnerships funded by the UK Engineering and Physical Sciences Research Council, on which only limited empirical evidence exists as far their impact on firms is concerned. Our data on U–I partnerships provides information on firms involved in a full range of projects funded during a 11 years time span; by combining it with firm-level data, we create a new and original dataset that allows us to carry out an evaluation study of a specific U–I R&D programme. Moreover, the employment of propensity score matching helps us to tackle the issue of selection bias typically arising in quasi-experimental settings, providing a useful tool to work out a sensible control group of non-participating firms to be compared to participating firms.

The remainder of the paper is organised as follows: in Section 2 we provide a review of the literature, an overview of the programme under study, and the hypotheses of the paper; in Section 3 we describe our data and illustrate the construction of the dataset; Section 4 is dedicated to the illustration and implementation of the methodology and to the description of the variables; in Section 5 we present the empirical results, we check the quality of the propensity score matching implemented and we illustrate the results of a robustness check; finally, we conclude the paper by summing up and discussing our findings in Section 6.

2. Literature and hypotheses

2.1. U–I knowledge interaction

The acquisition of external knowledge is necessary for firms' R&D innovation activities. The early literature on technological change as well as more recent studies on firms' knowledge sourcing strategies reckon that firms cannot only rely on their internal resources in order to successfully produce innovation (see e.g. Allen and Cohen, 1969; Allen, 1977; Arora and Gambardella, 1990, 1994; Cassiman and Veugelers, 2006, 2007; Frenz and Ietto-Gillies, 2009). Instead, they need to tap into knowledge that rests outside their boundaries. This is particularly true in the present context of market globalisation and fast technological change. In particular, seminal works such as those of Griliches (1987), Jaffe (1989) and Adams (1990), unveiled the role of knowledge sourced from academic institutions for firms' innovation activities and, more generally, for economic development. Since then, research on the process of knowledge transfer between universities and businesses has grown substantially, corroborating the assertion that firms exploit university knowledge to produce innovation and to successfully compete on the market (see e.g. Mansfield, 1995; Mansfield and Lee, 1996; Cohen et al., 2002).

U–I knowledge transfer is a broad concept identifying a wide set of interactions between firms and universities that are aimed at the exchange of knowledge related to research, science and technology. In particular, research collaborations include research partnerships, contract research, research consortia, consulting and founding of co-operative research centres. In this paper we study U–I cooperative R&D partnerships, which are aimed at carrying out specific R&D projects, particularly involving pre-competitive and basic research. These typically involve formal agreements that entail cash and in-kind contributions by both sides, so that university and firms share not only their knowledge and competencies but also their R&D facilities and personnel (D'Este et al., 2013).

Nowadays, U–I R&D-based interactions are among the most frequent policy instruments implemented by policy-makers to foster pre-competitive research and firms' innovation activities (D'Este and Iammarino, 2010; Fisher et al., 2009; OECD, 1998, 2002a). From a general equilibrium perspective, U–I knowledge exchange positively contributes to reducing R&D market failures and realising the full social benefits of R&D investments (Martin and Scott, 2000; Poyago-Theotoky et al., 2002). From a microeconomic perspective, both universities and businesses benefit from exchanging knowledge: universities obtain financial support from the private sector and increase the experience and employment opportunities of students and faculty professionals; firms get access to university research infrastructures and expertise, gain opportunities of recruiting high-skilled personnel, and keep abreast of cutting-edge academic research (OECD, 1998).

Despite the acknowledged relevance and potential benefits of U–I relations for the society, there are various barriers that hamper the exchange of knowledge between industry and academia. These are mainly related to the different sets of norms that regulate the university research system and the private sector (Dasgupta and David, 1994). The need to overcome existing obstacles, coupled with increasing pressures from the globalisation process, have put U–I knowledge interaction at the core of academic and policy consideration in the last thirty and more years.

2.2. U–I research collaboration and firms' performance

The relationship between U–I research collaboration and firm-level performance has been addressed by different strands of the empirical innovation literature. In the first place, studies on R&D cooperation, knowledge spillovers and productivity extensively analyse firms' R&D interactions with external organisations (including universities). Works addressing those topics predict that firms engage into cooperative R&D because this enables them to internalise knowledge spillovers, thus eliminating the disincentive effect of spillovers on R&D (Steurs, 1995; De Bondt, 1997; Cassiman and Veugelers, 2002; Belderbos et al., 2004; Schmidt, 2005; Lopéz, 2008). Firms engage into joint R&D also because it allows the acquisition and utilisation of external resources for their own purposes directly and systematically (Hagedoorn, 1993; Hite and Hesterly, 2001; Caloghirou et al., 2003; Scott, 1996) and sharing costs and risks among partners (Sakakibara, 1997; Beath et al., 1998).

Therefore, the benefits associated to R&D cooperation can be attributed to reducing uncertainty, joint financing of R&D, realising cost-savings, and realising economies of scale and scope (Becker and Dietz, 2004; Camagni, 1993; Robertson and Langlois, 1995). Accordingly, scholars have evaluated the impact of R&D cooperation at the level of both firms' innovation activities (input and output) and firm productivity.

Firms' engagement in R&D cooperation has been found to have a positive effect on various measures of firms' innovative performance, including sales of innovative products (see e.g. Klomp and Van Leeuwen, 2001; Lööf and Heshmati, 2002; Criscuolo and Haskel, 2003) and patenting (Vanhaverbeke et al., 2002). Some papers also investigate the effect of various typologies of cooperation, but produced ambiguous results. For instance, Faems et al. (2005) found a positive association between university cooperation and the share of new to the market innovative products in Belgian firms' sales, whereas an aggregate measure of other cooperation typologies was positively associated with the share in firm sales of innovative products new to the firm (but not new to the market).

By regressing French firms' innovative sales on a range of collaborations and incoming knowledge spillovers variables, Monjon and Waelbroeck (2003) found a mixture of positive and negative effects of the latter. Belderbos et al. (2004) found that R&D

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