Research Policy 43 (2014) 1398–1412

Contents lists available at ScienceDirect

Research Policy

journal homepage: www.elsevier.com/locate/respol

Science or graduates: How do firms benefit from the proximity of universities?

Bart Leten [a,b,*], Paolo Landoni [c], Bart Van Looy [a,d,e,f]

[a] KU Leuven, Belgium
[b] Vlerick Business School, Belgium
[c] Politecnico di Milano, Italy
[d] Steunpunt STI Indicators (ECOOM), Belgium
[e] Research division INCENTIM, K.U. Leuven R&D, Belgium
[f] Institute of Governance Studies, University of Twente, The Netherlands

ARTICLE INFO

Article history:
Received 19 April 2011
Received in revised form 7 February 2014
Accepted 6 March 2014
Available online 26 April 2014

Keywords:
Innovation
Universities
Education
Scientific research
Graduates
Patents

ABSTRACT

This paper examines the impact of universities on the technological performance of adjacent firms. We extend existing research by jointly analyzing, and comparing, the effects of education (graduates) and scientific research (publications) activities of universities on firms' technological performance. Adopting the knowledge production framework, our study is conducted at the level of 101 Italian territorial areas (provinces) and four industries. Overall, fixed-effect panel data models reveal a positive effect of both university graduates and scientific publications on the technological performance of firms. At the same time, considerable industry differences are observed. While the provision of university graduates positively affects firm performance in all industries under study, additional effects for scientific research are only observed in electrical and pharmaceutical industries that are science-intensive and where the scientific knowledge base is changing rapidly over time. The observation that spillovers from academia into the industrial texture of provinces rely on education and research in an industry-specific manner is relevant to the design of appropriate research and innovation policies.

1. Introduction

Since the seminal work of Schumpeter (1934), innovation is considered an important driver of economic growth and welfare. Countries and regions that build up strong competences in innovation are more productive, grow faster, and attain higher per capita income levels (Fagerberg et al., 1997; Maskell and Malmberg, 1999; Paci and Usai, 2000; Sterlacchini, 2008). Regional innovation dynamics benefit from interaction and spillovers between multiple actors including firms, financial institutions, governments and universities (Van Looy et al., 2003); an idea captured explicitly by notions such as national and regional innovation systems (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Acs, 2000) and the triple helix model (Leydesdorff and Etkowitz, 1996).

Universities play an important role in innovation systems. In particular, universities contribute to innovation systems in two different ways (Nelson, 1986). First, they educate and train people in fields that are critical to corporate R&D, such as sciences and engineering disciplines (Salter and Martin, 2001; Rothaermel and Ku, 2008). Second, they conduct scientific research, resulting in knowledge that can be instrumental for firms' innovation activities (Bercovitz and Feldman, 2007; Mansfield, 1995). The benefits of education and scientific research are, to some extent, 'localized' since the mobility of graduates is limited and knowledge spillovers are directly and indirectly shaped by geographic proximity (Boschma, 2005; Salter and Martin, 2001).

A number of studies have examined the impact of universities on firms' innovative performance. These studies have focused either on the effects of university research (e.g. Jaffe, 1989; Anselin et al., 1997; Autant-Bernard, 2001) or on university education (Rothaermel and Ku, 2008). Most studies examined the effects of *academic research* on firms' innovative performance. Jaffe (1989) observed a positive relationship between US state-level university R&D spending and the level of corporate patenting. Similar – positive – effects of university research have been reported at the level of US metropolitan statistical areas (Anselin et al., 1997, 2000), and for regions in various European countries (e.g. Autant-Bernard, 2001; Fischer and Varga, 2003; Piergiovanni et al., 1997; Blind and Grupp, 1999; Del Barrio-Castro and Garcia-Quevedo,

* Corresponding author at: KU Leuven, Belgium. Tel.: +32 16326900; fax: +32 16326732.
E-mail address: Bart.Leten@econ.kuleuven.be (B. Leten).

http://dx.doi.org/10.1016/j.respol.2014.03.005
0048-7333/

2005). Complementary to these studies, Rothaermel and Ku (2008) assessed the effect of *university education* on firms' innovative performance. Using data on medical device clusters in the US, they reported a positive effect of the number of university graduates in electrical engineering on the number of medical device patents within the region.

Our study extends this prior work by *jointly* analyzing, and comparing, the effects of university education and scientific research on firms' technological performance. Whereas previous research looked at the impact of universities either through science or graduates, studies simultaneously examining different academic 'knowledge-transfer channels' are still lacking. At the same time, it can be noted that the relevance of studies encompassing both channels is high, especially for defining and adopting policies aimed at improving the performance and (societal) impact of universities. Indeed, only to the extent that one can assess the differential impact of graduates and scientific research does designing relevant measures and policy initiatives including the delineation of activities and transfer mechanisms that are appropriate in this respect (see also Van Looy et al., 2011) seem feasible. For example, the European Commission published a new agenda, in September 2011, for the modernization of Europe's higher education systems, emphasizing the importance of increasing the number of graduates, improving the relevancy of curricula, and strengthening the 'links between education, research and business to promote excellence and innovation'. Relatively less attention is being paid to the productivity and quality of scientific research (see in this respect Dosi et al., 2006). To evaluate the appropriateness of such innovation and higher education policies, studies that examine the relative importance of university education and scientific research activities are essential. In addition, we analyze whether the relative importance of education and scientific research differs across industries. While prior research suggests that university effects are industry specific, only the role of scientific research has been investigated (e.g. Anselin et al., 2000), neglecting the potential differential simultaneous impact of education and scientific research across industries.

Adopting the Griliches–Jaffe knowledge production framework, our study is conducted at the level of 101 Italian territorial areas (provinces[1]) and four sectors (chemicals, pharmaceuticals, electrical engineering, and mechanical engineering). Analyses are conducted at the combined province and industry level, employing panel data (1992–1998). We construct indicators of the involvement of universities in education and scientific research using annual information on the number of graduates (per discipline) and the number of scientific publications (per scientific field) of Italian universities, respectively. We count graduates and publications at the level of provinces and disciplines (for graduates) or science fields (for publications), and calculate the relevant number of graduates and publications for each sector by using detailed concordance tables that link science fields, graduate disciplines, technology areas, and sectors. The construction of our key variables allows us to determine the significance and importance of university education and scientific research on the technological performance of firms, located nearby, with greater precision than prior work that relied largely on aggregated regional data.

Based on fixed-effect panel data models, we observe, overall, positive effects of education as well as scientific research on the technological performance of firms. At the same time, considerable industry differences are observed. While, for all industries under study, the number of graduates is positively associated with firms' technological performance, scientific research only has an additional positive effect on the technological performance of electrical and pharmaceutical firms. The observation that spillovers from academia into the industrial texture of provinces rely on education and research in an industry-specific manner is highly relevant to the design of appropriate research and innovation policies.

The remainder of the paper is structured as follows. The next section reviews the existing literature and outlines the contribution of this paper. The third section describes the data and indicators employed. The empirical findings are reported in the fourth section. In the final section, we summarize our main findings and suggest avenues for further research.

2. Literature review

During recent decades, there has been an increasing interest – both in research and policy circles–in understanding and measuring the impact of universities with respect to regional and national development (Drucker and Goldstein, 2007). A prime reason for this interest resides in the observation that many developed countries face a transformation from traditional-manufacturing to knowledge-intensive economies. Universities support the creation of a knowledge-based economy by their involvement in two different tasks (Nelson, 1986; Baptista and Mendonça, 2010). First, they educate people and, by doing so, supply skilled labor; second, they conduct scientific research and generate knowledge that can be instrumental for extending existing economical activities and/or creating new economic activity (Cohen et al., 2000).

A primary role of universities pertains to educating and training people, making them suitable for entering knowledge-intensive jobs in the private sector. The skills acquired during university education allow graduates, especially those in exact sciences and engineering disciplines, to perform industrial R&D jobs. Universities teach students scientific principles and research techniques that enable them to become involved in complex problem-solving activities (Salter and Martin, 2001). In addition, since academic education is based on scientific insights, including recent ones, hiring new graduates entails the promise of introducing novelty into the existing industrial texture on the level of problem-definition and problem-solving activities. Indeed, regions that can increase the average level of education of their employees tend to become more innovative (Chi and Qian, 2010; Gumbau-Albert and Maudos, 2009).

The benefits of university education, in the form of skilled labor, are not equally accessible to all firms: firms situated in the vicinity of universities seem to find themselves in an advantageous position. This is because a significant proportion of graduates look for jobs in the region where they receive their education (Felsenstein, 1995; Glasson, 2003). For example, Glasson (2003) calculated that 64% of the UK-domiciled graduates of Sunderland University were still living in the Sunderland region six months after graduation. Graduates tend to reside locally for many reasons including adherence to existing, local ties, sunk 'localization' costs, and risk aversion (Breschi and Lissoni, 2001). Recently, Rothaermel and Ku (2008) examined the effects of university graduates on the innovative performance of local firms. Using data on medical device clusters in the US, they reported a positive effect of the number of university graduates in electrical engineering on the number of medical device patents in the region.

A second role of universities, relevant to the technological activities of firms, relates to the conduct of scientific research leading to an expansion of the knowledge base available for firms to draw on in their technological activities (Klevorick et al., 1995). Scientific research can be defined as experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view (Nelson, 1959; OECD, 2002). At the

[1] An Italian province ('provincia') is an administrative division of intermediate level between a municipality ('comune') and a region ('regione').