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University effects on regional innovation

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ABSTRACT

This paper analyzes empirically whether expansion of a university system affects local industry innovation. We examine how the opening of new university schools in Italy during 1985–2000 affected regional innovation. We find that creation of new schools increased regional innovation activity already within five years. On average, an opening of a new school has led to a seven percent change in the number of patents filed by regional firms. The evidence suggests that the effect is mainly generated by high quality scientific research brought to the region with new schools.

1. Introduction

Between 1960 and 2000, there was a large expansion in universities in the industrialized countries. Early expansion was to deal with the baby boom coming of university age; later expansion was driven by the desire to increase the proportion of the population receiving tertiary education.[1] The clearest effect was just that: an increase in the general education level of the labor force. Naturally, a rise in student numbers tended to be accompanied by a rise in the size of the professoriate and an increase in the sizes and numbers of universities.

University expansion coincided with spectacular rise of innovation activity in industrialized world. In 1963 the US Patent Office granted around 45 thousand patents; by the end of the nineties the yearly number of granted patents approached 160 thousand (Hall et al., 2001). How to maintain this competitiveness and get more innovation out of a knowledge system has become a hotly debated issue. Following the line taken in the literature on innovation systems, it is often suggested that stimulating academic research and close interactions between academia, industry and government are necessary to promote knowledge flows and innovation. These policy suggestions are often based on the idea that universities have within them some of the keys to increasing innovative activity.[2]

The fact that the increase of innovation activity during past decades coincides with the increase in the size of the university sector might suggest that the innovation performance of an economy is determined in part by the supply of universities in the innovation system. This hypothesis motivates our analysis.

There have been many studies of the relationship between universities and industrial innovation, particularly at the regional level (see Section 2.1). The vast majority of these studies analyze cross-sectional data, focusing on either the presence or size of universities and the relationship with local innovation activity. Generally, they document a strong relationship between university research activity and industrial innovation. But there are well-known difficulties in drawing conclusions from cross-sectional analysis about phenomena that take place over time, so while the results are suggestive, one must be cautious in drawing the “obvious” policy conclusions from them, particularly in terms of whether opening new universities is a good idea. Additionally, endogeneity problems are rife in this kind of work – some of the effects of

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[1] According to the Global Education Digest 2009 by UNESCO Institute of Statistics, the share of students in North America and Western Europe that enroll in tertiary education during five years after the end of secondary education increased by 41 percentage points from 30% in 1970 to 71% in 2007.

[2] An OECD 2007 report “Higher Education and Regions: Globally Competitive, Locally Engaged” estimates that only 10% of UK firms currently interact with universities with most university–industry links focusing on big business and a few hi-tech fields. The report concludes that “the potential of higher education institutions to contribute to the economic, social and cultural development of their regions is far from being fully realized”.

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university–industry interaction are driven by supply of knowledge, some by demand for it; external factors may drive both public and private research output simultaneously; the location of universities and firms is often endogenously determined (Mairesse and Mohnen, 2010) – all imply that identifying empirically the effect of universities would ideally rely on exogenous shocks to university supply. Such shocks are rare in real life and most studies rely on strong assumptions to claim the existence of the supply-side effects.

There was, however, a period of several years in the 1980s and 1990s in which Italy opened many new university schools in different regions of the country.[3] University expansion was centralized and, as was acknowledged later by policy makers, the distribution of new schools across regions was largely independent of the properties of the regional economy. In fact no significant correlation can be observed between the number of new schools in a region and regional characteristics including population, share of graduates in the labor force, private and public investment in research and development, and value added produced by different economic sectors. We use this episode to ask directly whether expanding university activity by opening new universities has an identifiable effect on local industrial innovation. This is the first issue we address in this paper.

The second issue has to do with the nature of the relationship between universities and industrial innovation. There have been several studies on the "channels" of interaction between university and industry (see Section 2.2). By and large, these studies are based on firm surveys, asking firms about their external sources of knowledge or information. As one might expect, firms use many different channels for accessing university expertise: academic papers or patents, conferences, seminars, consulting, and so on. But one could frame the question in a slightly different way. What measures of university activity help explain their effects on local innovation? Scientific publications are thought to represent advances in basic knowledge. Patents represent advances in applied knowledge. Both of these activities indicate human capital capable of producing novel knowledge, basic and applied respectively. We construct measures of these activities using data from Thompson ISI and the European Patent Office. Additionally though, universities might possess other competences harder to quantify or describe, for example skills or accumulated knowledge that can be applied to issues other than creating novelty. These too could be of value in industrial innovation activities. In the latter part of the paper we perform an accounting exercise in an attempt to assess whether the human capital associated with creating new basic knowledge, creating new applied knowledge, or something different is what drives the university effect on industrial innovation.

For two reasons we focus on the short-term effects of academic research. First, it is likely that regional collaboration networks grow fastest in the first few years after opening of new university schools. Second, considering the short-run effect of universities allows us to identify the direct influence of academic research on innovation activity and to exclude other channels. In particular, it permits us to avoid the issue of how graduates contribute to innovation.[4] So by focusing on the short term effects, we can identify direct knowledge spillover effects from university faculties to local industries.

Our results suggest that there is indeed a significant effect of the creation of new university schools on regional research and innovation activity. Industrial patenting increases following the introduction of a new school to a region: on average, one new school has led to about a seven percent increase in the number of patents filed by regional firms five years later. But the quality of patents produced as a consequence of university supply shock is not different from the rest of regional patents. Given that the level of development of a region affects its absorptive capacity, one might expect that more developed regions with more intensive R&D activity benefit more from interactions with universities. However, contrary to this hypothesis, we find that less developed regions benefit more from university–industry interactions. Regarding the second issue, we find that the number of academic patents explains essentially none of the effect of universities on innovation. Publications corrected for quality explain most of the effect of universities on local industrial innovation. This suggests that in order to increase regional innovation the intermediate policy goal should be to increase the amount of high quality academic research carried out in the region.

The rest of the paper is organized as follows. Section 2 reviews the existent empirical findings concerning the role of academic research in innovation systems. Section 3 describes the data. Section 4.1 introduces the empirical model and comments on the main identification assumptions. The results of the empirical analysis are provided in Sections 4.2 and 4.3. Finally, Section 5 concludes.

2. Background literature

2.1. Identifying the effect of university R&D

There exists a large literature analyzing the relationship between academic research and industrial innovation activity. That university effects on industrial innovation might be localized stems from the nature of knowledge. While to a great extent the business of universities is to produce codified knowledge, tacit knowledge remains central in the diffusion process (see for example Cowan et al., 2000). While codified knowledge can be diffused very widely, and now very rapidly, tacit knowledge, by its nature, cannot. Jaffe et al. (1993) showed that diffusion of the knowledge contained in patents, which are by definition highly codified, has a strong geographical pattern – diffusion is very much local, and access to the knowledge spreads geographically over time. Breschi and Lissoni (2009) revisited this issue and showed that in fact it is social rather than geographic distance over which the diffusion takes place. That is, inventors learn about the existence of a patent (and presumably the knowledge it contains) through their direct social contacts. Since most social contacts are local, we can expect (geographically) localized knowledge diffusion.

As early as the 1980s it was suggested that technology clusters such as those in Massachusetts and California would be impossible without the technology transfer from universities in these areas (Saxenian, 1985; Dorfman, 1983). It was not long though, before several case studies questioned the generality of the role of university as an accelerator of regional innovation (Feldman, 1994a; Rogers and Larsen, 1984) and suggested that various characteristics of regional technological infrastructure (business services,

[3] In the Italian system teaching is organized into schools (*facoltà*) and research is organized into departments (*dipartimenti*). Departments and schools may or may not coincide. To simplify presentation, we refer only to "schools", and our measure of the date of opening of a new school is the year in which the first class was registered within a newly formed school. This should not be read to imply that university expansion affected only teaching. A new school in most cases implied creation of a new department. This conflation of schools and departments, teaching and research units, is not an issue for our analysis, as both measure university presence in the region.

[4] The effects of an increased quantity and quality of graduates in a region are likely to be very diffuse and hard to identify. However, they do not emerge within five years after a school opens: the official duration of most degrees in Italy (in the period analyzed) is five years. But fewer than 20% of graduates complete their education on time and, on average, students take two more years to graduate after the end of the official program (Bagues et al., 2008).