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Universities, Entry and Growth

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Universities, Entry and Growth

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Abstract

In this study we explore the extent to which entrepreneurship represents an effective mechanism to transform academic knowledge in economic growth. Specifically, we evaluate how three academic activities, teaching, research and IPR management, affect entry in the manufacturing sector and economic performance in 103 Italian provinces (NUTS3) between 2001 and 2006. For this purpose, we distinguish two main contributions of academic activities to local economies. Firstly, academic outputs can foster the entry of new ventures because the spillover of academic knowledge is at least partially captured as new companies. Secondly, academic knowledge can be exploited by new ventures and established firms and hence spur economic growth. We implement a recursive model where economic growth and entry are mutually reinforcing phenomena. Our findings show that academic outputs do not promote higher entry as entry seems to depend mainly on the presence of an existing industrial base. Rather, universities provide local entrepreneurs with knowledge of high economic potential. New ventures in high-tech manufacturing that have access to knowledge from scientifically productive universities positively influence growth. These findings support the thesis that new ventures are an effective vehicle to bring relevant knowledge to the market place.

1. Introduction

How does knowledge spur growth? Theories of endogenous growth have tended to use the informational characteristics of knowledge as introduced by Arrow (1962) to explain endogenous growth trajectories (Romer, 1986; Lucas, 1988). According to these theories, the sole generation of knowledge would spur growth because such knowledge is only partially appropriable and it spills over to third parties that would in turn use it to generate new knowledge and useful ideas. Although these theories have predicted general patterns of growth, they fail in explaining the several “paradoxes” that are recently crowding decision-makers’ agendas. Some scholars have proposed that it is not investments in knowledge per se that spur growth and thus competitiveness; rather the critical facet of the process of knowledge generation is the commercialization of the results stemming out of the knowledge produced (Acs et al., 2007; Audretsch and Keilbach, 2008). These authors posit the existence of a “knowledge filter” between the investments in knowledge and their economic exploitation. Such a filter results from the inherent peculiarities of knowledge, as opposed to information. Knowledge generating activities produce uncertain economic results; they are associated with high degrees of asymmetries between inventors and potential exploiters. Finally, high uncertainty and high asymmetries foster high transaction costs for transferring knowledge among economic agents (Audretsch, 2007). These characteristics are even more emphasized when knowledge is generated in academic laboratories. A strand of literature in the sociology and economics of science has stressed how the incentive system in place in the academic community would rarely lead scientists to produce findings of immediate industrial application (Dasgupta and David, 1994; Stephan, 1996). The recent involvement from universities in technological development has shown that whenever academic findings show potential technological applications, they are at an early stage of development and tend to serve several industrial purposes (Colyvas et al., 2002; Jensen and Thursby, 2001).

In such a context, entrepreneurship is seen as the main mechanism that ensures the flow of radical knowledge in the economy and eventually its economic exploitation (Audretsch, 1995; Klepper and Sleeper, 2005; Schumpeter, 1934). Schumpeter (1934) was the first to propose the notion that new and independent ventures bear the main responsibilities in the process of economic growth through innovations, something he defined as “creative destruction”. The main rationale underlying this argument is that large players would oversee promising ventures because locked in existing products (Christensen, 1997; Hill and Rotharmel, 2003).

In this study we explore the extent to which entrepreneurship represents an effective mechanism to transform academic knowledge into economic growth. Specifically, we evaluate the contribution of three academic activities, viz. teaching, research and IPR management, to economic performance in 103 Italian provinces between 2001 and 2006. For this purpose, we distinguish two main contributions of universities to local economies. Firstly, academic outputs can facilitate the entry of new ventures as the spillover of academic knowledge is at least partially captured as new companies. Secondly, academic knowledge can be exploited by new ventures and established firms and hence spur economic growth. We implement a recursive model where economic growth and entry are mutually reinforcing phenomena. Our findings show that academic outputs do not promote higher entry. Rather, entrepreneurial opportunities have larger importance for growth when they have access to knowledge from scientifically productive universities.

The study is organized as follows. In Section 2 we present the existing literature on the importance of academic activities for growth and the relevance of new ventures and existing companies in appropriating and economically exploiting academic outputs. Section 3 introduces the estimation strategy and describes the variables used. Section 4 presents and discusses the estimation results. Finally, Section 5 concludes, summarizing the main results in the paper.

2. Academic Knowledge, Diffusion and Growth

2.1 Universities and Economic Growth

The role of modern higher education institutions (universities henceforth) in the economic performance of firms, sectors, regions and countries has several facets. Traditionally established with the aim of educating civil servants for the newly created European states, universities have embraced a second mandate of institutionalizing the production of fundamental knowledge. The two activities – teaching and basic research – have been complemented by the more recent entrepreneurial attitude of academic organizations engaging in research collaborations with private parties through licensing, sponsored research and new venture creations (Etzkowitz and Leyersdorf, 1998).

Education is maybe the oldest contribution of academic activities to economic growth. It is usually associated with the formation of higher levels of human capital, expressed as the development and refinement of specific individual knowledge and capabilities. The increase in human capital enables individuals to perform higher value-added tasks more efficiently and

quickly, which translates in higher productivity of labour and capital (Becker, 1964; Barro, 1991; Lucas, 1988). Moreover, students have been found to be one of the main channels of knowledge transmission to the industry (Nelson and Wright, 1992; Murnmann, 2003). According to the authors, students have represented a critical conduit of the latest techniques and theoretical know-how from academic laboratories to the corporate ones in the chemical, mining and pharmaceutical industry. Also in the case of biotechnology, even more than by direct R&D expenditures firm performance has been driven by the supply of highly skilled graduates in life sciences, which has eased both the adoption of new process technologies and the commercialization of new products (Patel et al., 2006).

Secondly, universities are the most prominent producers of fundamental knowledge. Knowledge has been largely understood as one of the main drivers of economic growth. The theories of endogenous growth built upon the informational characteristics of knowledge as introduced by Arrow (1962) suggest that the generation of knowledge would enhance the production of more efficient processes and products and hence it would spur growth (Romer, 1986). However, scholars in the economics of technical change have long focused their attention to research and development activities (R&D henceforth) performed in corporate laboratories to explain technology-driven growth. Indeed, knowledge produced in academic laboratories is of somewhat different nature. Academic scientists pursue research goals which are informed by their personal curiosity and by the reward system in the academic community, based on peer recognition rather than on monetary compensations (Merton, 1973). Hence, academic findings rarely have immediate industrial applications. Rather, they expand the theoretical pool of knowledge from which technical advances of commercial value can be built upon. See Sanders (2007) for an endogenous growth model built precisely on this notion of scientists expanding the available pool of entrepreneurial opportunities. Adams (1990) shows that between 1949 and 1983 it took around 20 years for scientific advancements to be absorbed and exploited by industries and thus led to productivity growth.

Thirdly, the time lag of academic knowledge to result in economic gains has shortened in the last three decades or so. Three main facts highlight this convergence between science and technology: a) the higher productivity of corporate R&D led by the increasing pervasiveness of scientific approaches in corporate R&D as opposed to trial-and-error methods (Arora and Gambardella, 1994); b) the rise of new science-based sectors in which the innovation process depends mostly on developments arising from academic R&D, i.e. ICT and Biotechnology, as key sectors in industrialized countries (Zucker et al, 1998a; Pisano, 2006) and c) the increasing involvement of universities in commercialization activities such

as sponsored research, technology licensing and equity positions in academic spinoffs (Fuller, 1990; Di Gregorio and Shane, 2002; Henderson et al., 1998).

Notwithstanding the increasingly relevance of universities in technological progress, and leaving for the moment aside the discussion on whether universities should target more vocational or conceptual education (Kruger and Kumar, 2004), the transfer of technologies to the industry have several hindrances which result from the inherent peculiarities of knowledge, as opposed to information. Knowledge generating activities produce uncertain economic results; they are associated with high degrees of asymmetries between inventors and potential exploiters. Finally, high uncertainty and high asymmetries spur transaction costs for transferring knowledge among economic agents (Audretsch, 2007). These characteristics are even more prominent for knowledge generated in academic laboratories. According to a burgeoning body of literature in the economics and management of technology transfer, academic technologies are mainly at an early stage of development, general in purpose, characterized by high uncertainty about their effective applications, and demand further development efforts from the buyers and inventors to be commercialized (Colyvas et al., 2002; Jensen and Thursby, 2001; Jensen et al., 2003).

2.2 Diffusion of Academic Knowledge: Users and Location

2.2.1 New Ventures and Established Firms

In the context of academic knowledge and technical solutions, one line of reasoning points to entrepreneurship as the main mechanism that ensures the flow of them in the economy and eventually its economic exploitation (Acs et al., 2005; Audretsch, 1995; Klepper and Sleeper, 2005). Several explanations in the literature suggest that new ventures are more likely to embark in the risky activity of bringing to the market radical new technologies, as the ones developed in academic laboratories, than established firms. New products or solutions are often rejected by the latter as they already enjoy rents from market power; furthermore incumbents are organized in order to commercialize existing technologies being already embedded in established networks of customers and suppliers (Christensen, 1997; Hill and Rotheamel, 2003). Hence, new ventures are fitter to transform knowledge with high economic impact. Evidence on the critical role of new ventures in exploiting radical academic technologies is supported by the case of the electronics industry (Bania et al., 1993) and for biotechnology (Zucker et al. 1998a). However, systematic evidence on this topic has

concluded that academic R&D exerts only a modest effect on the entry of new firms in the proximity of research universities.

A second line of arguments points to established firms as better endowed to absorb academic knowledge and exploit it commercially. The ability of firms to absorb knowledge from external sources ultimately depends on their investments in knowledge creation (Cohen and Levinthal, 1990; Cassiman and Veugelers, 2002). Whereas the existence of sunk investments such as dedicated human and/or physical capital might restrict the range of acquirable knowledge (corporate myopia), it shortens the time to market of new products and processes embedding the newly acquired knowledge. In addition, established actors possess the necessary capabilities to market new processes and products as they can benefit from an existing customer base. Finally, incumbents are expected to show some degrees of internal organizations, which facilitate the hiring of higher-educated personnel and hence the transfer of knowledge through human capital (Piva et al., 2005).

2.2.2 Location and other factors

Theory and evidence agree on the limited spatial reach of knowledge spillovers, both in case of a start-up or an established company (Jaffe, 1989). The spillover of academic knowledge through new ventures is likely to be spatially bounded. Irrespective of the mode of commercialization, new ventures exploiting knowledge developed in academic laboratories are likely to locate nearby the main source of expertise (the inventors). In addition, academic entrepreneurs choose to locate at commuting distances from the university as they prefer retaining the academic employment (Shane, 2004). More systematically, there exists a positive relation between academic R&D spending and entry of new ventures (Banias et al., 1993; Harhoff, 1999; Woodward et al., 2006). By the same token, when incumbents are interested in investing in the acquisition of academic knowledge, it is also likely that they will be at close distances from the university, as the commercial development of academic knowledge demands strong commitment and involvement from the holder of the tacit knowledge (Agrawal, 2006; Jensen et al., 2003; Wright, 2002). Hence, for the transaction to be successful, incumbents prefer neighbouring universities (Mansfield and Lee, 1996).

In addition to geographical distance, necessary to ease personal contacts and thus effective transfer of tacit knowledge, some other considerations have to be made. A first issue concerns the quality of the knowledge to be transferred. The interest in the role of academic R&D as driver of growth through entry draws largely on the examples of ICT and Biotech in California and Massachusetts, which host some of the most prolific scientific universities

worldwide (Saxenian, 1994). The link between the quality of research outputs and the likelihood of generating technologically useful knowledge has received empirical support from a burgeoning body of literature in the field of technology transfer. This literature has fleshed out that highly productive scientists are also those who engage in technological developments: they manage contractual agreements with industrial partners, engage in consulting relationships and fund companies (Agrawal and Henderson, 2002; Azoulay et al., 2009; Di Gregorio and Shane, 2003; Zucker et al., 1998b). Abramovsky et al. (2007) conduct a systematic exploration of the determinants of location and entry of corporate R&D and quality of academic research in Great Britain. The authors show that top-quality research in Chemistry is related to entry in the pharmaceutical industry, whereas lower tier departments in other disciplines seem to have more relevance in location decisions of other R&D-performing firms.

A second concern about the effective contribution of academic research to economic growth stresses the role of university policies in commercialization issues. Faculty in universities that openly oppose any involvement in commercialization activities might exert little if any influence on the transfer of academic knowledge (Owen-Smith and Powell, 2001; Feldman and Desroches, 2003). Feldman and Desroches (2003) provide a detailed case of how the “reluctance to allow commercial interests to influence faculty research agendas and an abhorrence to engage in activities that might involve proprietary restrictions on knowledge dissemination” at the John Hopkins University, despite its scientific eminence, slowed down the emergence of a high-technology cluster in the Baltimore area.

3. Estimation strategy

The main goal of this study is to evaluate the contribution of a range of academic outputs to economic performance. For this purpose, we distinguish two main contributions of universities to local economies: universities can facilitate the diffusion of knowledge through the entry of new ventures and established firms. Theory and empirical evidence suggest that new ventures are more likely to introduce novel solutions in the marketplace than their established counterparts. However, established firms appear better at absorbing knowledge from academic laboratories.

We firstly aim to measure empirically the relevance of university outputs in the determination of business entry. Secondly, we assess the contributions of established

companies and new ventures in contributing to economic growth. For this purpose, we estimate two models:

$$\text{a) } \text{Entry}_{(i,t)} = f(\text{Growth}_{(i,t-1)}; \text{University}_{(i,t)}; Z_{(i,t)})$$

$$\text{b) } \text{Growth}_{(i,t)} = g(\text{Entry}_{(i,t)}; \text{University}_{(i,t)}; \text{Established}_{(i,t)}; W_{(i,t)})$$

where Z is a set of structural characteristics that can potentially determine the rate of entry in the manufacturing sectors and W is a set of additional explanatory factors affecting growth. Equation (a) and equation (b) are recursively related: new ventures promote growth and growth encourages potential entrepreneurs.

3.1 *Universities and Entry*

In order to test whether the presence of universities facilitate the entry of new ventures in the marketplace, we model entry as a function of several outputs of academic activities, the presence of science parks and other control factors in the province. All measures are reported between 2001 and 2006, unless stated differently.

We measure entry rate in two ways. In a first specification, we use the gross number of new registrations in the manufacturing sector each year (t ranging between 2001 and 2006) divided by the total labour force in the province (i indicates the 103 provinces).

$$1) \quad E_{(i,t)} = \text{new registrations}_{(i,t)} / \text{Labor}_{(i,t)}$$

In a second specification, we employ the net number of new businesses registered in each year calculated as follows

$$2) \quad e_{(i,t)} = (\text{new registrations}_{(i,t)} - \text{cancelations}_{(i,t)}) / (\text{Labor}_{(i,t)})$$

Moreover, entry in some sectors can rely on academic activities to a greater extent. We thus differentiate entry in high-tech entry and in low-tech entry (according to their R&D intensity), as it presumably reflects the extent to which economic activities depend on external knowledge sources, i.e. universities¹. Entry in the high-tech sectors encompasses new registrations in the sectors of Electric and Electronic Equipments, Chemicals, Automotive and Machinery. It represents 16.6% of all new registrations during the period of analysis, ranging between 3.6% and 38.7% in the provinces. We denote the entries in the remaining sectors as low-tech. They represent the bulk of the Italian manufacturing sector: on average 81.8% of all

¹ We follow the sectors aggregation used in EUROSTAT. Although four classifications are proposed – high, medium high, medium-low and low tech – we grouped the first two in high-tech and the remaining in low-tech.

companies operate in these sectors, ranging from 59% to 92.3% across provinces. Gross and net entry in low-tech and high-tech manufacturing is defined as the following

$$3) HT_E_{(i,t)} = \text{high-tech new registrations}_{(i,t)} / Labor_{(i,t)}$$

$$4) LT_E_{(i,t)} = \text{low-tech new registrations}_{(i,t)} / Labor_{(i,t)}$$

$$5) ht_e_{(i,t)} = (\text{high-tech new regs}_{(i,t)} - \text{high-tech cancelations}_{(i,t)}) / (Labor_{(i,t)})$$

$$6) lt_e_{(i,t)} = (\text{low-tech new regs}_{(i,t)} - \text{low-tech cancelations}_{(i,t)}) / (Labor_{(i,t)})$$

Information about entry in Italian provinces was retrieved from the database *Movimprese*, provided by *UnionCamere*, the Italian Association of Chambers of Commerce. It contains yearly new registrations and cancellations at each provincial chamber of commerce. Data are further organized per 2-digit NACE sector.

As reported above, the relationship between entry and economic growth is recursive. We hence include the growth rate as explanatory variable ($GROWTH_{(i,t-1)}$). It is lagged by one year as it is assumed that the decision to start a business and the start-up date can take some time due to the fulfilling of logistic and bureaucratic obligations.

We control for entry in the previous year ($E_{(i,t-1)}$). This variable serves two main purposes. Firstly, we partially avoid problems of omitted variables as some areas can support a more favorable environment to venture creations that we cannot control for. Secondly, entry and exit represent two processes that characterize disequilibria in the number of firms a can sustain. The adjustment to the equilibrium number is partial over time and hence some provinces that are undergoing a similar process can witness persistent entry (Carree and Turik (1999)).

Three indicators of academic outputs are included in the analysis. First, we measure the educational mandate of universities as the share of Science and Technology (S&T) graduates over the local population (STUDS). Information on the number of students was retrieved from the statistical office of the Ministry of Higher Education and Research². It reports the number of graduates from each university, the faculty, the location of the teaching activities and whether the students attained vocational education. We retrieved data on graduates in 2000 (excluding vocational degrees) and aggregated according to the location of

² www.mur-statistica.it

the university which issued the degree. Indeed, over the last two decades larger institutions have delocalized teaching activities in adjacent provinces to meet the local demand for education.

The second measure of academic output is related to scientific research (PUBS). We accounted for the internationally recognized scientific production in Science and Technology fields. Data about scientific production was collected by Breno et al. (2002) and provided by the Institute for Scientific Information (ISI). The authors reported all articles between 1985 and 1999 with at least one author affiliated to Italian universities. Data were then aggregated at provincial level, when necessary. The long timeframe aims at considering the potentially useful accumulated stock of scientific knowledge produced by institutions. Moreover, it discerns between those institutions that obtain the legal status of universities in the late 1990s and universities with longer tradition. Finally, we divided the number of ISI publications by the number of researchers in science and technology disciplines at Italian universities in 2000.

Thirdly, the technological activity of universities is included (UNI_PATS). We used the share of national patent applications from universities between 1995 and 2000 over the total provincial patenting activity in the same years. Information about university patenting was obtained from *Patjunkie*, a web-based patent search engine realized by the Bologna University based research group IRIS³. We are aware that this measure is strongly biased downward as Italian academic professors tend to leave ownership of their inventions to companies (Lissoni et al., 2007). Although information regarding the patenting activities of academic inventors is available, focusing on academic inventors would raise problems of localization of technological activities as academic inventors are mobile during their careers; we thus avoid some inconveniences due to the gathering procedure.

Last, we include a dummy for the presence of science parks in the province. Science parks differ from other measures listed above as they are usually set up by local governments. They have been found to provide a nurturing environment for business ventures and value adding services to clients (Mian, 1996). The location of science parks was retrieved from the web site of the Italian Association of Technology and Science Parks (APTISI).

The reader might have noticed that the variables concerning academic outputs are time invariant and measured in the pre-sample period. This choice is twofold. First of all, academic outputs hardly vary significantly over time. Larger universities issue more degrees than

³ <http://www.evp.at.net/patjunkie/search.asp>

smaller ones and the number of degrees remains quite stable; scientific production is rather consistent over short time periods. On the other hand, technological production in academic laboratories is subject to high levels of disturbance in the short run. Secondly, for academic knowledge to bear its economic fruits, it needs to diffuse. It is reasonable to consider a quite long time frame between the generation of academic knowledge and its economic implications.

Other factors encouraging entry are the presence of agglomeration economies (AGGLO), the presence of business services (BUS_SER) and the quality of road infrastructures (INFRA).

Agglomeration economies can arise both from specialization of regions in some specific industries (Marshall-Arrow-Romer hypothesis) or from diversification of the economic activities (Jacob hypothesis). By the same token, they can signal concentration of economic activities and subsequent high competition both upstream and downstream. We measure agglomeration economies as the number of manufacturing establishments per 1000 employees (*Movimprese*). In an alternative specification, we differentiate between agglomerations of high-tech manufacturing (AGGLO_HT) and of low-tech manufacturing (AGGLO_LT) where we account for establishments in the high-tech and low-tech manufacturing sector respectively. Business Services (BUS_SER) is measured as the share of the workforce in the business service sector (ISTAT). They can advice companies in a variety of issues ranging from the credit and real estate to the legal, fiscal and marketing domain. Finally, the quality of infrastructures is crucial to ease accessibility to suppliers, markets and other sources of information. We use an index of road infrastructures developed by the Istituto Tagliacarne and UnionCamere in 2000 (INFRA). We exclude railway transportation as they only account for a small fraction of passengers and freighting.

We hence estimate the following equations:

$$a.1) \quad E_{(i,t)} = a_1 + b_{11} * Growth_{(i,t-1)} + b_{12} * E_{(i,t-1)} + b_{13} * Studs_{(i)} + b_{14} * Pubs_{(i)} + b_{15} * Uni_Pats_{(i)} + b_{16} * Sc_Park_{(i)} + b_{17} * Agglo_{(i,t-1)} + b_{18} * Bus_Ser_{(i,t-1)} + b_{19} * Infra_{(i)} + \varepsilon_{(i,t)}$$

$$a.2) \quad HT_E_{(i,t)} = a_2 + b_{21} * Growth_{(i,t-1)} + b_{22} * E_{(i,t-1)} + b_{23} * Studs_{(i)} + b_{24} * Pubs_{(i)} + b_{25} * Uni_Pats_{(i)} + b_{26} * Sc_Park_{(i)} + b_{27} * Agglo_LT_{(i,t-1)} + b_{28} * Agglo_HT_{(i,t-1)} + b_{29} * Bus_Ser_{(i,t-1)} + b_{20} * Infra_{(i)} + \varepsilon_{(i,t)}$$

- a.3) $LT_E_{(i,t)} = a_3 + b_{31} * Growth_{(i,t-1)} + b_{32} * E_{(i,t-1)} + b_{33} * Studs_{(i)} + b_{34} * Pubs_{(i)} + b_{35} * Uni_Pats_{(i)} + b_{36} * Sc_Park_{(i)} + b_{37} * Agglo_LT_{(i,t-1)} + b_{38} * Agglo_HT_{(i,t-1)} + b_{39} * Bus_Ser_{(i,t-1)} + b_{30} * Infra_{(i)} + \mathcal{E}_{(i,t)}$
- a.4) $e_{(i,t)} = a_4 + b_{41} * Growth_{(i,t-1)} + b_{42} * E_{(i,t-1)} + b_{43} * Studs_{(i)} + b_{44} * Pubs_{(i)} + b_{45} * Uni_Pats_{(i)} + b_{46} * Sc_Park_{(i)} + b_{47} * Agglo_{(i,t-1)} + b_{48} * Bus_Ser_{(i,t-1)} + b_{49} * Infra_{(i)} + \mathcal{A}_{(i,t)}$
- a.5) $ht_e_{(i,t)} = a_5 + b_{51} * Growth_{(i,t-1)} + b_{52} * E_{(i,t-1)} + b_{53} * Studs_{(i)} + b_{54} * Pubs_{(i)} + b_{55} * Uni_Pats_{(i)} + b_{56} * Sc_Park_{(i)} + b_{57} * Agglo_LT_{(i,t-1)} + b_{58} * Agglo_HT_{(i,t-1)} + b_{59} * Bus_Ser_{(i,t-1)} + b_{50} * Infra_{(i)} + \mathcal{E}_{(i,t)}$
- a.6) $lt_e_{(i,t)} = a_6 + b_{61} * Growth_{(i,t-1)} + b_{62} * E_{(i,t-1)} + b_{63} * Studs_{(i)} + b_{64} * Pubs_{(i)} + b_{65} * Uni_Pats_{(i)} + b_{66} * Sc_Park_{(i)} + b_{67} * Agglo_LT_{(i,t-1)} + b_{68} * Agglo_HT_{(i,t-1)} + b_{69} * Bus_Ser_{(i,t-1)} + b_{60} * Infra_{(i)} + \mathcal{E}_{(i,t)}$

3.2 Universities, Entry and Growth

Equation (b) tests for the contribution of the measures of academic output to economic growth. As we highlighted in section 2, two main mechanisms ensure the flow of academic knowledge to the economy: new ventures and established companies. We hence model growth as function of entry in the same year, of the size of manufacturing workforce, the same set of academic outputs as reported in Equation (a) and their interaction with entry and the manufacturing workforce.

We employ two measures of economic growth. The first one (GROWTH) reflects the overall economic performance of a local economy and it is calculated as the relative rate of growth of value added or of employment per province

$$7) \quad \Delta VA_{(i,t)} = (VA_{(i,t)} - VA_{(i,t-1)}) / VA_{(i,t-1)}$$

$$8) \quad \Delta EMP_{(i,t)} = (EMP_{(i,t)} - EMP_{(i,t-1)}) / EMP_{(i,t-1)}$$

The second dependent variable represents a crude approximation of the competitiveness of the manufacturing industry and it is measured as the relative rate of growth of value added or employment restricted to the manufacturing and mining sector per province (ISS_GROWTH).

$$9) \quad \Delta VA_ISS_{(i,t)} = (ISS_VA_{(i,t)} - ISS_VA_{(i,t-1)}) / ISS_VA_{(i,t-1)}$$

$$10) \quad \Delta EMP_ISS_{(i,t)} = (EMP_ISS_{(i,t)} - EMP_ISS_{(i,t-1)}) / EMP_ISS_{(i,t-1)}$$

We include the one-period lagged dependent variable to account for cumulative causations.

We use the gross rate of entry in the manufacturing sector ($E_{i,t}$) to accommodate for the direct effects of the entrepreneurial activities in the province to economic growth in the short run⁴. In a second specification of the same equation, we distinguish between high-tech entry rates (HT_E) and low-tech entry rate (LT_E)⁵. Entry is calculated as in 1), 3) and 4). Regional industrial structure can affect the growth rate of local economies and the extent to which agglomeration economies emerge. We use three measures to account for the industrial composition of the regional economies and its innovativeness. The manufacturing sector is the most likely sector to benefit from scientific and technical advancements and translate them in economic growth in the short run. The presence of the manufacturing sector (ISS) is measured as the share of the labor force in the industry sector (source: *ISTAT*). Furthermore, the ability of the latter to absorb and exploit external knowledge ultimately depends on its current innovative performance (Cohen and Levinthal, 1990). We hence control for the degree of innovativeness of the manufacturing sector (PAT_ISS). It is defined as the number of national patents granted per 1000 employees in the industry sector and it is lagged of one year (source: *UMBI*). The presence of the business service sector indicates the level of development of the manufacturing sector and the existence of agglomeration economies due to diversification. We include the share of workforce employed in the business service sector (BUS_SER).

Measures of university presence have been already presented in the previous section. We will briefly describe their implications for growth. The share of S&T graduates per resident provides a measure of the relevance of student population in a local economy (STUDS). There are at least two effects of the presence of large teaching universities with respect to growth. First of all, large portions of students per resident population can hamper economic growth as their spending power may be limited as compared to workers. Secondly, they signal the extent to which high-quality human capital is present in the province: the hiring of graduates from local companies can result in higher productivity growth. However,

⁴ See Fritsch and Muller (2004) for a summary of direct and indirect effects of entry on economic growth. According to the authors, entry of new business adds new capacities to the existing ones and hence causes current increases in employment.

⁵ Unlike in the Equation (a), where we have used both gross and net entry rates, we here focus only on the gross entry. The reason is that we use also interaction terms of entry with measures of academic activities. Interacting net entry would lead to results of difficult interpretation as it is made of two components: gross entry and exit.

this effect is mediated by the ability to absorb the human capital by a local industrial base. To control for the latter, we interact STUDS with our measure of entry (E). We do not expect the latter variable to have an influence on economic growth as new ventures may prefer to hire experienced workers to make use of their social capital.

The scientific productivity of the academic personnel (PUBS) may represent a proxy of the quality of the knowledge produced in academic laboratories. However, the implications for growth remain unclear. Scientific productivity has been found to be a good predictor of technological solutions as theoretical advancements might either improve existing technologies or require new ones to tackle new scientific challenges (Franzoni, 2007). For academic knowledge to translate in economic growth it needs to be brought to the marketplace. We hence interact PUBS and E to control for the diffusion of scientific knowledge. We expect new ventures to introduce solutions of greater economic impact when compared to established companies.

Given the limited extent of the direct involvement by universities in IPR-related issues, it can hardly have a direct effect on growth (UNI_PATS). However, technological activities at academic laboratories may indicate the orientation of academic research towards industrial applications and the propensity to collaborate with external partners. This can turn be beneficial for established companies and new ventures unaffected by institutional frictions. We control for these effects with two variables resulting from the interaction between UNI_PATS and ISS and UNI_PATS and E.

Finally, we control for the quality of road infrastructures (INFRA) measured as in Equation (a) and the one-year lagged level of value added per capita (VAPC). The latter variable controls for the heterogeneity of productivity and income across Italian provinces. We estimate the following equations:

$$\begin{aligned} \mathbf{b.1)} \quad \Delta VA_ISS_{(i,t)} = & d1 + c_{11} * \Delta VA_ISS_{(i,t-1)} + c_{12} * E_{(i,t)} + c_{13} * ISS_{(i,t-1)} + \\ & c_{14} * BUS_SER_{(i,t-1)} + c_{15} * PAT_ISS_{(i,t-1)} + c_{16} * STUDS_{(i)} + c_{17} * PUBS_{(i)} + \\ & c_{18} * UNI_PATS_{(i)} + c_{19} * SC_PARK_{(i)} + c_{10} * STUDS_{(i)} * E_{(i,t)} + c_{101} * PUBS_{(i)} * E_{(i,t)} + \\ & c_{102} * UNI_PATS_{(i)} * E_{(i,t)} + c_{103} * INFRA_{(i)} + c_{104} * VAPC_{(i)} + vI_{(i,t)} \end{aligned}$$

$$\begin{aligned} \mathbf{b.2)} \quad \Delta EMP_ISS_{(i,t)} = & d2 + c_{21} * \Delta EMP_ISS_{(i,t-1)} + c_{22} * E_{(i,t)} + c_{23} * ISS_{(i,t-1)} + \\ & c_{24} * BUS_SER_{(i,t-1)} + c_{25} * PAT_ISS_{(i,t-1)} + c_{26} * STUDS_{(i)} + c_{27} * PUBS_{(i)} + \end{aligned}$$

$$c_{28} * UNI_PATS_{(i)} + c_{29} * SC_PARK_{(i)} + c_{20} * STUDS_{(i)} * E_{(i,t)} + c_{201} * PUBS_{(i)} * E_{(i,t)} + c_{202} * UNI_PATS_{(i)} * E_{(i,t)} + c_{203} * INFRA_{(i)} + c_{204} * VAPC_{(i)} + v2_{(i,t)}$$

$$\mathbf{b.3) } \Delta VA_{(i,t)} = d3 + c_{31} * \Delta VA_{(i,t-1)} + c_{32} * E_{(i,t)} + c_{33} * ISS_{(i,t-1)} + c_{34} * BUS_SER_{(i,t-1)} + c_{35} * PAT_ISS_{(i,t-1)} + c_{36} * STUDS_{(i)} + c_{37} * PUBS_{(i)} + c_{38} * UNI_PATS_{(i)} + c_{39} * SC_PARK_{(i)} + c_{30} * STUDS_{(i)} * E_{(i,t)} + c_{301} * PUBS_{(i)} * E_{(i,t)} + c_{302} * UNI_PATS_{(i)} * E_{(i,t)} + c_{303} * INFRA_{(i)} + c_{304} * VAPC_{(i)} + v3_{(i,t)}$$

$$\mathbf{b.4) } \Delta EMP_{(i,t)} = d4 + c_{41} * GROWTH_{(i,t-1)} + c_{42} * E_{(i,t)} + c_{43} * ISS_{(i,t-1)} + c_{44} * BUS_SER_{(i,t-1)} + c_{45} * PAT_ISS_{(i,t-1)} + c_{46} * STUDS_{(i)} + c_{47} * PUBS_{(i)} + c_{48} * UNI_PATS_{(i)} + c_{49} * SC_PARK_{(i)} + c_{40} * STUDS_{(i)} * E_{(i,t)} + c_{401} * PUBS_{(i)} * E_{(i,t)} + c_{402} * UNI_PATS_{(i)} * E_{(i,t)} + c_{403} * INFRA_{(i)} + c_{404} * VAPC_{(i)} + v4_{(i,t)}$$

Table 1 presents the descriptive statistics for the two sets of equations that we estimate. The upper part presents the dependent variables of both sets of equations, whereas the bottom part presents the independent variables.

Table 1: Summary Statistics for equation a.1 - a.6 and equation b.1 – b.4

Equation	Variable	Obs	Mean	Std. Dev.	Min	Max
Dependent						
<i>Entry</i>	E	618	1.381	0.711	0.490	9.931
	HT_E	618	0.222	0.108	0.029	0.771
	LT_E	618	1.159	0.673	0.389	9.578
	e	618	-0.345	0.422	-2.112	1.389
	ht_e	618	-0.025	0.109	-0.579	0.464
	lt_e	618	-0.299	0.372	-1.981	1.197
<i>Growth</i>	D_va_iss	618	0.020	0.049	-0.117	0.214
	D_emp_iss	618	0.004	0.037	-0.112	0.155
	D_va	618	0.044	0.031	-0.049	0.142
	D_emp	618	0.013	0.023	-0.066	0.103
Independent						
<i>Entry</i>	E (t-1)	618	1.419	0.650	0.493	8.060
	HT_E (t-1)	618	0.232	0.110	0.035	0.771
	LT_E (t-1)	618	1.188	0.610	0.389	7.680
	e (t-1)	618	-0.276	0.406	-2.037	1.389
	ht_e (t-1)	618	-0.015	0.108	-0.579	0.464
	Lt_e (t-1)	618	-0.242	0.357	-1.902	1.197
	Agglo (t-1)	618	31.847	8.902	15.893	88.197
	Agglo_ht (t-1)	618	5.685	1.985	1.883	13.240
	Agglo_lt (t-1)	618	26.161	8.241	11.835	81.381
<i>Entry & Growth</i>	Student_pop	618	0.711	1.080	0.000	5.471
	Publ_prof	618	2.035	3.048	0.000	20.547
	Uni_pats	618	0.001	0.002	0.000	0.011
	Sc_park	618	0.233	0.423	0.000	1.000
	Infra	618	1.057	0.381	0.529	2.406
	Bus_serv (t-1)	618	0.118	0.025	0.063	0.230
L_vapc (t-1)	618	3.893	0.112	3.561	4.149	
<i>Growth</i>	D_vaiss (t-1)	618	0.024	0.054	-0.117	0.225
	D_empiss (t-1)	618	0.004	0.041	-0.116	0.155
	D_va (t-1)	618	0.047	0.031	-0.049	0.142
	D_emp (t-1)	618	0.013	0.024	-0.066	0.103
	ISS (t-1)	618	0.218	0.095	0.060	0.442
	Pat_iss (t-1)	618	0.127	0.073	0.000	0.623

4 Results

4.1 Entry

Table 2 reports the results for the set of entry equations. The first three columns show the estimations for gross entry; the second set of three columns reports the coefficients for net entry. Column 1 refers to gross entry in the whole manufacturing sector, whereas column 2 and 3 consider gross entry in high and low tech manufacturing, respectively. Column 4 reports the estimation results for net entry in the whole manufacturing sector and column 5

and 6 again refer to high and low tech manufacturing. The postulated model has better explanatory power when we deal with gross entry, as it explains between 70.2% and 87.5% of the variation in gross entry in the manufacturing sector across 103 provinces between 2001 and 2006. The proportion of the explained variance drops to 36.3% - 40.9% in the models with net entry as dependent variable.

The coefficient of the lagged value added growth variable is negative, but not significant at a 5% significance level. Provinces which experience higher growth rate in value added might witness lower gross entry in the manufacturing sector. However, from column 2 and 3 we observe that this result is driven by the lower entry in the lower-tech manufacturing, whereas high-tech is not sensitive to growth. When we then move to columns 4, 5 and 6, where net entry is considered, the effects of economic growth on entry vanish.

The amount of science and technology graduates has no effect on entry, irrespective of the correction for exit and the technological intensity of the sectors. The intensity of research activities in science and technology disciplines does not lead to higher entry – column 1 to 3. However, from columns 4 to 6 we can deduce that higher scientific productivity is associated to higher net entry, hence lower exit rates. Surprisingly to a certain extent, the low-tech sectors benefit the most from it. The involvement of universities in formal IPR management goes along with lower gross and net entry rates. New ventures in high-tech suffer more severely from higher university IPR involvement, their coefficients being the most significant. To conclude with the university related measures, science parks neither support nor hinder entry. It points to the marginal role of universities in the explaining higher entry rate. This result is consistent with previous evidence that rather pointed to some specific circumstances that led some universities play a pivotal role in the creation of new sectors. Entry is not sensitive to traditional academic activities such as teaching and research; the new entrepreneurial mandate of universities on the opposite seems not to promote entry, not even in high-tech. It suggests that strategies based on proprietary approaches to intellectual management might restrain the flow of critical knowledge to the economy and its exploitation through ventures.

Table 2: Results for equation a.1 - a.6: Entry in the Manufacturing sector

<i>Dependent Variable</i>	Gross Entry			Net Entry		
	<i>Total</i>	<i>High Tech</i>	<i>Low Tech</i>	<i>Total</i>	<i>High Tech</i>	<i>Low Tech</i>
<i>l_vapc</i> (t-1)	0.0233 (0.258)	-0.0024 (-0.083)	0.1132 (1.182)	-0.2813 (-1.840)	0.0258 (0.495)	-0.2329 (-1.573)
<i>Growth</i> (t-1)	-0.7017 (-1.901)	0.0116 (0.116)	-0.5676 (-1.696)	0.089 (0.168)	0.0248 (0.200)	-0.0211 (-0.043)
<i>E</i> (t-1)	0.9316*** (8.082)					
<i>HT_E</i> (t-1)		0.5649*** (6.771)	-0.3173 (-1.550)			
<i>LT_E</i> (t-1)		0.0147 (1.509)	0.9872*** (8.251)			
<i>E</i> (t-1)				0.3592*** (5.472)		
<i>ht_e</i> (t-1)					0.5791*** (7.177)	-0.0019 (-0.015)
<i>lt_e</i> (t-1)					-0.0011 (-0.096)	0.3335*** (4.771)
<i>Infra</i>	-0.0116 (-0.437)	0.0133 (1.944)	-0.0002 (-0.011)	-0.0177 (-0.576)	0.0126 (1.272)	-0.0268 (-0.992)
<i>Bus_serv</i> (t-1)	0.4154 (1.307)	0.0972 (1.038)	0.6126 (1.867)	-0.1706 (-0.266)	0.1369 (1.000)	-0.3282 (-0.551)
<i>Agglo</i> (t-1)	0.0062** (2.123)			-0.0109*** (-4.858)		
<i>Agglo_HT</i> (t-1)		0.0155*** (4.168)	0.0075 (0.882)		-0.0081 (-1.650)	-0.0029 (-0.341)
<i>Agglo_LT</i> (t-1)		-0.0004 (-0.523)	0.0056 (1.488)		0.0004 (0.664)	-0.0120*** (-3.866)
<i>student_pop</i>	-0.0006 (-0.085)	-0.0045 (-1.392)	-0.0009 (-0.129)	-0.0085 (-0.720)	-0.0038 (-1.037)	-0.0055 (-0.585)
<i>publ_prof</i>	-0.0029 (-1.563)	0.0000 (0.005)	-0.0025 (-1.493)	0.0039 (1.396)	0.001 (0.640)	0.0029 (1.326)
<i>uni_pats</i>	0.064 (0.211)	-0.021 (-0.192)	-0.0893 (-0.353)	-0.7612 (-1.445)	-0.1148 (-1.004)	-0.7146 (-1.404)
<i>sc_park</i>	-0.0057 (-0.416)	-0.0077 (-1.705)	-0.0118 (-0.922)	-0.021 (-0.788)	-0.0102** (-2.008)	-0.0095 (-0.384)
<i>Time Dummies</i>	Included	Included	Included	Included	Included	Included
<i>N</i>	618	618	618	618	618	618
<i>R-squared</i>	0.8642	0.7027	0.8752	0.3679	0.4093	0.3628

Significance at the 1% and 5% level is indicated by *** and **, respectively. Standard errors are robust to heteroskedasticity and clustered around provinces.

The lagged dependent variables indicate the magnitude of the partial adjustment process an industry undergoes. According to Carree and Thurik (1999), the size of the coefficient indicates the speed of adjustment. We can observe that sectors in high-tech manufacturing are subjected to higher adjustment processes, whereas the low-tech manufacturing, despite higher gross entry rates, could be considered mature to some extent.

The agglomeration of manufacturing activities in the provinces favors the entry of new ventures, suggesting the existence of positive externalities due to economic specialization.

This effect is particularly significant for high-tech sectors – column 2. However, higher concentrations of manufacturing activities are also associated to higher exit – column 4 to 6. Net entry appears negatively affected by the agglomeration of manufacturing activities, indicating the presence of congestion costs or a more developed labor market which raises opportunity costs for unsuccessful entrepreneurs. This effect is especially marked in the low-tech industries. Therefore, entrepreneurs in high-tech sectors benefit the most from the concentration of manufacturing activities as it eases the dissemination of tacit knowledge and hence widens the range of commercial opportunities.

The presence of business services in the province does not impact entry at aggregated levels. Finally, the quality of road infrastructure is never significant; nevertheless, the fact that it is only positive for high-tech sectors might signal that knowledge-based opportunities are better captured in well connected locations.

4.2 Growth

Table 3 reports the results for the growth equations in the Industry sector. The first section illustrates the estimates for the growth rate in value added; the second section reports the results for the growth rate of employment. We consider entry in the whole manufacturing sector in columns 1 and 4, whereas we only consider high-tech entry in column 2 and 5; finally, columns 3 and 6 take into account low-tech entry.

The model has limited explanatory power. The explained variation in the value added growth equations are in the magnitude of about 15%, whereas we can explain about 7% of the variation of the employment growth in the manufacturing sector.

Provinces with an overwhelming presence of manufacturing activities witness lower economic performances. However, the innovative intensity of the manufacturing activities improves the economic performances of the manufacturing sector. This effect vanishes when we deal with the growth rate of employment. Finally, the presence of business services does not affect the growth rate of local economies. These results do not come as a surprise. During the period under analysis the whole manufacturing sector has undergone a severe crisis caused by the introduction of the Euro. The industrial districts, the core of the Italian manufacturing sector, have lost the advantage of operating in international markets with an undervalued currency.

Table 3: Regression results for equation b.1 and b.2: Growth in the Manufacturing sector

	<i>Value Added Growth ISS</i>			<i>Employment Growth in ISS</i>		
<i>l_vapc (t-1)</i>	0.0083 (0.427)	0.0109 (0.580)	0.0061 (0.306)	-0.0149 (-0.870)	-0.0139 (-0.818)	-0.0175 (-0.999)
<i>D_VAINDSS (t-1)</i>	0.0421 (1.063)	0.0423 (1.065)	0.0464 (1.174)			
<i>D_EMPINDSS (t-1)</i>				0.0902** (2.299)	0.0923** (2.346)	0.0942*** (3.650)
<i>iss (t-1)</i>	-0.0845*** (-3.514)	-0.0883*** (-4.203)	-0.0810*** (-3.481)	-0.0307 (-1.893)	-0.045*** (-3.009)	-0.033** (-1.835)
<i>pat_iss (t-1)</i>	0.0735*** (2.76)	0.0677** (2.525)	0.0699*** (2.649)	0.0164 (0.567)	0.0136 (0.468)	0.0134 (0.476)
<i>Bus_serv (t-1)</i>	-0.1717 (-1.387)	-0.2143 (-1.712)	-0.1829 (-1.436)	-0.0913 (-1.119)	-0.1295 (-1.606)	-0.0895 (-1.151)
<i>Infra</i>	-0.0106** (-2.574)	-0.0103** (-2.451)	-0.0102** (-2.483)	-0.0048 (-1.648)	-0.0058** (-1.991)	-0.0049 (-1.679)
<i>student_pop</i>	-0.0120 (-1.852)	-0.0062 (-1.438)	-0.0071 (-1.056)	-0.0041 (-0.777)	-0.006 (-1.587)	-0.0101 (-1.811)
<i>publ_prof</i>	-0.0044** (-2.074)	-0.0043** (-2.311)	-0.0027 (-1.573)	-0.0009 (-0.610)	-0.0011 (-0.604)	0.0012 (0.791)
<i>uni_pats</i>	5.6883 (1.932)	4.8592*** (2.848)	1.0373 (0.528)	-1.2011 (-0.820)	3.375 (1.721)	2.2245 (0.668)
<i>sc_park</i>	0.0119** (2.232)	0.0126** (2.403)	0.0120** (2.225)	0.0051 (1.519)	0.006 (1.728)	0.0037 (1.104)
<i>E</i>	-0.0043 (-1.561)			-0.0027 (-1.845)		
<i>E*Studentpop</i>	0.0059 (1.357)			0.0003 (0.073)		
<i>E*Publ_Prof</i>	0.0030** (2.418)			0.001 (1.097)		
<i>E*Uni_Pats</i>	-4.1526 (-1.659)			1.3491 (1.416)		
<i>HT_E</i>		-0.0129 (-0.902)			0.016 (1.218)	
<i>HT_E*Student_pop</i>		0.0125 (0.908)			0.011 (0.917)	
<i>HT_E*Publ_Prof</i>		0.0147*** (2.831)			0.005 (1.048)	
<i>HT_E*Uni_Pats</i>		-21.3338 (-1.814)			-14.196 (-1.438)	
<i>LT_E</i>			-0.0045 (-1.374)			-0.0016 (-0.660)
<i>LT_E*Student_pop</i>			0.0023 (0.398)			0.0055 (1.201)
<i>LT_E*Publ_Prof</i>			0.0023 (1.774)			-0.0005 (-0.365)
<i>LT_E*Uni_Pats</i>			-0.657 (-0.355)			-1.6865 (-0.722)
<i>Time Dummies</i>	Included	Included	Included	Included	Included	Included
<i>N</i>	618	618	618	618	618	618
<i>R-squared</i>	0.1564	0.1551	0.1507	0.0689	0.0723	0.0673

Significance at the 1% and 5% level is indicated by *** and **, respectively. Standard errors are robust to heteroskedasticity and clustered around provinces.

Only companies in the high-tech sectors have witnessed an increase in value added after 2001 (Amil et al., 2007). However, the results from the second column indicate that

these gains did not reflect in faster employment growth. Indeed high-tech companies have downsized their personnel during the same years, suggesting the implementation of outsourcing strategies (Amil et al., 2007).

The measures of academic activities suggest that manufacturing companies located in provinces with large universities have not enjoyed faster growth rates. On the contrary, these results indicate that the growth of value added has slowed down in those provinces hosting scientifically productive universities (Publ_Prof). The technical orientation of academic research appears to affect value added growth positively and significantly only when we account for entry of new ventures in the high-tech sector. However, the effect weakens sensibly when we measure employment growth, although it remains positive. Science and technology parks have a positive impact on the rate of growth of value added in the manufacturing sector. This effect however is no longer significant when we look at the employment growth, with the partial exception of the case when we consider high-tech entry.

The entry of new ventures in the manufacturing sector does not affect the growth rate of sector's value added; the same holds for the sectoral employment growth rate. When we turn our attentions to the interacted variables, we note that the entry of manufacturing firms in provinces with scientifically productive universities is associated with faster growth in the sector value added. From columns 2 and 3 it emerges that this result is especially relevant when high-tech entry is considered. This effect is no longer in place when we consider entry in provinces with large universities or technologically active ones. If the growth of value added is sensitive to entry to some extent, employment growth seems to be unaffected by the entry of new production capacities.

Table 4 reports the results for the growth rate of value added and employment for the total economy of the province. The results resemble to a large extent those regarding the growth rate of manufacturing. As for the manufacturing sector, the regressions for value added growth show better goodness of fit, with values of the R-squared around 52%, than those for employment growth that are around 13%. We will mention here only the differences with the previous estimates. Provinces with higher than average value added per capita grow at faster rate. The same does not hold for employment growth. Whereas patenting was found to spur value added growth in manufacturing significantly, it does not affect total value added growth as the tertiary sector, which does not make use of patents, represent the largest share of the Italian economy.

Table 4: Regression results for equation b.1 and b.2: Growth in Italian Provinces

	<i>Value Added Growth</i>			<i>Employment Growth</i>		
l_vapc (t-1)	0.0439*** (4.437)	0.0386*** (4.015)	0.0443*** (4.366)	-0.0014 (-0.141)	-0.0019 (-0.198)	-0.001 (-0.092)
D_VAINDSS (t-1)	0.0009 (0.023)	0.0031 (0.083)	0.0026 (0.068)			
D_EMPINDSS (t-1)				0.1518*** (3.086)	0.1547*** (3.166)	0.1561*** (3.164)
iss (t-1)	-0.0459*** (-4.028)	-0.0422*** (-3.764)	-0.0443*** (-4.007)	-0.0038 (-0.347)	-0.0061 (-0.515)	-0.0046 (-0.442)
pat_iss (t-1)	0.0053 (0.473)	0.0046 (0.383)	0.0066 (0.557)	0.0035 (0.231)	0.0057 (0.359)	0.0045 (0.293)
Bus_serv (t-1)	-0.037 (-1.089)	-0.0438 (-1.207)	-0.0442 (-1.324)	0.0084 (0.228)	0.0026 (0.075)	0.0059 (0.166)
Infra	-0.0015 (-0.694)	-0.0014 (-0.603)	-0.0015 (-0.691)	0.0014 (0.59)	0.0013 (0.546)	0.0013 (0.542)
student_pop	0.0039 (1.362)	-0.0006 (-0.225)	-0.0008 (-0.204)	0.0038 (1.197)	0.0014 (0.779)	-0.0008 (-0.318)
publ_prof	-0.0033*** (-5.018)	-0.0016** (-2.010)	-0.0020 (-1.905)	-0.001 (-1.076)	0 (-0.003)	-0.0001 (-0.091)
uni_pats	-3.3608*** (-2.973)	-1.5298 (-1.682)	0.3264 (0.131)	-3.3660** (-2.054)	-1.4943 (-1.642)	-0.6669 (-0.412)
sc_park	0.0035 (1.937)	0.0028 (1.53)	0.0027 (1.453)	0.0023 (1.373)	0.0018 (1.074)	0.0019 (1.126)
E	0 (0.032)			-0.0008 (-0.940)		
E*Studenpop	-0.0050** (-2.236)			-0.0042 (-1.945)		
E*Publ_Prof	0.0025*** (6.122)			0.0009 (1.512)		
E*Uni_Pats	2.8430*** (3.164)			2.7037** (2.071)		
HT_E		-0.002 (-0.191)			0.0044 (0.371)	
HT_E*Student_pop		-0.0089 (-0.762)			-0.0134** (-2.046)	
HT_E*Publ_Prof		0.0067*** (2.993)			0.0012 (0.631)	
HT_E*Uni_Pats		9.8744 (1.59)			7.7259 (1.455)	
LT_E			0.0006 (0.314)			-0.0004 (-0.358)
LT_E*Student_pop			-0.0018 (-0.482)			-0.0009 (-0.435)
LT_E*Publ_Prof			0.0020** (2.422)			0.0003 (0.703)
LT_E*Uni_Pats			-0.2943 (-0.118)			0.5407 (0.35)
Time Dummies	Included	Included	Included	Included	Included	Included
N	618	618	618	618	618	618
R-squared	0.5215	0.5175	0.516	0.1361	0.1326	0.1304

Significance at the 1% and 5% level is indicated by *** and **, respectively. Standard errors are robust to heteroskedasticity and clustered around provinces.

The same conclusion can be drawn for the presence of science and technology parks as they mainly provide services to manufacturing companies. A large recourse to IPRs from universities is associated to lower growth in value added growth and eventually in

employment growth. Whenever we consider high-tech and low-tech entry, however, the results are no longer significant. An extensive use of IPRs can indicate a strict control of universities on the commercial activities of their faculty, which happen mainly through informal contacts. Like for the manufacturing growth estimations, new ventures contribute to the growth rate of value added when they are in the vicinity of prolific scientific departments. This contribution is stronger when new ventures are in high-tech sectors. We also observe that entry in provinces with technologically oriented universities is associated with faster rates of growth in value added and employment. As for the use of IPRs, it vanished when we use entry in high-tech and low-tech separately.

5. Conclusions

We have explored the different roles of modern universities and their implications for entry and growth. We have postulated that knowledge produced in universities can affect the competitiveness of the local manufacturing sector and the whole economy conditional on being exploited by local companies. The results of the paper are two-fold.

Firstly, new ventures do not represent an effective means of appropriating academic knowledge spillovers: higher measures of graduates, scientific productivity and patenting activities do not promote higher entry rates. Rather, entry is largely explained by the presence of a large manufacturing base and disequilibria in the supply side of the manufacturing sector. We also find some evidence for the presence of diseconomies of agglomeration for the low-tech manufacturing sector.

Secondly, universities dedicated exclusively to teaching mansions could ultimately suffocate local economies as they would specialize in the provision of services for students. It is rather the involvement of scientific personnel in the production of knowledge that enables entrepreneurs to bring to the market place ideas and solutions with non-negligible economic impacts. This finding is further corroborated by the fact that high-tech entrants benefit the most from the production and diffusion of open knowledge. The recourse to legal protections over academic inventions is shown to be effective for improving the competitiveness of the manufacturing sector; however, it has detrimental implications for the whole economy.

To conclude, knowledge spillovers from universities do not lead to higher entry. They rather lead to better entry as they provide local entrepreneurs with ideas that translate in higher economic performance. Not surprisingly, the traditional activity of production of knowledge has the highest impact on the competitiveness of the local industry. Furthermore, new ventures in the high-tech manufacturing sectors are found to benefit more than their low-tech counterparts.

6. References

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