Establishment of Higher Education Institutions and Entry of Technology-based Firms – A Policy Evaluation

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Abstract

The presence of universities has generally been associated with technological entrepreneurship. But what is the real impact of new universities on the levels of firm creation in a region? The present paper uses policy evaluation methodologies and longitudinal data on the establishment of higher education institutions in Portuguese municipalities for the period 1992-2002, to examine their effect on entry rates of new firms in different sectors. We find that the establishment of a new university has a positive and significant effect on subsequent levels of knowledge based firm entry in municipalities, and a negative effect on the levels of entry in other sectors, such as low-tech manufacturing.

Keywords: Universities; Entry Rates; Regional Development; Policy evaluation; Propensity Scores.

1. Introduction

A variety of studies have examined the role played by universities in promoting entrepreneurship. Some of these studies have been carried out at the micro level, examining institutional strategies and performance in technology transfer and commercialization (see, for instance, Di Gregorio and Shane, 2003; Grandi and Grimaldi, 2005; Markman *et al.*, 2005; and Clarysse *et al.*, 2005). Other studies have been done at a more macro level, examining the impact of universities on entrepreneurial activity, focusing particularly in nearby regions. Audretsch *et al*. (2005) found that, in general, new knowledge based firms have a high propensity to locate close to universities. Lindelof and Lofsten (2004) claim that co-operative resources provide new technology based firms located in university science parks with competitive advantages over other new technology based firms. Academic research and development expenditures have been found to be significantly associated with rates of new firm formation across regions (Lee *et al*., 2004). There is strong evidence for the United States of a growth effect of clusters influenced by active research universities (Feldman, 2000).

In modern economies, universities generate a steady flow of novel technical ideas, with the system of public research and higher education institutions largely responsible for the creation of modern technology capacity (Mazzoneli and Nelson, 2007). In addition to their traditional role as sources of ideas, knowledge and intellectual capital, universities are now agents of innovation through the development and commercialization of ideas generated by academic R&D. Entrepreneurial universities enhance regional development and international competitiveness and their role is especially important in structurally weak and peripheral regions where universities tend to have a monopoly over the production of intellectual capital.

The presence of universities generates positive externalities both through performing knowledge-generating R&D activities and educating specialized human capital capable of absorbing such knowledge. Firms can cultivate relationships with universities, participating in research consortia and partnering with academics that do related scientific work (Audretsch and Feldman, 2004). For instance, personal networks of academics and industrial researchers facilitate the commercial exploitation of knowledge generated at universities by existing firms or university spin-off start-ups. Moreover, fresh graduates may be important channels for disseminating the latest knowledge from academia to the local high tech industry (Varga, 2000). Empirical studies have found that new firms are highly likely to start in the home region of their founders (Klepper, 2002). As a result, universities and other research institutions can become important focal points for regional economic development.

The presence of a university in a region is an additional factor influencing the location decision made by new firms. This influence should be greater in industries where new knowledge plays an important role. The transmission of new and uncodified knowledge tends to occur only within limited geographic areas, embedding resulting economic activity within the region (Baptista and Swann, 1999). As a result, it is expected that access to local knowledge sources is particularly significant for high technology and knowledge based manufacturing and services.

In Portugal, there was a revolution in 1974 ending the dictatorship. Until then, the university education system was reserved for elites, and characterized by a low number of students. After the revolution, education was democratized and the higher education system was expanded. In the 1980s the growth of the private higher education sector garnered political support (Correia *et al*., 2002). Due to this political context, several new private and public universities emerged. The present paper examines the effect of the establishment of these new higher education institutions on subsequent regional levels of entry by knowledge based firms. We apply first differences and propensity score matching methods in order to identify shifts in the firm entry rates in regions with new universities versus regions with similar characteristics that maintain the same number of universities.

Our results indicate that the establishment of new higher education school in a region has a positive impact on the lagged share of new firm entry in knowledge intensive sectors, which is followed by a significant decrease in the entry of firms in low-technology sectors. In general, our results suggest that universities contribute to the regional development of knowledge related businesses.

The paper is organized as follows. The next section presents some background on the role played by universities in regional development, presenting the research questions addressed. Section 3 presents the data and methodological approach used in the present study, while section 4 reports and discusses the results obtained. Section 5 presents our main conclusions, and highlights avenues for improving and broadening this research.

2. Universities and new firm creation

2.1 Universities and location

One of the major socio-economic trends observed since the 1980s is the rise of entrepreneurship as a driver of innovation, competitiveness and economic development.

Both academics and policy makers claim that entrepreneurial activity is vital to economic progress. As a result, government policies fostering new firm creation have been adopted by many countries. Empirical research suggests that the entrepreneurial efforts more likely to impact on subsequent economic development and employment growth are knowledge based firms (Baptista and Preto, 2008). Knowledge based entrepreneurial activity requires a steady flow of novel ideas in order to flourish. The existence of human capital with the technological knowledge required to recognize and implement entrepreneurial opportunities arising from novel ideas is essential for successful technology commercialization. Universities and R&D laboratories are fundamental sources of technical knowledge which can be commercialized. Universities and polytechnic institutes also play a major role in educating human capital capable of recognizing and implementing technological opportunities.

Recent research addresses the issue of ‘technology transfer and commercialization’, that is the mechanisms and incentives through which universities bring knowledge from the laboratory to the market. Fewer works address the regional dimension of university knowledge transfer. As a variety of research streams have demonstrated the importance of geographical proximity for the transmission of new knowledge, it is reasonable to expect that the economic exploitation of new knowledge will occur close to the sources generating it.

Complex technological knowledge (seemingly the most valuable type of knowledge) usually contains a strong element of tacitness, meaning its flow and diffusion is constrained by the geographic proximity and extent of interaction between individuals within whom the tacit component resides. Considering tacit knowledge as an important element for new innovative firms, access to this type of knowledge can become a major determinant in the competitiveness of regions and location of these firms (Audretsch *et al.*, 2004). A host of empirical studies have confirmed that knowledge spillovers are geographically bounded (Jaffe, 1989, Anselin *et al.*, 1997). Accordingly, the location decision of new firms appears significantly influenced by access to knowledge spillovers, including specialized human capital and institutions performing R&D activities (Audretsch *et al.*, 2005). In addition, the propensity to cluster geographically should be greater in industries where new knowledge plays a more important role because such knowledge is less likely to be codified and less simple to transmit over great distances (Baptista and Swann, 1999).

Recent literature advocates that knowledge spillovers play an important role in fostering entrepreneurship and innovative activity (Sorenson and Audia, 2000; Baum and Sorenson, 2003). Companies in innovative sectors tend to choose locations where significant knowledge-generating activities associated with these sectors occur (Audretsch and Stephan, 1996; Zucker *et al.*, 1998, 2002). These activities may be performed by universities or other firms and implies the presence of world class scientific research and human capital. Spillovers from universities, as well as from private firms, have been recognized as key sources promoting firm innovation and performance (Stuart and Sorenson, 2003). Stahlecker and Koschatzky (2004) indicate that spatial proximity matters for the founding and early performance of firms in the knowledge intensive business services sectors. Also, Capello (2002) finds that high technology industries display high spatial concentration. In contrast to start-ups with traditional products and processes, knowledge based firms tend to offer new or improved products, operating in markets in early development stages. Thus, access to knowledge sources should be particularly significant for high technology and knowledge based industries and services.

2.2 Universities as knowledge sources

Modern universities have had a role in the dissemination and transmission of knowledge since their creation (Caraça *et al.*, 2000). In particular, university research contributes to the basic stock of scientific knowledge available in any country or region and it appears to have potential to improve national competitiveness (Spencer, 2001). Research identifies the important role that universities play in generating knowledge spillovers (Audretsch *et al.*, 2004). Studies find that academic research is linked to a high percentage of product innovations, and that the development of certain sectors happens in countries where there are strong university research programs in related areas. Public research is used not only to help generate ideas, but also to help completing existing R&D projects in firms. Start-up in particular can be a vehicle to transfer university research into commercial innovation, especially in science-based sectors (Laursen and Salter, 2004). Geographical proximity of an academic institution to a knowledge intensive industry may be a source of positive knowledge externalities, since firms can cultivate relationships with universities, establishing partnerships with academics doing related scientific work, thus allowing the sharing and exchange of tacit knowledge (Audretsch and Feldman, 2004). Cooperative relationships are a channel for knowledge spillovers, and cooperation is favoured by location proximity (Fritsch, 2001). For instance, personal networks of academics and industrial researchers, may lead to the commercial exploitation of knowledge generated at universities by existing firms or university spin-off start-ups. The possibility to elaborate research partnerships with academic institutions may also affect positively the absorptive capacity of firms

(Scott, 2003). Fresh graduates may be important channels for disseminating the latest knowledge from academia to the local high tech industry (Varga, 2000). Also students can provide a channel to transmit knowledge from the university, where it is created, to the firm, where it can be commercialized (Audretsch *et al.*, 2004). In addition, the establishment of new firms can also be advantageous to the universities, since they can make the institutions more attractive to students, faculty and other partners. By creating new knowledge and training people, universities support the formation of new firms, and therefore are an important source of investment ideas for venture capitalists (Lerner, 2005).

Given that the commercialization of knowledge depends on knowledge generation by universities and public R&D institutions, as well as on R&D activities by firms, a low level of new business formation in knowledge dependent sectors should be associated with a lack of knowledge-generating sources (Cohen and Levinthal, 1989). Acs *et al*. (1994) find that small firms receive R&D spillovers generated by both universities and the R&D centres of their larger counterparts, and that these spillovers are apparently more significant at stimulating innovative activity by small firms than by larger ones. Evidence of local spatial externalities between university research and high technology innovative activity is also found by Anselin *et al*. (1997). Feldman (2000) reports strong evidence favouring a growth effect of geographical clusters influenced by active research universities in the United States, while Fisher and Varga (2003) provide evidence of the importance of geographically mediated knowledge spillovers from university research activities to regional knowledge production in the Austrian high tech industry. Bania *et al*. (1993), find that the relationship between university research and firm births varies across industrial sectors. Also, the role played by universities in the commercialization of knowledge has increased over time; Henderson *et al*. (1998) have found evidence of an increase in the rate of technology transfer to the private sector.

2.3 Hypotheses Formulation

In the 25th April 1974 there was a revolution in Portugal, ending the authoritarian regime that lasted for nearly half a century. Under the authoritarian regime there was widespread regulation and private ownership of the means of production. The state exercised extensive authority regarding private investment decisions and the level of wages. After the revolution, the Portuguese higher education system grew significantly as a consequence of a political effort to democratize and facilitate access to universities. Since then several public and private higher education institutions have been established across the country, giving rise to a private higher education sector and to a network of polytechnic institutions supported by the government. This growth is reflected in the number of enrolled students each fall, which increased from approximately 30,000 in the 1960s to 400,000 in the 1990s (Correia *et al*., 2002; Horta, 2008). The emergence of these institutions represented an attempt to offer new degrees while addressing specific local or regional needs. In particular, new private higher education institutions tried to explore market niches previously untouched (Correia *et al*., 2002). These developments enable us to identify new higher education institutions in specific regions and evaluate their effects.

As not all regions gained universities, by doing cross-regional analysis we are able to identify the economic impact of having higher education institutions. If universities foster entrepreneurial activity, then we can assume that the establishment of a university will impact the number of start-ups in its region. In this mindset, we wish to address the following research question: What is the impact of the establishment of a new university on the levels of firm entry in a region? We address this research question by testing the following hypothesis:

H1: *The establishment of a new higher education institution in a municipality has a positive effect on subsequent levels of new firm entry in that municipality.*

Furthermore, it is not clear if universities will affect entrepreneurial activity across industries, or if this effect will be more pronounced in knowledge related sectors. Firms in high-technology industries often seek to increase levels of intellectual capital through the use of external sources, making proximity to a university more important. Thus, we test a second hypothesis:

H2: The impact of a new higher education institution in a municipality will vary according to the sector considered.

In particular, we assume that there should be a more short term impact on the entry of new firms, focused on supplying the new higher education institutions with services and technology. We also expect that there will be a gradual effect, over the long term, which will take some years to peak, whereby new firms are started by faculty and graduates of these institutions as a consequence of knowledge spillovers generated by the educational and research activities. In addition, we assume that activities in knowledge based industries and services will benefit more from locating in the proximities of higher education institution and we expect that these new institutions to have a bigger impact in knowledge dependent sectors.

3. Regional Data on New firms and Higher Education Institutions

Data on firm dynamics and levels of human capital are drawn from the Portuguese *Quadros de Pessoal* database. This is a longitudinal matched employer-employee database built from mandatory information submitted by firms to the Portuguese Ministry for Employment and Social Security. It includes extensive information on all private firms, establishments, workers and business owners in the Portuguese economy. There are on average over 145,000 firms, 170,000 establishments and 2 million workers in each annual return, which are fully linked through the use of unique identification numbers, thus allowing the recognition of both entering and exiting firms, as well as the opening and closure of subsidiary establishments. For each firm, data are available for size, age, location, sector and number of establishments. Data on business owners and employees for each firm and establishment include gender, age, function, tenure, schooling and skill levels.[1] The present study distinguishes firms in manufacturing sectors and in knowledge intensive business services, from the remaining sectors, making use of OECD classifications (OECD, 2002). Appendix 1 has the detailed sectors description. We identified entry by observing the appearance of a new firm identifier in the database and comparing this entry with the earliest employee admission date. We considered entry if the workers' admission date did not differ for more than two years from the firms' entry date identified. Firms for which entry year was not identified were not included in the analysis. A dataset was built containing all new firms starting their activity in the period 1992-2002 in the considered sectors. Data were aggregated at the municipality level, including all 275 continental Portuguese municipalities.[2]

Data for higher education institutions were obtained from the Portuguese Ministry for Science, Technology and Higher Education. The dataset includes information for all Portuguese higher education institutions, both public and private, between 1992 and

[1] See Cabral and Mata (2003) for a description of the quality and coverage of the data.
[2] Municipalities located in the Islands of Madeira and Azores are excluded due to the lack of available data

2002. For each year, institutions provide information on the number of students, number of graduates and the degrees provided. This information is collected and aggregated at the municipality level.

Table 1 presents the descriptive statistics for the variables used. Portuguese municipalities display differences in terms of number of start-ups (Baptista and Mendonça, 2007). There is also significant demographic dispersion with municipalities along the coast having growing population densities, while those inland have experienced population decline. This regional asymmetry is reflected in the demography of new firms; indeed, previous research indicates that Portuguese entrepreneurs tend to start firms in the region where they live, infrequently choosing to locate their business elsewhere (Figueiredo *et al.,* 2000). These differences between municipalities are controlled for using a series of variables which are known to influence the location of new firms. We use population density, which can be regarded as measure of regional demand size. Thus, regions with higher population density are more likely to attract more start-ups (Kangasharju, 2000). We control for the share of micro firms, which represents the business environment of the region. Regions with a higher percentage of small firms tend to attract more (small) new firms. The regional workforce is used as a measure of human capital availability in the region; regions with more workers will attract more new ventures. The distances to the main urban centres of Oporto and Lisbon, are used to capture access to the country's largest markets, and access to information about market and regulatory requirements (Figueiredo *et al.,* 2002). More new firms tend locate closer to the larger urban centres. Finally, we introduce in our estimation year dummies to capture time/business cycle effects.

Insert Table 1 about here

In the present paper, we evaluate the policy aimed at creating new higher education institutions by measuring its impact on the formation of new firms. Thus, we compare levels of firm entry in municipalities where new higher education institutions were established against firm entry in municipalities where there were no new institutions. We check whether or not the establishment of a new institution significantly affects subsequent rates of new business formation, and how this effect varies across sectors. As such, we consider the establishment of a new institution to be a treatment variable and evaluate the impact of this treatment by creating a dummy variable equal to one where new institutions are established versus a zero for those municipalities where no new higher education institutions were established. We compare the group of municipalities where a new higher education institution was established with two control groups: A) municipalities where the number of institutions is zero and remains zero during the entire time of the study; B) municipalities where the number of institutions is different from zero and remains constant.[3] We excluded municipalities where there was a decrease in the number of institutions, because there may be effects of this decrease that we are unable to control for. We also excluded municipalities where new institutions were established outside the time span of our analysis, since these new institutions have impacts that we cannot identify and we wished to ensure we were observing only the effect of new institutions.

Between 1992 and 2002, 46 municipalities had a new institution established while multiple institutions were established in 14 other municipalities. There are 204

[3] There are no municipalities where an institution of higher education closed and was replaced by another.

municipalities with no institutions in the same period (group A), and 17 municipalities for which the number of institutions was one or more, and remained constant throughout the time period (group B).

In this analysis, we choose to observe the treatment on the years 1993 and 1994, so that we have at least two years before treatment to control for pre-treatment characteristics. Since we compare municipalities in the different groups, we need to be able to observe the municipalities at least two years before the treatment, to make sure we compare municipalities with similar characteristics regardless of the new institution establishment. In addition, we want to have a large number of years after treatment in order to distinguish between the short, indirect effects and the long term effects. Furthermore, using two adjacent years avoids comparison of treatment in different environmental conditions.

In 1993 and 1994, we identified 17 new higher education institutions in 17 different municipalities. Of these institutions, six are private schools, while eight of the eleven state schools are polytechnics. Five of the 17 new institutions have active research centres and develop research activities, and four provide technology related degrees. There are 204 municipalities without any higher education institutions throughout the period of analysis (control group A), and 17 that already had at least one higher education institution without any additional institutions established in the period of analysis (control group B). The time scale is used with reference to the treatment period: for municipalities where a new higher education institution was established, the time zero ($t = 0$) corresponds to the year of establishment (i.e. of treatment, 1993 or 1994); for municipalities where no higher education institutions were established, the time $t = 0$ is set to the first year of treatment (1993).

Table 2 displays the relevant characteristics two years before treatment (t = –2) across the groups of municipalities considered. The control group A, which has no universities or polytechnics throughout the whole period of analysis, displays lower average levels of education, population density, and number of workers, as well as smaller firms on average. In addition, group A is dominated by municipalities relatively distant from the two main urban centres of Lisbon and Oporto. In contrast, municipalities in the treated group display higher average levels of education, higher population density, and greater numbers of employed workers. In our analysis we control for these pre-treatment differences by matching municipalities within each group that have similar pre-treatment conditions. Without such matching, it is impossible to compare the two groups as shown by the figures presented in Table 2. The same pattern of differences in the pre-treatment variables is observed for group B (municipalities with number of institutions constant and different from zero). The municipalities in this group are larger than those in group A, but smaller than those treated, as measured by population density and number of workers. The same type of relationship is found for average workforce years of education. As expected, these municipalities are closer to the two main urban centres. Moreover, the share of small firms is smaller than in municipalities belonging group A and the treated group.

Insert Table 2 about here

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4. Applying the Propensity Score Mathing Method

We wish to determine the effect of the establishment of new universities on the regional subsequent levels of new firms. The establishment of new universities can be seen as an exogenous shock, and provide the setting of a natural experiment. A natural experiment always has a control group, which does not experience any change, and a treatment group which is affected. In this case, the exogenous event is the establishment of higher education institutions during the 1990s because of government policies designed to change the structure of the higher education sector while increasing the level of education in Portugal. Accordingly, the control group consists of those municipalities without any changes in the number of higher education institutions they host (in the entire period from 1992 to 2002), while the treatment group consists of those municipalities where a new higher education institution was established in either 1993 or 1994.

We start by applying a first-differences method to determine the effect of the establishment of a new higher education institution on entry rates. A first differenced-equation of the entry rates of firms is estimated using OLS, distinguishing the control group from the treated group. The treatment is introduced using a dummy variable which assumes the value 1 (one) for treated regions, and 0 (zero) otherwise. The treatment effect is captured in the municipality entry rates. We difference the entry rates across adjacent time periods for the same cross-sectional units (municipalities). We control for differences between municipalities by including in the estimation our set of control variables: population density; the share of micro firms; regional workforce (log); the distances to the main urban centres of Oporto and Lisbon; and year dummies to capture time/business cycle effects, which are also differenced over time.

With the first-differences method we are unable to capture the effect of a new university on the one year lag of regional rates of entry of firms given that the estimator on the treatment variable is not statistically significant.[4] The first-differences estimator compares the group of treated regions with the group of non-treated regions, regardless of individual characteristics within the two groups. Since we have very heterogeneous groups of municipalities, which cannot be directly compared, we are unable to isolate the effect of the establishment of new higher education. Another reason for these results is that one year differences are not enough to observe any effects of the new institutions in the regional levels of new firm formation. It is reasonable to assume that a new university will take more than one year to affect new firm creation in a region. This may be even more important for knowledge intensive activities that can only be generated through knowledge spillovers resulting from university R&D, or by companies started from graduates coming out from these institutions.

In order to observe the treatment effect more accurately, we use a different matching technique, allowing for more accurate comparisons between municipalities. The propensity score matching estimator allows us to match municipalities according to their characteristics and observe the effect more than one year after the establishment of new institutions. The propensity score matching method is a matching technique which makes the distribution of observable characteristics of treatment and control groups similar (Rosenbaum and Ruben, 1983). The difference is that we now compare treated municipalities with non-treated municipalities that are similar in a number of characteristics, controlling for the heterogeneity of the treated group. The principal advantage of propensity scores matching methods is this correction for sample selection

[4] Results are available from the authors upon request.

bias due to observable differences between the treatment and comparison groups (Dehejia and Wahba, 2002).

The propensity score is the conditional probability of receiving a particular treatment (in this case, having a new higher education institution) given a vector of observed covariates (pre-treatment characteristics):

$$p(X) \equiv \Pr\{D = 1|X\} = E\{D|X\} \qquad (2)$$

Where D = {0, 1} is the indicator of exposure to treatment and X is the multidimensional vector of pre-treatment characteristics (Becker and Ichino, 2002).

We estimate the propensity score of the treatment on the control variables using a probit model and stratify individuals in blocks according to the estimated score. We estimate the probability of having an increase in the number of universities, given the municipalities' characteristics from period $t = -2$ (pre-treatment variables). The propensity score is estimated and the balancing property is tested. The balancing property ensures that the means of each characteristic do not differ significantly between treated and control municipalities, which allows us to compare municipalities of the different groups that are similar in terms of their pre-treatment characteristics. This estimated probability of another institution conditional on the full set of covariates included in the regression is used to match treated and control municipalities. The matching involves pairing treatment and comparison units that are similar in terms of their observable characteristics (Dehejia and Wahba, 2002).

The matching between municipalities to create the blocks was carried out using variables that reflect the municipalities' size and industry structure: workforce (log); share of small firms, and the distances to the main cities, Oporto and Lisbon. These variables control for the probability that new firms will locate in each municipality regardless of the existence of higher education institutions (Figueiredo *et al.*, 2000). The results for this estimation are presented in Table 3.

Insert Table 3 about here

Afterwards, we use the stratification method to match the treated group and the control groups' observations and to estimate the Average effect of Treatment on the Treated (ATT). With stratification matching, the range of variation for the propensity score is divided in intervals such that within each interval treated and control units have on average the same propensity score (Becker and Ichino, 2002). The ATT is then estimated within each block:

$$\tau_q^s = \frac{\sum_{i \in I(q)} Y_i^T}{N_q^T} - \frac{\sum_{j \in I(q)} Y_j^C}{N_q^C} \qquad (3)$$

Where I(q) is the set of units in block q while N_q^T and N_q^C are the numbers of treated and control units in block q, and Y represents the outcome variable. The estimator of the ATT based on this method is then computed with expression (4):

$$\tau^s = \sum_{q=1}^{Q} \tau_q^s \frac{\sum_{i \in I(q)} D_i}{\sum_{\forall_i} Di} \qquad (4)$$

Where the weight for each block is given by the corresponding fraction of treated units, and Q is the total number of blocks. The matching estimator computes the average difference in the outcome of interest (share of new firms) between the treatment and control group.

We observe the effect of the treatment in the variation on share of new firms in the region from the pre-treatment ($t = -2$) to the post-treatment ($t = 3$, $t = 5$ and $t = 7$). The main argument for this time differences is that we need at least three years to observe any effect of a new institution establishment on new firm formation, since it takes at least three years for graduating students to leave with a bachelor's degree. There is a chance of spin-off created by results of R&D performed in these institutions, for which a time lag is necessary.

We compare municipalities where there was a new institution with two control groups: A) municipalities where the number of institutions is zero and remains zero during the entire time of the study; B) municipalities where the number of institutions is different from zero and remains constant. We then distinguish effects for two sectors: knowledge based firms and low technology manufacturing. In addition, we try to separate the effect on high technology manufacturing, ICT and knowledge intensive services. The results are presented in Tables 4 to 7.

In Table 4 we use the difference in share of new firms in the sample as the outcome variable. We observe positive coefficients five years after treatment when compared with control group B. This means that for the general manufacturing firms, the establishment of a new university in a region generated an increase of 6.5% in the share of new firms 5 years after the entrance of a new higher education institution. All other estimations provided insignificant results. Such results mean that there is no significantly different in the rates of new firm entry between treated municipalities and the control groups, when considering the manufacturing sectors.

Insert Table 4 about here

In Table 5 we present results for knowledge based firms. We observe that the establishment of new universities has a positive impact on the entry of firms in knowledge related activities. This positive effect is observed in the differences of share of new firms three and five years after treatment. When we use both control groups together, we obtain an effect of 21% and 24%. When compared to only group A the effect increases to 30% and 33%. Comparing with control group B has no significant results. For the difference in the share of new KBE firms seven years after treatment, we observe an increase of 27% when using both control groups, but this impact is not visible when comparing control groups A and B separately. Access to external knowledge sources is important for firms' innovative activity. Thus we would expect sectors that are more dependent on new knowledge will benefit more from locating near a university. According to Audretsch *et al*. (2005), younger firms are more likely to locate closer to universities with a large number of students. These results reflect this tendency and provide evidence of the role played by higher education institutions in the shift toward knowledge based sectors, visible in municipalities where a new university was established. This result is strengthened when we compare the treated group with municipalities that have no higher education institutions.

Insert Table 5 about here

The opposite effect is observed when we focus on low tech firms, as seen in Table 6. All estimations revealed a negative and significant coefficient, showing a negative impact of new higher education institutions on entry of firms in these sectors. There is evidence that low-technology sectors benefit less from locating close to a university, since they are less likely to use it as a source of knowledge and as a cooperation partner (Faria *et al.*, 2007). These results are consistent with a shift toward the "new economy". The fall of low-technology sectors entry is stronger in regions where a new university is established. Again, these results suggest that higher education institutions play a role in the municipal economic activity.

Insert Table 6 about here

We try to distinguish if entry in knowledge based firms is more focused on high technology activities, ICT, or knowledge intensive services, by dividing our sample into these three sectors. The results are presented in Table 7. In the knowledge intensive services sample, we obtain a positive effect in the difference of the share of new firms between t = -2 and t = 5, when comparing the treated group with control group B. Thus, we observe a 9% increase in firm entry for knowledge intensive services in the treated group, five years after treatment versus regions with constant number of universities. This may be the combination of short and long term effects. On the one hand service firms may be established to serve the needs of new institutions in the municipality. On the other hand, some firms are established by faculty members and students from the new institutions. All other estimations have insignificant results. These results are unexpected; we expected an effect on entry for ICT firms, at least in the short term, taking advantage of the opportunity to serve the new institution. As we increase the time lag, the number of observations in the sample decreases, which does not allow identifying any effects.

The results give partial support to hypothesis one, since the impact of new higher education institutions will affect new firm entry only in certain sectors, and provides support to hypothesis two, given that we obtained different results when differentiating the sector.

Insert Table 7 about here

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5. Concluding Remarks

In this paper we determine the impact of the establishment of new higher education institutions in municipalities on subsequent levels of new firm entry. We study this effect making use of the first-differences and propensity score matching approaches, appropriate for policy analysis. This approach captures the effect of an increase in the number of universities within a municipality on the levels of new firm entry while explaining the differences between treatment and the control groups. We compare municipalities where there was an increase in the number of universities with municipalities lacking universities throughout the entire time period and with municipalities with a constant number of universities. We find that these three groups (the treatment and two control groups) have different patterns of new firm entry. Estimations of the average treatment effect reveal a positive impact for the establishment of new universities on the lagged share of new firm entry in knowledge intensive sectors. There is a significant decrease in the entry of firms in low technology industries in regions where a new higher education institution was established. We also observe an increase in the entry of firms in knowledge intensive services five years after treatment. We cannot observe any other effects when distinguishing knowledge based activities in high-tech manufacturing; ICT and knowledge related services, probably due to the small number of entries observed in these sectors when municipalities are used as the regional unit of analysis. The overall results indicate that the establishment of a new higher education school in a region will contribute to a shift toward the knowledge based economy.

Our analysis contributes to the literature on the role played by universities and regional knowledge bases as sources of entrepreneurial opportunities, through the use of data allowing the application of econometric techniques for the analysis of policy and treatment effects. The identification of the structural determinants that have impact on the growth of start-up rates, at a regional level, is useful for formulating public policies with an objective of influencing the start-up activity in regions. Many governments have created initiatives to foster technology commercialization, and with that purpose in mind have supported the interaction between universities and regions (Laursen and Salter, 2004). However, even without establishing formal relationships, firms and regions can benefit from the presence of a university. Our results indicate that universities enhance regional development and suggest that less favoured regions would benefit from establishment of a new higher education institution. These regions can benefit not only from knowledge spillovers from the institutions, but also from the settling of highly educated human capital.

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Table 1 - Descriptive statistics

	Mean	Std. Dev.	Min	Max
Pop. Density (inhabitants per km^2)	252.577	809.145	6.240	7835.059
Workforce Education (No. years)	6.056	0.857	1.813	9.609
Regional Workforce	8115.832	32343.93	52	564964
Share micro firms in the region (proportion of firms with less than 10 employees)	85.083	5.909	46.667	100
Entry (nº of new firms)	23.534	52.746	0	911
Distance to Lisbon (Km)	198.106	99.041	6.5	396
Distance to Oporto (Km)	174.104	116.574	3.5	463.5

Data for 275 regions (municipalities), pooled 1992-2002

Table 2- Pre-treatment characteristics of regions

***t* = –2**	Pop. Density	No. workers	Workforce Education	Share micro firms	Distance to Lisbon in Km	Distance to Oporto in Km
Treated group	1132.329	6.020	80.749	178.031	167.062	1132.329
	(2447.756)	(0.956)	(5.201)	(110.592)	(104.297)	(2447.756)
Group A	117.909	4.764	82.823	197.362	179.593	117.909
	(247.854)	(0.816)	(8.128)	(96.985)	(113.731)	(247.854)
Group B	863.055	5.151	78.901	177.529	119.088	863.055
	(1847.325)	(0.748)	(7.280)	(98.376)	(97.360)	(1847.325)

Standard errors in brackets
Treated group = municipalities where there was a new higher education institution between 1993 and 1994 (t = 0)
Group A = municipalities with no. institutions equal to zero
Group B = municipalities with no. institutions constant and different from zero

Table 3- Propensity scores estimation- probit regression

in $t = -2$	Dummy for treatment
Distance to Oporto	-0.002
	[0.001]
Distance to Lisbon	-0.001
	[0.001]
Regional Workforce (ln)	0.544***
	[0.125]
Share of micro firms	0.071**
	[0.031]
Constant	-11.750***
	[3.279]
Observations	530

Note: Dummy for treatment equals 1 for treated regions at the time of treatment
Standard errors in parentheses
*significant at 10%; ** significant at 5%; *** significant at 1%

Table 4- Effect of a new higher education institution on firm entry in regions – ATT Estimation with the stratification matching method

	No. Treated	*No. Control*	*ATT*	*Std. Err.*
Difference in the share of new firms between $t = 3$ and $t = -2$				
Control group A+B	15	441	-2.176	1.448
Control group A	13	406	-2.806	2.125
Control group B	13	37	0.087	2.185
Difference in the share of new firms between $t = 5$ and $t = -2$				
Control group A+B	15	441	0.115	1.799
Control group A	13	406	-1.247	1.995
Control group B	13	37	6.511*	2.036
Difference in the share of new firms between $t = 7$ and $t = -2$				
Control group A+B	15	441	-1.489	2.146
Control group A	13	406	-2.712	2.593
Control group B	13	37	2.436	2.319

Note: ATT - Average Treatment effect on the Treated
*significant at 10%; ** significant at 5%; *** significant at 1%
Group A = municipalities with no. institutions equal to zero
Group B = municipalities with no. institutions constant and different from zero

Table 5- Effect of a new higher education institution on the entry of knowledge based firms in regions - ATT Estimation with the stratification matching method

	No. Treated	*No. Control*	*ATT*	*Std. Err.*
Difference in the share of new firms between $t = 3$ and $t = -2$				
Control group A+B	15	441	23.862*	13.069
Control group A	13	406	30.338*	17.132
Control group B	15	35	166.945	120.570
Difference in the share of new firms between $t = 5$ and $t = -2$				
Control group A+B	15	441	26.739**	13.286
Control group A	13	406	33.068**	15.715
Control group B	15	35	172.001	118.146
Difference in the share of new firms between $t = 7$ and $t = -2$				
Control group A+B	15	441	27.014*	16.047
Control group A	13	406	---	---
Control group B	13	37	321.946	225.462

Note: ATT - Average Treatment effect on the Treated
*significant at 10%; ** significant at 5%; *** significant at 1%
Group A = municipalities with no. institutions equal to zero
Group B = municipalities with no. institutions constant and different from zero

Table 6- Effect of a new higher education institution on the entry of Low-Tech firms in regions - ATT Estimation with the stratification matching method

	No. Treated	*No. Control*	*ATT*	*Std. Err.*
Difference in the share of new firms between $t = 3$ and $t = -2$				
Control group A+B	15	441	-3.989***	1.010
Control group A	15	407	-3.484***	1.071
Control group B	15	35	-4.723***	1.461
Difference in the share of new firms between $t = 5$ and $t = -2$				
Control group A+B	15	441	-3.190**	1.574
Control group A	15	407	-3.725**	1.599
Control group B	15	35	0.792	1.620
Difference in the share of new firms between $t = 7$ and $t = -2$				
Control group A+B	15	441	-4.589***	1.914
Control group A	15	407	-4.502**	2.106
Control group B	13	37	-2.788	2.230

Note: ATT - Average Treatment effect on the Treated
*significant at 10%; ** significant at 5%; *** significant at 1%
Group A = municipalities with no. institutions equal to zero
Group B = municipalities with no. institutions constant and different from zero

Table 7- Effect of a new higher education institution on the entry of different knowledge based sectors - ATT Estimation with the stratification matching method

	No. Treated	*No. Control*	*ATT*	*Std. Err.*
High-Tech firms				
Difference in the share of new firms between *t = 3* and *t = –2*				
Control group A+B	15	441	-0.138	17.746
Control group A	15	407	2.997	20.439
Control group B	15	35	---	---
Difference in the share of new firms between *t = 5* and *t = –2*				
Control group A+B	15	441	-4.219	19.251
Control group A	15	407	-3.649	13.738
Control group B	15	35	---	---
Difference in the share of new firms between *t = 7* and *t = –2*				
Control group A+B	15	441	-13.088	20.797
Control group A	15	407	-13.080	22.898
Control group B	15	35	---	---
ICT firms				
Difference in the share of new firms between *t = 3* and *t = –2*				
Control group A+B	15	441	2.857	13.507
Control group A	15	407	5.983	13.647
Control group B	15	35	---	---
Difference in the share of new firms between *t = 5* and *t = –2*				
Control group A+B	15	441	-3.271	9.999
Control group A	15	407	0.146	11.467
Control group B	15	35		
Difference in the share of new firms between *t = 7* and *t = –2*				
Control group A+B	15	441	-7.626	9.507
Control group A	15	407	-3.842	11.139
Control group B	13	37	---	---
Knowledge intensive service firms				
Difference in the share of new firms between *t* = 3 and *t* = –2				
Control group A+B	15	441	-0.997	2.697
Control group A	15	407	1.143	3.239
Control group B	15	35	3.459	6.148
Difference in the share of new firms between *t* = 5 and *t* = –2				
Control group A+B	15	441	2.778	2.879
Control group A	15	407	5.396	3.388
Control group B	13	37	9.942***	3.868
Difference in the share of new firms between *t* = 7 and *t* = –2				
Control group A+B	15	441	0.785	3.135
Control group A	15	407	1.558	3.272
Control group B	13	37	8.489	7.675

Note: ATT - Average Treatment effect on the Treated
*significant at 10%; ** significant at 5%; *** significant at 1%
Group A = municipalities with no. institutions equal to zero
Group B = municipalities with no. institutions constant and different from zero

Appendix 1 – Sectors considered (OECD, 2002)

High-technology industries:

- Aircraft and spacecraft (35.3)
- Pharmaceuticals (24.4)
- Office and computing machinery (30)
- Radio, TV and communication equipment (32)
- Medical, precision and optical equipment (33)

Medium-High-Technology industries:

- Chemicals excluding pharmaceuticals (24 except 24.4)
- Machinery and equipment (29)
- Electrical machinery and apparatus (34)
- Motor vehicles and trailers (34)
- Railroad and transport equipment (352 + 359)

Medium-Low-Technology industries:

- Coke, refined petroleum products and nuclear fuel (23)
- Rubber and plastic services (25)
- Other non-metallic mineral products (26)
- Basic Metals (27)
- Fabricated metal products except machinery and equipment (28)
- Building and repairing of ships and boats (351)

Low technology industries:

- Food products, beverages and tobacco (15-16)
- Textile, textile products, leather and footwear (17-19)
- Wood, pulp, paper, paper products, printing and publishing (21-22)
- Manufacturing and recycling (21-22)

Information and Communication Technologies industries (ICT):

- Office and computing machinery (30)
- Radio, TV and communication equipment (32)
- Medical, precision and optical equipment (33)
- Post and Communication (64)
- Computer and related activities (72)

Knowledge based industries (KBE):

- High-technology industries: Aircraft and spacecraft (35.3) + pharmaceuticals (24.4) + Office and computing machinery (30) + Radio, TV and communication equipment (32) + Medical, precision and optical equipment (33)
- Medium-High-Technology: Chemicals excluding pharmaceuticals (24 except. 24.4) + Machinery and equipment (29)+ Electrical machinery and apparatus (34)+ motor vehicles and trailers (34) + Railroad and transport equipment (352 + 359)
- Post and Communication (64)
- Finance and insurance (65-67)
- Business services (71-74)