Universities and the emergence and development of high-tech and knowledge-intensive industries in a region

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Abstract

This study addresses the question if universities are able to stimulate regional development. Based on information about the foundation of universities and technical colleges in West Germany since 1975, difference-in-difference estimation technique is applied to study the impact of universities on regional development. We find empirical evidence that the foundation of new universities and technical colleges has a positive impact on the number of high qualified employees in the private sector, while there is no evidence for an increase in total employment. Additional evidence suggests an increase of employment in high-tech manufacturing and knowledge intensive services. Furthermore, we find evidence for a positive impact of universities and technical colleges on the start-up activities in knowledge intensive services. Overall, the results of the empirical analysis suggest that the foundation of Universities and Technical Colleges resulted in shifts of the local industry structure towards high-tech and knowledge intensive activities.

JEL classification:

Keywords: structural change, regional development, universities

Introduction

Universities are assumed to contribute to regional economic development in a number of different ways. Universities generate new technological knowledge and opportunities that stimulate the innovative performance of local industry (Jaffe 1989; Acs et al. 1992). Academic institutions are often parts of international knowledge networks any may, through their pronounced degree of interregional linkages, absorb globally generated knowledge and circulate it regionally (Benneworth and Hospers 2007; Malecki 2010; Graf 2011; Owen-Smith and Powell 2004). The access to new and diverse knowledge may reduce the risk of technological lock-in for local economy (Grabher 1993; Bathelt et al. 2004). Moreover, the new technological knowledge, created and absorbed by universities, may create new technological pathways and new business opportunities that cause new industries to emerge and to grow. However, due to the (at least partly) embryonic and tacit nature of academic knowledge and the importance of personal interactions and physical proximity for its transfer, academic knowledge is likely to influence not only the temporal but also the spatial evolution of industries, particularly high-tech and knowledge intensive ones. In fact, Zucker et al. (1998) find that the intellectual human capital that flourishes at universities is important determinant of where and when the American biotechnology industry emerged and developed. More specifically, Zucker et al. (1998) find that biotechnology firms are likely to be found in close geographic proximity to where scientists who have published articles on gene sequencing are located. In addition, Audretsch and Stephan (1996) suggest that the specific role played by the scientist and the importance of geographic proximity for the firm-scientist link shape the spatial evolution of the US biotechnology industry. Similarly, Abramovsky et al. (2007) and Adams (2002) provide evidence that industrial R&D tend to disproportionately locate near to relevant university research.

Not least, universities are assumed to constitute nuclei of high technology districts (Castells and Hall 1994; Keeble and Lawson 1997). For example, it is thought that the Stanford University not only gave birth to Hewlett-Packard, the first significant electrical engineering company in Silicon Valley, but is also thought to have deliberately and carefully nurtured (among others) the actual development of the Silicon Valley (Leslie and Kargon 1996; Dorfman 1983). Unlike Stanford, the MIT and the Harvard University have not involved themselves seriously as institutions in the local economy. Nevertheless, the graduates and staff of both universities have provided the single most important source of high-tech entrepreneurs to the Boston area (Dorfman 1983; Roberts 1991). Accordingly, the MIT and the Harvard University are credited (among others) with the development of Route 128 and

the biotech cluster in Greater Kendall Square. Similarly, the Cambridge University in the United Kingdom is thought to have significantly influenced the development of the Cambridge Technology Region (Wicksteed 1985; Keeble 1989; Garnsey and Haffernan 2005).

Based on such empirical evidence, policy makers and regional planners increasingly consider universities as a local advantage and as a mean to stimulate the development of regions, particularly of poorly performing ones (Goddard and Chatterton 1999; Malecki 2007; Gunasekara 2006; Kitagawa 2004).

Against this background, this study aims at providing additional and more comprehensive evidence about the causal impact of universities on regional development. In particular, this study assesses the impact of the foundation of universities between 1975 and 2002 on the development of 15 West German planning regions that did not have university in 1975. By 2002, 12 of these became location of university or technical college at different points in time. Given the variety of different functions academic institutions are supposed to accomplish and the various interactions with the local environment, the impact of universities and technical colleges on local development is rather complex. However, in this study we focus on the development of high-tech and knowledge intensive industries. More specific, we first analyze the impact of a university foundation on regional employment, particularly in both high-tech and knowledge intensive industries. Second, we investigate the impact of universities and technical colleges on the local start-up rate in high-tech and knowledge intensive industries.

Given our set up—15 regions over 27 years and university foundation at different points in time—we apply within (fixed effects) estimator to empirically assess the impact of university's foundation on subsequent local development. The results provide robust evidence that the foundation of universities and technical colleges benefits employment in high-tech and knowledge intensive industries, while we do not find evidence for the impact of university foundation on total employment. Regarding start-up activities, we find evidence for the impact of university foundation on total start-ups activities. However, the results suggest that the total effect is rather due to start-up activities in high-tech and knowledge intensive industries. Overall, the results suggest that the foundation of a new university is related to a shift in the local economy towards more high-tech and knowledge intensive industries as well as employment shifts towards highly qualified employees.

The remainder of this study is organized as follows. Section two presents the empirical strategy applied in order to assess the impact of universities' foundation on regional

development. Section three elaborates on the foundation of universities in Germany—major motives and choice of location. Section four introduces the data and the variables. Section five presents the results of the empirical analysis. Section six concludes.

Identifying the effect of universities' foundation on regional development

We want to assess the impact of the foundation of universities and technical colleges on regional development. The set up we have is one where we observe the outcome of 15 different regions for a number of time periods, 1975-2002. Neither of these 15 regions is location of a university or technical college in the first period (1975). In subsequent periods, 12 of these regions are exposed to a treatment (foundation of an university or a technical college), while only three regions are not exposed to the treatment during either period. There is no closure of universities or technical colleges. A simple model to assess the impact of a foundation of university is

$$y_{it} = \rho D_{it} + u_{it}\,,\ t=1,\ldots,T, \tag{1}$$

where y_{it} is the outcome of interest in region i and time t, D_{it} is treatment indicator, and u_{it} is residual. We are interested in the coefficient for the treatment effect, ρ. However, the estimate for ρ is likely inconsistent if our treatment indicator D_{it} is correlated with u_{it}. This is likely the case if there are further factors that are correlated with both, the treatment indicator and the outcome variable. Hence, the model to be estimated is

$$y_{it} = \alpha_i + \lambda_t + \rho D_{it} + X'_{it}\beta + \varepsilon_{it}\,,\ t=1,\ldots,T, \tag{2}$$

where α_i is region specific fixed effect that controls for all unobserved time-invariant regional factors. λ_t is time specific effect that controls for all kinds of aggregate macro-economic influences that are equal for all i's. X_{it} is a vector of observed variables that control for (the most obvious) region specific time-variant influences. α_i, λ_t and X_{it} are permitted to be correlated with D_{it}. ε_{it} are the idiosyncratic errors.

A first step is to remove the unobserved region specific time-invariant fixed effects, α_i, in model (2). Treating the unobserved effects as parameters to be estimated is algebraically the same as estimation of the deviations from the mean of the same unit over time

$$\bar{y}_i = \bar{\lambda} + \rho\bar{D}_i + \bar{\mathrm{X}}_i'\beta + \bar{\varepsilon}_i\,, \tag{3}$$

where, for example, $\bar{y}_i = T^{-1}\sum_{t=1}^{T} y_{it}$. The unobserved region specific time-invariant fixed effects in model (2) can be eliminated by subtraction of the corresponding model for the individual means (3) from model (2):

$$(4) \qquad \left(y_{it} - \bar{y}_i\right) = \left(\lambda_t - \bar{\lambda}\right) + \rho\left(D_{it} - \overline{D}_i\right) + \left(X_{it} - \overline{\mathrm{X}}_i\right)'\beta + \left(\varepsilon_{it} - \bar{\varepsilon}_i\right).$$

Model (4) is known as within (or mean-difference) model and can be estimated by OLS. Equation (4) is largely equivalent to the difference-in-difference estimator, except that it different the means of the same units over time (Wooldridge 2010; Imbens and Wooldridge 2007).

Because α_i has been eliminated, OLS leads to consistent estimates of ρ, provided that D_{it} is strictly exogenous.[1]

Universities' foundation in Germany and exogeneity of treatment

In this section we discuss the process of university foundation, in particular the degree to which the decisions about where and when to locate a new university are related to region specific characteristics. This is particularly important, since the validity of the estimation of the impact of the creation of new universities on local economic development depends crucially on the exogeneity of the treatment. From (4), the within estimator requires strict exogeneity in order to be consistent, $E(\varepsilon_{it}|\alpha_i, D_{i1}, \ldots, D_{it}, \ldots, D_{iT}) = 0$. Correlation beween D_{it} and ε_{ir} for any t and r causes inconsistency. The assumption of strict exogeneity might not hold true if treatment is a reaction to past outcomes on y_{it} or if the foundation of a university is related to policy considerations about future development of the respective region.

The present West German university landscape is a rather modern phenomenon. Apart from the traditional universities, the most of which can be traced back to medieval time, a significant part of the universities that exist today in West Germany are comparably new, founded after the WWII. The reason for this some particularities is the German history.

At the beginning of the industrial revolution in the 19th century only about 10 percent of the universities and colleges that exist today already existed. These universities and colleges were located mainly in the Southern Germany (i.e. Baden-Wuerttemberg, Bavaria, Rhineland-Palatinate, Saarland, Saxony, and Thuringia) and the Free Hanseatic Cities. Since the

[1] Alternative approach to remove a_i is to first difference (FD) equation (2). However, for large T, as in our case, the within estimator is superior to the FD estimator in case of weak exogeneity (Wooldridge 2010; Imbens and Wooldridge 2007).

beginning of the 19th century a lot of universities and colleges were founded. However, the spatial distribution of these newly founded universities and colleges was uneven. In particular, universities and colleges were still founded mainly in Southern Germany, while were still missing in the centre and the north of the country. One particular reason is that Prussia feared the "free spirit" educated at universities and opposed the foundation of new universities in areas where it had less influence and control. For that reason and due to the WWI, comparably few significant academic institutions were created by 1920—mainly small colleges of education and/or ecclesiastic/parochial colleges rather than universities. After the WWI, reparations were significant burden for the German economy. Starting from the early 1930's on, the Nazi dictatorship—similar to the Prussian sovereigns—was less inclined towards the creation of new universities where freethinking and intellectual human capital could flourish.

After the WWII, highest priority for the Allied was the support of the ruined economy and the foundation of new universities and technical colleges started roughly 15 to 20 years later, in the late 1950' and the early 1960s'. The foundation of universities and technical colleges was mainly a reaction to an increased demand for higher education. There were several reasons for the demand for higher education to increase. One reason is that, as a result of the WWII ca. 8.000.000 expellees moved from territories that belonged to Germany before the WWII to West Germany. Since the overwhelming part of the German cities was destroyed during the WWII, a disproportionally large part of the expellees was diverted to rural regions, which were not typical locations of universities and technical colleges. For example, the overwhelming part of the nearly 2.000.000 expellees in Bavaria (ca. 21% of the population of the State) were diverted not to the capital Munich but rather to rural regions. The most populous Federal State in Germany, North Rhine-Westphalia, was entered by ca. 1.300.000 expellees (ca. 10% of the population of the State). Since the WWII, a significant fraction of the new universities and technical colleges was founded in Bavaria and North Rhine-Westphalia. Similarly, Schleswig-Holstein, a State with relatively few inhabitants, was entered by ca. 850.000 expellees, which accounted for ca. 33% of the local population.

Moreover, there was significant civil and policy commitment for more higher education institutions. In particular, Universities were considered as a mean to establish stable civil society and culture in Germany and there were particular efforts in this direction.

Potential effects of the creation of universities and technical colleges on the regional economy were appreciated, were, however, not the main motivation for the foundation of academic

institutions. Moreover, at that time, merely labor market effects as well as effects due to increasing local demand (i.e. multiplier effects) were considered. This is well reflected in prevalent paradigm among economists at that time, namely to analyze the possible effects of higher education institutions from macroeconomic perspective, mainly in term of multiplier effects (for critical discussion see Rosenthal et al. 2004 and Drucker and Goldstein 2007). Analyzing universities from a microeconomic perspective as a source of knowledge, high-tech and knowledge based entrepreneurship, and, therefore, as a source of sustainable competitive advantage, is rather a fairly modern approach. Accordingly, the foundation of new universities cannot be really considered a typical measure to stimulated knowledge-based regional development.

Thus, regarding the location of the newly founded universities and technical colleges in West Germany, we are able to indentify two major criteria: (i) to prevent overcrowding of existing universities due to increasing demand for tertiary education, and (ii) the creation of spatially equally distributed educational possibilities. A very convincing evidence for that, can be found in Schindler et al. (1991) who provide an excellent documentation of the decision making process with respect to the location of newly founded institutions for higher education at the example of Bavaria. In particular, the very aim of this study was to analyze and to recommend locations for the foundation of several technical colleges to the Government of the Federal State of Bavaria.

The two major criteria for the location of new academic institutions imply that new academic institutions are founded either in populous regions with already existing universities and technical colleges that face excess demand for higher education, or in regions that did not have universities and technical colleges yet. However, in this paper, we focus only on cases in which universities and technical colleges are founded in regions without such at that time. We do so, because assessing the pure impact of newly founded academic institutions in regions that host such is a difficult task. Additionally, populous regions with existing universities and technical colleges might be more likely to be relatively well performing regions.

To classify for university location, typically, regions have to fulfil a number of preconditions (Schindler et al. 1991). For the choice of location following factors play an important role: (i) the attractiveness of the location in terms of availability of medical, child care, sport, cultural and other facilities, costs of living and rental prices, (ii) the accessibility by means of public transport, (iii) the carrying capacity of the location (the ability to accommodate additional population induced by the foundation of the academic institution), (iv) the availability of

appropriate area to place the new academic institution. However, there are two further criteria that play particularly important role for the location of a new academic institutions: (v) a sufficient population size that ensures certain level of potential demand for higher education, and (vi) certain distance from locations of already existing universities.

This is particularly important for us, since it means that new universities and technical colleges have been placed in space so as to ensure sufficiently large catchment area. In other words, new universities and technical colleges have been placed in space so as to cover and serve relatively large regions, rather than small spatial entities like particular cities and counties. Once the demand for higher education has been estimated and sufficiently large catchment areas have been identified, criteria (i)-(iv) have been considered to determine the specific location of a new university or technical college. Accordingly, the choice of specific location is unlikely random, however, in our empirical analysis (see below) we use larger geographical units that cover the area of influence and the catchment area of new universities and technical colleges. For these larger geographic units, the location of new universities and technical colleges is less likely an issue.

Moreover, the decision to found new universities and technical colleges and the choice of location are made in Germany by the Federal States and regional administration has hardly any influence. The reason is that higher academic institutions in Germany are funded by the Federal States. Accordingly, there are likely policy influences that play an important role. Hence, it does not seem the case that regions have been selected which have the greatest prospect to benefit from the availability of academic institutions. Moreover, Kemmerling und Stephan (2002) analyze the extent to which the allocation of public capital by the Federal States to the municipalities in Germany depends on political factors and deviate from the welfare optimum. The authors find significant evidence that Federal Governments in Germany use the allocation of public capital to reward municipalities and electoral districts with the same political orientation.

An example for such political influences is the university of Goslar that was intended but not created. In the late 1990s, the ruling party in the Federal State of Lower-Saxony intended to create a new university in the city of Goslar. The choice of Goslar was politically motivated and influenced by the fact that the prime minister of the Lower-Saxony was born in Goslar and heavily involved in local policy prior to his career as the Minister-President of Lower-Saxony. Moreover, Goslar was the electoral district of the Minister-President. There were first steps undertaken towards the creation of a university in Goslar and the city council started

looking for appropriate area to locate the new university. However, the elections in 2003 led to a change of the ruling party in Lower-Saxony and the new Federal Government stopped the creation of a new university in Goslar.

Other examples for the influence of policy are the foundations of the universities of Bochum and Dortmund that are, however, founded before our period of analysis and therefore not included in the sample. The committee of the parliament of the Federal State of North Rhine-Westphalia which was responsible for the creation of the new university recommended Dortmund as a location for the new university. There were two key arguments for creating the new university in Dortmund. First, there were efforts by the city of Dortmund to create a new university dating back to 1897. The second argument was the reduction of the number of student at already existing universities in North Rhine-Westphalia. In this respect, Dortmund appeared reasonable choice due to its advantageous geographical location and the comparably easy accessibility of the city. However, at the same time there were close negotiations between the ruling party and the city of Bochum. Quite surprisingly, in spite of recommendation of the parliament committee, the government of North Rhine-Westphalia decided in favour of Bochum and the city became the university in 1962. The decision in favour of Bochum was motivated, besides the availability of building area, mainly by party- and power-political interests. This resulted in fierce protest by the public, the opposition party and the city of Dortmund, particularly by the city council. This protest forced the government of the Federal State of North Rhine-Westphalia to create another university and Dortmund became it in 1968.

Further evidence for the influence of policy, rather than that of contemporaneous regions specific factors, is the fact that a lots of universities and technical colleges have be founded at the same time. For example in Bavaria, there were two major ‘waves’ of creation of universities and technical colleges. The first wave took place in 1978-80 when the University of Passau and the University in Eichstaett-Ingolstadt as well as the technical colleges in Kempten and Landshut were created. The second ‘wave’ took place in 1994-96 when the technical colleges were created in Ansberg-Weiden, Ansbach, Aschaffenburg, Deggendorf, Hof, and Neu-Ulm.

There is also some anecdotic evidence that creation of universities has been aimed for a very long time but was not possible for a number of reasons that were not related to contemporaneous regional specific characteristics. One such example, that is included in our

sample, is the University of Flensburg.[2] The University of Flensburg located in the Federal State of Schleswig-Holstein in the north of Germany at the Danish border. The city of Flensburg strived to found a university already before the Thirty Years' War from 1618 to 1648. However, the city of Flensburg was heavily impacted by the war, which set the plans to an end. In 1652 the emperor of the Holy Roman Empire allowed the Duke of Schleswig-Holstein-Gottdorf to establish a university and the city of Flensburg negotiated with the Duke to place the university there. However, since the Duchy of Schleswig (where Flensburg is located) was only a Danish fief, therefore not a part of the Holy Roman Empire, locating the University in Flensburg was not possible. Instead, a new university was founded in the city of Kiel which was ruled by the Duke of Schleswig-Holstein-Gottdorf, but was located within the borders of the Holy Roman Empire. For a very long time residents of Schleswig-Holstein could study either at the University of Kiel or at the University of Hamburg. When Schleswig-Holstein decided to establish a new university Flensburg became the natural choice.

As to the question of non random selection of university location and strict exogeneity, the following can be said. The anecdotic examples provided in this section suggest that important motivation for the creation of new universities has been to prevent overcrowding of existing universities and to create spatially equally distributed educational possibilities. We were not able to find evidence that new universities and technical colleges tend to be founded in regions that would developed well in the future anyway rather than in regions without such prospects. Regarding the choice of date and location for new universities, the provided evidence suggests that there are various sources of variation which cannot be directly related to unobserved regional characteristics that influence the development prospects of a region. In some cases the creation of a new university in a particular region has been intended long before the actual event. Such influences should be accounted for by including fixed effects. In other cases, the choice of date and location for new universities seem to be motivated by political reason that can be considered exogenous.

Moreover, in the empirical analysis, we use relative large regions that cover the area of influence and the catchment area of new universities and technical colleges. As mentioned above, the issue of non random choice of specific location for a new university or technical college is much more important within these relative large regions than between. And even if not each of these relatively large regions is equally suitable as a location of a university, 12 of

[2] There is similar evidence for the University of Augsburg, which, however, is unfortunately not included in our sample.

these 15 regions become a location of university or technical college by the end of our period of analysis (2002). However, for convenience, we provide robustness check while excluding the three regions that were still no university location in 2002. Moreover, in the empirical analysis we make use only of the within-unit variation and do not compare the average outcome of two groups (treatment and control). Finally, the university indicator (for description of the treatment variable see next section) used in this study measures the years since foundation of the particular higher education institution and is less likely correlated with the specific characteristics of the particular academic institution and, therefore, with time-variant regional characteristics.

Data and variables

Data source

We use data from the Establishment History Panel which is based on official employment statistics provided by the Institute for Employment Research (IAB) of the German Federal Employment Agency. The data contain establishment aggregated data derived from social security statistics that makes this data highly reliable and is available from 1975 onwards. This data is not a random sample but covers the total population of West-German businesses that have at least one employee subject to social security. A considerable advantage of these data is that regional information is included. We use data for West-German regions for the period 1975 to 2002 since this period allows an analysis based on the same industry classification. The unit of observation are 74 West-German planning regions that can be considered as spatial functional units (BBR 2003). Each planning regions consists of a core city and its surrounding, and the functional separation is based on commuter flows. The following sectors of the local economy are excluded from the analysis: agriculture, mining, public services and education. We restrict the data to private industries only in order to assure that the effect of a new university or technical college is not due to changes in the regional employment structure caused by the university itself (e.g. new employees hired by the university). We collected data about new universities and technical colleges for the period 1976 to 2002. Academic institutions such as public administration colleges, colleges of arts, and conservatories are not included because we are interested in the technological dimension and the role of such universities is not clear (Jaffe 1989; Fischer and Varga 2003; Mueller 2006). During the period under investigation 15 regions had no university or technical college in 1975, with 12 regions that became a technical college or university between 1976 and 2002

and three regions that did not had any university/technical college in 2002 yet. A list of all regions and further information is documented in table A1 in the appendix.

Dependent variables

Several variables are used to proxy regional development. First, we employ the total number of private sector employees in a region. However, since high-tech and knowledge intensive industries are more likely to benefit from academic knowledge we further employ the number private sector employees with tertiary education, the number of employees in R&D intensive manufacturing industries, as well as the number of employees in knowledge intensive services. We consider employment of high qualified, and employment in high-tech and knowledge intensive industries as more suitable to assess the knowledge impact of new universities as opposite to total employment which is more likely to be influenced by the increase of local market potential. Finally, we use the total number of start-ups, the number of start-ups in R&D intensive manufacturing industries and the number of start-ups in knowledge intensive services as further proxies for regional development.

Treatment

New universities impact on local economy not only in the year of foundation but rather develop their impact over a longer period of time. It is also very unlikely that the University will have a constant effect over time. Rather the new University needs some time integrate into local economy and to unfold their full potential. Therefore we employ the number of years that the university is located in the region as a treatment indicator.

Control variables

Next to the set of region and time fixed effects we consider the regional firm size structure (regional employment shares in large and medium sized firms) and employment density (total employment over area size) as further controls. Furthermore we control for the regional industry structure by including the regional employment shares of 27 out of 28 industries.

Results

Table 1 reports the results of the estimation of the impact of university foundation on regional employment according to equation (6). Columns one and two in Table 1 report results for overall private sector employment. Column 1 does not include the control variables for the regional industry structure while the results in column 2 include the regional employment

shares of 27 out of 28 industries. We do not find a significant positive impact of the foundation of a university on total private employment.

Column three and four presents the results for high qualified workers. The foundation of university is significantly related two the total number of high qualified workers. When controlling for the existing regional industry structure (column 4) the coefficient nearly doubles. We find that the foundation of a university on average increases private employment of high qualified workers by 32 to 62 employees for each year that the university exists.

In column five and six private employment in R&D intensive industries is used as an outcome variable. Although a significant share of employees in these industries has tertiary education this group is by far not the largest. Again our results indicate a significant positive contribution of university foundation to employment in these industries. For every year of existence, employment in R&D intensive industries increases by 100 to 118 employees. Again we find that controlling for the regional industry structure yields a larger coefficient.

Columns seven and eight report the results for employment in knowledge intensive services. Our results hint to a yearly employment contribution of a newly founded university in the range of 96 to 117 workers in knowledge intensive services.

Table 2 reports the results of the estimation of the impact of university foundation on regional start-up activities according to equation (6). In column one our results indicate a positive relationship between university foundation and total start-ups in the region – approximately 11 start-ups per year of university's existence. However, when controlling for the local industry structure the significance level of the treatment variable drops to ten percent level.

Similar to above, we then focus on start-up activity in R&D intensive manufacturing industries and knowledge intensive services since these industries are assumed particularly dependent on academic knowledge. For start-ups in R&D intensive manufacturing industries we find a positive and significant impact of university foundation (columns three and four). As in the case of employment in R&D intensive manufacturing industries, the coefficient of the treatment variable increases when local industry structure is controlled for. For every year of university existence our results indicate between 0.3 to 0.7 additional start-ups in these industries.

The foundation of university is also significantly positive related to start-ups in knowledge intensive services. Here our results suggest on average 7.5 to 8.5 more start-ups. After a time period of 5 years (assuming 8 additional start-ups every year due to the new university) the

number of start-ups that can be attributed to the university foundation makes up approximately 1.8 percent of all local businesses in knowledge intensive services.

Table 1: The effects of universities and technical colleges on regional employment.

	Private sector employment	Private sector employment	HQW	HQW	Employment in R&D intensive manufacturing	Employment in R&D intensive manufacturing	Employment in knowledge intensive services	Employment in knowledge intensive services
	I	II	III	IV	V	VI	VII	VIII
University (Years of Existence)	83.10 (95.6)	131.8 (117)	32.20*** (8.51)	61.93*** (8.79)	100.4** (41.9)	117.8*** (45.0)	96.22*** (13.7)	116.8*** (13.9)
Population Density, t-1	215.8*** (46.9)	24.06 (46.5)	40.79*** (4.17)	10.70*** (3.50)	-3.294 (20.6)	-31.14* (18.0)	45.31*** (6.72)	5.579 (5.56)
% share of employees in firms >250	1433*** (200)	571.3** (246)	63.32*** (17.8)	85.75*** (18.6)	965.7*** (87.8)	311.0*** (95.0)	-223.7*** (28.7)	-96.42*** (29.4)
% share of employees in firms >50 & <=250	1081*** (330)	359.0 (320)	50.80* (29.4)	58.86** (24.1)	875.4*** (145)	49.42 (123)	-316.7*** (47.4)	-168.8*** (38.2)
% share of employees in firms <=50	ref.	ref.	ref.	ref.	ref.	ref.	ref.	ref.
Time effects	yes	yes	yes	yes	yes	yes	yes	yes
Industry controls	no	yes	no	yes	no	yes	no	yes
Constant	-25459 (15451)	-1633591*** (282648)	-9931*** (1375)	-88483*** (21286)	-35763*** (6778)	-30113 (109041)	7805*** (2215)	-152006*** (33768)
R2 within	0.48	0.80	0.84	0.96	0.40	0.82	0.78	0.94
Log likelihood	-4003	-3809	-3023	-2762	-3670	-3424	-3217	-2949
F	11.26	23.65	64.39	129.4	8.095	27.10	42.85	94.30

Fixed effects regression. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The number observations is 405 (15 regions, 27 years).

Table 2: The effects of universities and technical college on regional start-up activity.

	Private sector start-ups	Private sector start-ups	Start-ups in R&D intensive manufacturing	Start-ups in R&D intensive manufacturing	Start-ups in knowledge intensive services	Start-ups in knowledge intensive services
	I	II	III	IV	V	VI
University (Years of Existence)	11.16***	9.066*	0.295**	0.708***	8.552***	7.564***
	(3.69)	(5.23)	(0.13)	(0.21)	(1.57)	(2.84)
Population Density, t-1	6.199***	2.903	0.0941	0.0439	2.430***	1.076
	(1.81)	(1.96)	(0.062)	(0.083)	(0.77)	(1.13)
% share of employees in firms >250	-28.18***	-18.87	0.250	0.128	-3.666	-8.368
	(7.73)	(11.5)	(0.26)	(0.44)	(3.28)	(5.99)
% share of employees in firms >50 & <=250	-44.37***	-33.83***	0.147	-0.272	-5.646	-15.09*
	(12.8)	(13.9)	(0.44)	(0.57)	(5.42)	(7.78)
% share of employees in firms <=50	ref.	ref.	ref.	ref.	ref.	ref.
Time effects	yes	yes	yes	yes	yes	yes
Industry controls	no	yes	no	yes	no	yes
Constant	1730***	-27921*	-13.39	31.30	-169.5	-4518
	(597)	(15648)	(20.4)	(507)	(253)	(6877)
R2 within	0.81	0.85	0.51	0.65	0.81	0.84
Log likelihood	-2686	-2637	-1318	-1248	-2339	-2304
F	50.66	32.86	12.29	10.86	49.86	29.81

Fixed effects regression. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. The number observations is 405 (15 regions, 27 years).

Conclusions

In West Germany significant number of universities and technical colleges has been founded after the WWII. In many of these cases foundation of new organization took place in regions that did not have universities before for various reasons. In order to cope with the increasing demand for analysis of the effects of these university foundations, this paper aims to analyze some important aspects of regional development. Although university foundation can be viewed as a policy instrument for regional development, we provide evidence that time and place of university foundation often did not depend on regional characteristics and/or has been politically motivated. Hence, we assume that the foundation of a new university in certain region is rather exogenous which allows us to draw causal inference by using a generalized difference-in-difference approach.

The empirical evidence of our analysis suggests an important role of university foundation for employment creation in innovative and knowledge intensive private sector industries as well as for high qualified workers. Furthermore we find a significant positive impact on start-up activity in innovative and knowledge intensive industries. Overall, the results suggest that university are agents of change. That is, the foundation of a new university is related to a shift in the local economy towards more high-tech and knowledge intensive industries. Since most of the regions under consideration are moderately congested and/or rural regions our results may also allow important policy implications with respect to university foundation as an instrument for regional development.

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Appendix:

Table A1: Universities and regions used in the analysis.

Region (ROR)	Region name	Region type	Population in 1975	Population in 1975	HQW in 1975	HQW in 2002	Foundation	Years w/o treatment	Years with treatment
2	Schleswig-Holstein Süd-West	Rural area	266377.6	274292.6	351	1285	1993 (TC)	17	10
5	Schleswig-Holstein Süd	Agglomerated area	773705.9	954880.7	2586	8038	1993 (TC)	16	11
17	Emsland	Rural area	353850.6	440784.8	1604	2477	-	27	0
20	Südheide	Rural area	291977.5	324688.8	664	1769	-	27	0
38	Arnsberg	Moderately congested region	540172.4	589864.1	1221	4976	-	27	0
40	Emscher-Lippe	Agglomerated area	1074210	1050026	3031	5475	1992 (TC)	16	11
62	Mittelrhein-Westerwald	Moderately congested region	1131866	1279696	2409	7952	1984 (Univ)	8	19
80	Bayerischer Untermain	Moderately congested region	316862.3	375110.5	702	4075	1995	19	8
82	Main-Rhön	Rural area	418800.7	456030.8	1585	4265	-	0	0
85	Oberpfalz-Nord	Rural area	494197.3	521860.1	838	3354	1995 (TC)	19	8
87	Westmittelfranken	Rural area	367138.6	419472.9	418	1728	1996 (TC)	20	7
89	Ingolstadt	Moderately congested region	332904.6	445573	832	7064	1994 (TC)	19	8
91	Donau-Wald	Rural area	570478.4	662132.7	971	3229	1979 (Univ)	3	24
94	Donau-Iller (BY)	Moderately congested region	395625.1	461223.6	1057	3989	1994 (TC)	19	8
95	Allgäu	Rural area	400565.5	464665.8	1161	4071	1978 (Univ)	2	25