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History of Success: Regensburg – A Local Growth Miracle

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Abstract Regensburg, the fourth largest city in Bavaria, and its surrounding areas were until the early 1980s considered to be among the crisis regions of Germany. In the past 30 years, however, the region has experienced deep structural transformation and is nowadays ranked as one of Bavaria's economic hot-spots. Several decisions can be seen as catalysts for this still ongoing dynamic development. Probably the most important one – apart from the establishment of a BMW production plant – was the opening of the University of Regensburg in 1967, which had and still has a strong impact on the skill structure of the local labour force. The city also implemented a regional cluster policy that connected economic activities with the new opportunities arising from the young higher education institute. In this paper we take a closer look at where all the graduates of the University of Regensburg have gone since 1995 by drawing on a unique data source in which data about individual graduates is linked to German social security data. Through this we are able to evaluate to what extent graduates stay in the region after finishing their studies. We find a significant "adhesive effect" both for students originating in the region and students from outside the region. We therefore conclude that the university plays a key role in the dynamic economic development of the region.

Keywords: • economic development • regional cluster policy • business • universities • mobility patterns

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1   Introduction

The University of Regensburg in Bavaria was founded in 1962 and opened in 1967 as a regional university. Since then, Regensburg and the surrounding areas have experienced deep structural transformation. Until the 1980s, the location was considered to be among Germany's crisis regions. Now, by contrast, Regensburg is ranked as one of Bavaria's economic hot-spots. In contrast to the national trend, manufacturing jobs constitute a considerable share of employment. Several high-tech firms are located in the region along with important manufacturing firms, among which there are several so-called "hidden champions". Together with this astonishing economic development, a change in cultural life can also be observed. Cultural offerings now range from high-quality cinemas, music and film festivals to theatre and poetry. The atmosphere has changed from that of a provincial town to one of openness, diversity and creativity. Due to the variety of local amenities, the quality of life in the location has improved enormously.

Economic success has manifested in a low unemployment rate in the region (2.2% in May 2017), along with an increase in employment, wages and housing prices. The city of Regensburg in particular has a growing population and is strongly attracting young people. Due to these developments, Regensburg is one of the regions with the lowest average population age in Germany. In this paper, we shed some light on the factors that are, we believe, primarily accountable for driving this development.

It turns out that a fortunate combination of investments from various high-tech companies, successful regional economic policy, and – possibly the most important factor – the foundation of the University of Regensburg have driven this exceptional development.

This paper is structured as follows: The next section describes important milestones in the economic development that has occurred since the 1980s. In section three we analyse the mobility patterns of graduates from the University of Regensburg which have different core implications for regional economic development. Section four concludes.

2   Regensburg, the case study

2.1   Economic history and milestones

Until the 1980s, Regensburg was often referred to as a "sleepy administrative city". The location was then marked by a declining population,[1] having one of the lowest birth rates and tax incomes in Germany, along with a declining textile and clothing industry. Unemployment rose above twelve percent at the time. In comparison, since 2010 the former has been continuously and clearly below four percent in the city and the surrounding area, while in spring 2018 it was as low as 2.2% (German Federal Employment Agency).[2]

One strong boost to the economic development of the city came from the foundation of the University of Regensburg, which started operating in 1967. Additionally, the opening of the University of Applied Sciences Regensburg (today the Eastern Bavarian Technical University Regensburg, OTH[3]) followed in 1971. It typically takes a few years for the impact of a university to unfold in a region (Goldstein and Drucker 2006; Warnecke 2016). The staff of lecturers and administration must be built up, faculties gradually take up their activities, economic actors recognize and increasingly make use of the opportunities offered by joint research projects, and the first students graduate after several years and look for their first jobs.

In Regensburg, these effects merged with a second development: industry discovered the potential of the location, stimulated by the active economic policy of the city. An analysis in the 1970s indicated the lack of space for development, so a new structural policy with new targets was conceived. As a first step, a political process of annexation was implemented. This made the city area 1.5 times larger, creating new space for business and increasing flexibility in terms of efforts to attract investment. The active economic development policy led to the establishment of a BMW car plant in 1983,[4] which also attracted suppliers and encouraged long-established companies to expand. Further corporate decisions that led to a significant improvement in the image of Regensburg were the expansion of a preexisting Siemens location into a mega-chip plant[5] in 1984, the establishment of Toshiba's first European notebook production facility in 1989,[6] and the company-internal creation of Siemens Automobiltechnik[7] in the same year (Daminger and Litzel 2017).

2.2   External shocks

In the same decade, the international trend in business to slice up value-added chains (Krugman 1995) gained momentum. Moreover, in 1989 the Iron Curtain fell and the ensuing path towards EU-enlargement in 2004 turned formerly peripheral regions into centrally located economic spaces. For Regensburg, located close to the border to former Czechoslovakia, the combination of these two external shocks brought drastic changes. The integration of markets, fueled by the opening of the former Eastern Bloc, created new opportunities for firms, especially in the border regions. On the supply side, new sourcing partners made efficiency gains possible, while on the demand side the new markets brought new customers and the opportunity to shift production to a nearby neighbouring country with much lower labour costs ("in the mid-1990s wages were at current exchange rates more than eight times higher in the eastern Bavarian border region than in the Czech Republic"; Moritz 2011, 42). These factors made corporations as well as small and medium-sized firms think about relocating business activities there. Companies were forced to keep up the pace by making efficiency gains just to stay in business, and also reorganized their internal processes accordingly.

The increasing disintegration of the production process combined with outsourcing and offshoring required more coordination between business partners. Both forward and

backward linkages and informal co-operation gained in importance, partly because more complex parts of the value-added chain were gradually outsourced and business partners became integrated into the innovation process. Hence, co-operation and interaction between partners had to become more intense, a situation made easier due to geographic proximity.

Relocating businesses are attracted by locations that offer favourable regional conditions, which are often found not in places with cheap production factors, but in locations with a supply of the relevant skilled labour, opportunities for co-operation, local suppliers and customers, as well as research and higher education institutions – in other words, in locations with clusters (see Litzel and Möller (2011) for an overview). These are defined "…as significant geographic concentrations of major end-market industries, their extended supply chains, other sectors that share close technological or human capital affinities, and various specialized supporting institutions" (Feser and Sweeney 2002, 111). It is now at the regional rather than the national level that competition for economic activities and skilled labour has emerged between economic spaces. It can be observed "that even as competition and economic activity globalize, ... competitive advantage can be localized" (Enright 2003, 100). Porter (1990) calls this the "location paradox". Cluster policy was an important economic and science policy instrument at the beginning of the 1990s – as it still is today in an advanced form.

2.3   Cluster policy in Regensburg

For a location like Regensburg to compete with other economic spaces and find its own distinctive position, the policy of promoting regional clusters offered an opportunity to make its existing economic strengths, advantages and distinctive features more visible, and to increase innovation by establishing business contacts that would not have come about without such an external initiative.

Building on the leading industries in the region and, above all, on the competencies of the University of Regensburg and the Regensburg University of Applied Sciences, the city administration began to support networking between science and business in the mid-1990s. The first cluster – biotechnology – represents an example of the path taken by the municipal economic development department: at that time, the German government put the BioRegio initiative[8] out to tender. Regensburg was already a renowned location due to the University Hospital, which went into operation in 1992, and due to the life-sciences-related research and educational activities at the University of Regensburg. Young, ambitious scientists produced high-calibre research achievements there. The Regensburg University of Applied Sciences, with an orientation towards applied research, also offered important opportunities for making connections, for example in the field of medical technology. The initiative involved organizations from science, industry and administration with highly qualified personnel who recognized the opportunity for commercializing biotechnology and developed the ambition to take part in the BioRegio competition – not least because of the funding opportunities. And not without success: in

Regensburg development was initiated that is now unparalleled anywhere in Germany. In addition, the establishment of a biotechnology-oriented start-up scene provided a boost to innovation for the entire region. In 1997, 13 biotech companies were already active in Regensburg. In 1999, the city of Regensburg founded BioPark Regensburg GmbH as a municipal subsidiary in order to provide a stable organizational structure for coordination-related tasks. On campus, the Hans Vielberth University Foundation erected a multifunctional building and developed it into the first BioPark. Since 2005, the number of employees in the participating organizations has increased by 50%. Today, 33 companies work in three buildings with high-quality laboratory and office space, whose approximately 550 employees have direct access to university infrastructure due to their location on campus, such as the library, canteen, and seminar rooms – and, of course, to the know-how of scientists.

Spurred on by these noticeably positive effects, the city successfully participated in broader competition, this time in the field of information and communication technology. Together with the State of Bavaria, Hewlett-Packard and the city of Regensburg initiated the establishment of an IT start-up centre, in which support was offered to the related field. Today, the IT-cluster has developed into an IT-security and IT-logistics cluster now active throughout Bavaria and located in the municipal subsidiary R-Tech GmbH. Both clusters bring together small and medium-sized companies, large enterprises and various higher education institutions; they also initiate numerous research and development projects and advise and support spin-offs from universities and young companies. Similar initiatives exist in the fields of sensor technology, e-mobility, energy, and, since 2015, in the health industry and the cultural and creative industries.

The city will continue to follow the path it has already taken. Its "Vision 2030" is formulated accordingly: "Economy and science in Regensburg merge into a place of knowledge and innovation. The city is an attractive place for developers and an important centre for the production of high-quality goods" (Daminder and Lautenschläger 2018).

In this context, a major investment was made into establishing an industrial zone, the TechCampus, in the immediate vicinity of the University of Regensburg, the Eastern Bavarian Technical University Regensburg (OTH), and the University Hospital. The TechBase building opened on this campus in 2016, offering offices, workshop and research space to high-tech companies and development groups. Teaching, research, innovation and production take place on one campus. This is where business and science merge.

The city will continue to vigorously expand this model. Together with the university, for example, it is working to create non-university research institutions. Together with other partners it has launched a Digital Start-Up Initiative for the region and aims to establish STEM funding for children and young people in co-operation with the University of Regensburg, Eastern Bavarian Technical University Regensburg (OTH), the districts of Regensburg and Kelheim, and several companies, foundations, schools, chambers and

associations. It is also considered important to create good conditions for company start-ups and spin-offs from universities. Thus, numerous consulting offers for entrepreneurs exist to facilitate the startup of young companies.

The networking of companies from trade and industry as well as young and well-established companies of all sizes, universities and institutions creates a network that distinguishes the Regensburg economic area and makes it unique. Such a network is also a factor in why companies stay in the area and continue to grow.
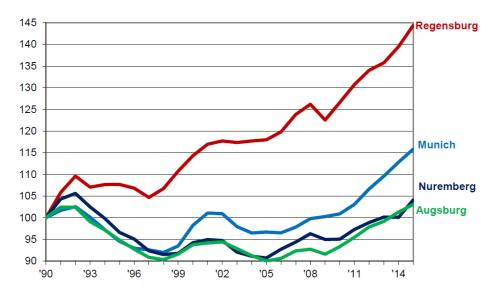
Figure 1: Employment subject to social security

* Graph: Stadt Regensburg, Amt für Stadtentwicklung, 09/2016.
Source: Statistics of the German Federal Employment Agency, German Federal Statistical Office (Bundesagentur für Arbeit, Statistische Ämter des Bundes und der Länder) (2019).

2.4 Development in figures

The dynamism of the business and science location has had an effect on the entire city and region. Regensburg is attractive for both living and working: At the end of 2016, just under 164,000 inhabitants were registered as living there; the population has thus increased in the last decade by almost 13%.[9] The labour market is extraordinarily well established: More than 148,000 people are employed,[10] the number having risen by almost 13% over the last ten years (in comparison: Bavaria +6%, Germany +2%) (City of Regensburg 2017, 135). The number of academic jobs doubled during this time (16% of all jobs).[11] If only employees liable to social security are taken into account, the number

of employees represents – at 780 per 1,000 inhabitants – the third highest employment density in Germany, after Wolfsburg and Erlangen (City of Regensburg 2017, 361). Figure 1 shows how dynamically the labour market has developed compared to other Bavarian cities since 1990. For example, while employment in Nuremberg and Augsburg after periods of heavy job losses increased by just under five percent, in Regensburg it increased by 45%. The unemployment rate in the city and district has been continuously below four percent since 2010, while in June 2017 it was 2.5%, reaching almost full employment. Regensburg is also a location for production. The share of the gross value added of the manufacturing industry (46.3%; Bavaria 34.3%) is comparatively high for a city of that size (City of Regensburg 2017). Regensburg continues to attract new companies engaged in production. Thus in 2015 and 2016 the economic development department of the city addressed about 120 cases of business settlement, of which about 90% originated in the region and had grown or wanted to get closer to the universities or other network partners.[12]

Trade tax revenues in 2015 of 226 million euros and income tax of 82 million euros reflect the good employment situation. In 2016, the lowest level of per capita debt since 1994 (less than 1,000 euros) was achieved (City of Regensburg 2017, chapter 15). Revenues (2016 to 2020) will be used for urban projects, in particular for (social) housing, infrastructure, education and childcare services; i.e., investing in the fields that are affected by population growth. The overall budget for the above-mentioned areas will be just under 900 million euros, the highest sum in the recent history of the city.

3   Impact of the University of Regensburg on regional development

It is clear that the economic success of Regensburg cannot be explained by the establishment of manufacturing firms alone. The continuing path of growth – in our understanding – can only be explained by a related change in the city's cultural life. This cultural change is undoubtedly related to the foundation of the University of Regensburg, which had and still has a profound impact on Regensburg's overall appearance. The literature has identified various channels through which universities can influence their environment. They range, inter alia, from direct and indirect spending effects (e.g. Blume and Fromm 1999), knowledge production and the formation of human capital, to changes of regional milieu (see Goldstein *et al.* (1995) for an overview of possible channels). Such changes make a location attractive to the so-called creative class (Florida 2014), a term that refers to people who are active in the creation of new ideas (new technology, artwork, etc.) and who establish a breeding ground for innovation activities, which in turn facilitates local economic development.

With the opening of the University of Regensburg and the growing share of students in the local population (Regensburg in 2017 had roughly 160,000 inhabitants and around 33,000 students), many amenities have became locally available, making Regensburg an attractive place. Many bars, clubs and cafés nowadays strongly influence the overall appearance of the city. Moreover, the university hosts a variety of cultural events, such

as concerts, theaters and exhibitions. Empirical evidence for the attractiveness of the city is given in Möller and Rust (2017), for example.

Finally, and probably most importantly, every year a significant number of graduates leave university and enter the labour market as part of the highly qualified labour force. These employees (or self-employed persons) create an essential basis for innovation and economic development. In terms of regional development it is therefore of significant relevance in which regions graduates start to work. Graduate mobility, therefore, has received increasing attention in the literature in recent years. The empirical part of this contribution is devoted to examining the choices of graduates from the University of Regensburg by drawing on a unique data source which allows us to address the mobility of graduates in a very detailed manner.

3.1   Data

This data source is based on process data made available by the University of Regensburg and contains information about all students who obtained degrees between 1995 and 2015. The information in this dataset encompasses, among other details, the field of study, university entrance certificate grade, date of graduation, final grade, and region of origin (see Figure 2). This data source has been linked to official register data from the German social security system (Integrated Employment Biographies, IEB), available at the Institute for Employment Research (IAB), and contains information (which is exact to the day) about individual employment status and type of occupation, region of workplace, wages, profession, sector and many more characteristics related to labour market topics; see for example Dorner *et al.* (2010) for a detailed description of the IEB.

The two data sources were combined based on a well-established linking procedure developed at the IAB (Sakshaug *et al.* 2017) while – due to the fact that both sources are based solely on register data – the final dataset includes very reliable information. The linked data set finally contained employment spells for more than 35,000 graduates. Note that as a consequence of the nature of the German social security system, several groups are not contained in the data: these include civil servants and self-employed persons.
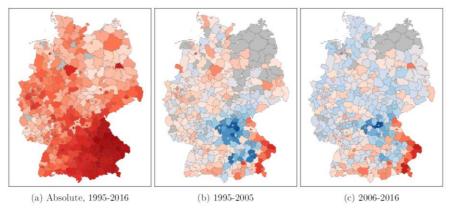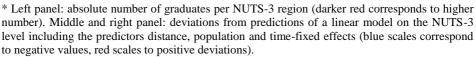
Figure 2:   Spatial distribution of graduates' origin

(a) Absolute, 1995-2016   (b) 1995-2005   (c) 2006-2016

* Left panel: absolute number of graduates per NUTS-3 region (darker red corresponds to higher number). Middle and right panel: deviations from predictions of a linear model on the NUTS-3 level including the predictors distance, population and time-fixed effects (blue scales correspond to negative values, red scales to positive deviations).

3.2   Empirical results

Distribution of graduates' spatial origin
Assuming that only a small number of graduates moved from one region to another prior to receiving their university entrance certificate (Abitur), one can take the region where the entrance certificate was acquired as a reasonable proxy for the graduates' region of origin. Looking at the spatial distribution of the region of origin for those students who went on to study at the University of Regensburg, one finds three strong predictors: (i) the population of the region of origin, (ii) (average) distance to the University of Regensburg, and (iii) a time effect, because the number of university students increases over time. To characterize the specific attractiveness of the University of Regensburg for the various regions of origin one can purge these effects from the raw data.

To this end, we estimate on NUTS-3 level data the following model:

$$\log(grad_{i,t}) = g(dist\_to\_rgbg_i) + \beta_1 \log(pop_i) + \beta_2 \, bavaria_i + \phi_t + \varepsilon_{it}, \qquad (1)$$

where $grad_{i,t}$ is the number of graduates in year t who originate from region i, and the function $g(\bullet)$ is a spline-based[13] nonlinear transformation of the distance of the region of origin to the University of Regensburg, $dist\_to\_rgbg_i$. The parameter β1 accounts for the effect of the origin region's population, pop_i, and is the coefficient of a dummy variable indicating whether the region is located in Bavaria. Φ_t, finally, are cohort-specific fixed effects. The residuals of the regression model can now be interpreted as an indicator of the attractiveness of the University of Regensburg in a specific region.

The spatial distribution of graduates' regions of origin is depicted in Figure 2; the left panel shows the absolute number (aggregated over the whole period) of graduates originating from each region, while the middle and right panel depict the aggregated residuals from model (1) for the periods 1995–2005 (middle panel) and 2006–2016 (right panel). In absolute terms, the University of Regensburg primarily receives its students from the surrounding regions, most predominantly from eastern and south-eastern Bavaria. After controlling for population, distance and time effects, at first glance the spatial distribution of the (purged) attractiveness seems to be characterized by a very similar pattern for both cohort groups. For the more distant regions, relatively more graduates originate from the eastern part of Lower Saxony and Saarland, while relatively few, by contrast, originate from the Ruhr area. The highest attractiveness of the University of Regensburg is found in regions in the eastern part of Bavaria, especially for those located within or close to the Bavarian Forest. Moreover, one can clearly identify regions within Bavaria in which the university is of comparably low attractiveness (for instance, Nuremberg, Würzburg, Bamberg, Augsburg, Munich and Landshut). All of these regions are university towns or at least located close to other full universities or universities of applied sciences. Hence, the lower attractiveness of the University of Regensburg is very likely due to intervening opportunities.[14]

This indicates that there are regional preferences that influence the location of study beyond the effect of sheer distance. The existence of a local university can mobilize this potential. Comparing the outcome of the attractiveness indicator for the two cohort groups, one can observe that regional concentration is less pronounced for the cohorts 2006–2016, reflecting greater attractiveness of the University of Regensburg for students throughout Bavaria in recent years.
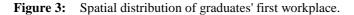
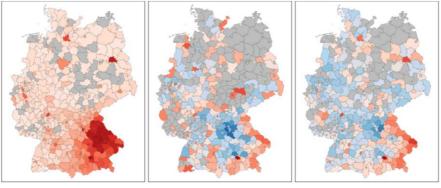*The location (region) of graduates' first workplaces*
The same methodology was applied to the location of graduates' first workplaces after graduation as for the region of origin. In the selection of this first workplace we only considered regular employment spells, but imposed no restriction regarding the time between the first occurrence of such a spell and graduation. Note that for a minor share of graduates we cannot identify any regular employment spell. This could be for various reasons; for instance: (i) the graduate went abroad and thus is no longer visible in the German administrative employment register; (ii) the graduate worked as a civil servant or in a liberal profession (as a teacher, doctor, lawyer or consultant, for instance); or (iii) the person did not enter the labour market during our observation period, perhaps for family or other reasons (e.g., raising a child).

The regional distribution of the first workplace is illustrated in Figure 3. The left panel again shows the absolute number of graduates starting to work in the corresponding region and reveals that graduates of the University of Regensburg overwhelmingly tend to begin their labour market careers rather close to their place of study. The lion's share take up their first employment in the eastern and south-eastern part of Bavaria. Outside of Bavaria, a significant number of graduates can be found only within a few regions.

Unsurprisingly, when absolute numbers are considered these regions coincide with Germany's most populous cities (e.g., Berlin, Hamburg, Frankfurt, and Stuttgart). The fact that a relatively large number of graduates remain within the wider region around the city of Regensburg for work is in large part explained by the factors included in the linear model; in particular, by distance and the homeland effect. However, even after we control for the systematic factors included in the linear model, there remains an over-representation not only of the city of Regensburg but also some regions in Eastern Bavaria, in particular those along the eastern and south-eastern borders of Bavaria. Outside Bavaria it is visible that Berlin increasingly attracts relatively large numbers of graduates. In absolute terms, Munich is the most important location for the employment of graduates among all large German cities. By contrast, the greater Nuremberg area receives significantly fewer graduates than is suggested by the linear model; i.e., according to the conditional average given distance and population and the other factors contained in the linear model.

Figure 3: Spatial distribution of graduates' first workplace.

(a) Absolute number   (b) 1996-2005   (c) 2006-2015

* Left panel: absolute number of graduates working in the respective NUTS-3 region (darker red corresponds to higher number). Middle and right panel: deviations from predictions of a linear model on the NUTS-3 level including the predictors distance, population and time-fixed effects (blue scales correspond to negative values, red scales to positive deviations).

As pointed out earlier in this paper, it is of particular importance how many of the university's graduates remain in the region after graduation. Based on the linked data, we evaluated for a period of up to 10 years after graduation how many graduates were working within the wider Regensburg region (consisting of NUTS-3 regions within a circle with a radius of 100 km around Regensburg) and how many had left it for another area. The result is given in Figure 4, where on the left panel is illustrated the share for graduates coming from outside the region, and on the right for those who originate from the region.
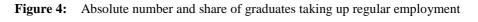
The findings reveal that 50% of graduates from outside the region who found a job immediately after graduation stayed in the region. This can be termed the "adhesive effect" for incoming students. Due to the mobility of highly skilled workers, the adhesive effect declines over time. However, approximately 20% of the graduates from outside the region were in regular employment within the region even 10 years after graduation. Thus, a significant part of the adhesive effect is permanent. The adhesive effect for graduates originating from the region is considerably larger: 90% of graduates who found regular employment immediately after graduation remained in the region and after 10 years roughly two-thirds were still in the region. It is quite obvious that a larger part of this group would have permanently left the region if the university had not existed. The adhesive effect thus has the potential to mobilize highly skilled workers in the region, and is thus an important driver of regional development. Note that this effect is probably reinforced by those graduates who are not included in our data set, such as civil servants and the self-employed.

Modeling mobility decisions: results of a discrete choice approach

To be able to quantify in greater detail what covariates are associated with a higher probability of working in the region, we estimated both an ordered choice model and various binary choice models.

$$P(D_i = d_j \mid \mathbf{x}_i) = \Lambda(\mathbf{x_i}'\beta), \tag{2}$$

The empirical models are of the class where the dependent variable D_j is a discrete choice variable with values d_j, $j = 1, …., J$. Depending on the actual location of the individual's workplace, D_i has five different outcomes in the case of the ordinal model: (i) Germany, (ii) Bavaria, (iii) the wider region around Regensburg, (iv) the County of Regensburg, and (v) the City of Regensburg. In the case of the binary choice models, we used different aggregations of this ordinal variable. The first setup models the probability of working within the wider region around Regensburg (thus, $D_i = 1$ if person i is working in the greater Regensburg area, $D_i = 0$ otherwise), while the second specification investigates the decision to work in the city of Regensburg. Finally, the third specification's dependent variable is a dummy indicating whether the individual is working in the wider region, which in this case does not include Regensburg City. For the link function Λ we chose a logistic function. The covariates comprise educational characteristics (such as field of study, type of university degree obtained, and overall performance measured via final grades), the individual's gender and regional origin (proxied via workplace; see also previous section, making the same distinction as the ordinal dependent variable). Furthermore, we also include a discrete variable for firm size and dummies for the years after graduation to capture possible dynamics in the time domain. These models were estimated based on a specific selection of social security spells.[15] For each graduate we took a sequence of employment spells such that the first spell included the day one year after graduation, the second spell included the day two years after graduation, and so forth, covering at most a period of 10 years after graduation.
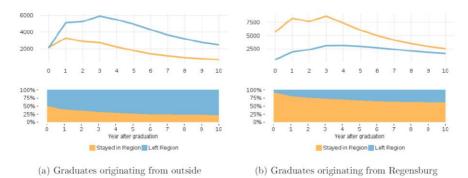
Figure 4: Absolute number and share of graduates taking up regular employment

(a) Graduates originating from outside   (b) Graduates originating from Regensburg

Table 1: Ordered Logit Estimate for Graduates Working in the Region

	ordinal	binary		
	(1)	(2)	(3)	(4)
Dependent variable:		wider region	city	region w.o. city
Field of study (reference: Humanities)				
Sports	−0.269	−0.585*	0.019	−1.070**
Law/Economics/Social Sciences	−0.269***	−0.280***	−0.332***	0.006
Mathematics/Natural Sciences	0.045	0.091	0.150**	−0.041
Medicine/Health	0.467***	0.502***	0.292***	0.424***
Informatics	−0.268***	−0.328***	−0.498***	0.078
Arts	0.036	−0.139	0.135	−0.416***
Type of degree (reference: Bachelor)				
Master	0.637***	0.521***	0.807***	−0.128
Diploma	0.644***	0.582***	0.664***	0.100*
Magister	0.797***	0.738***	0.979***	−0.05
Teaching Profession	0.813***	1.434***	0.246	1.270***
Medicine SE	0.238***	0.211***	0.490***	−0.258***
Pharmacy SE	0.117	−0.011	−0.757***	0.640***
Law SE	1.222***	1.304***	1.047***	0.590***
Grades				
final grade	0.044**	0.080***	−0.121***	0.211***
grade univ. entrance qualif.	0.165***	0.209***	0.141***	0.113***
Firm size (reference: 1-50 empl.)				
51-250 empl.	−0.296***	−0.355***	−0.440***	−0.021
251-1000 empl.	−0.380***	−0.427***	−0.434***	−0.118***
>1000 empl	0.072***	0.037	0.252***	−0.245***
log_dist	−0.303***	−0.343***	−0.016	−0.416***
female	0.048**	0.015	0.100***	−0.087***
Constant		2.601***	−1.645**	2.100***
Observations	37,386	37,386	37,386	37,386
Log Likelihood	-52,857.090	-22,059.700	-19,191.720	−18,551.150

Additional variables not reported: year after graduation, region of origin

Note: *p<0.1; **p<0.05; ***p<0.01

The estimation results are given in Table 1, where the first column refers to the ordinal model and the remaining columns refer to the different binary outcome models: Column 2 distinguishes between working inside and outside of the wider region of Regensburg, and Column 3 distinguishes between working inside and outside the city of Regensburg. The choice to work in the greater Regensburg region but outside the city of Regensburg is incorporated in the model corresponding to Column 4. Thus, the model corresponding to Column 2 can be seen as a more aggregated version of the ordinal model, while the models in the latter two columns split the decision into two different choices. We decided to use these specifications because choices made in favour of the city of Regensburg seem to follow different patterns and should be analysed separately. In doing this, one can clearly identify specific drivers related to the location decision. By comparing different fields of study, for instance, we find that graduates in the fields of law, economics, social sciences and informatics tend to leave the Regensburg region, while medical graduates are more to likely to stay in the region. Doctors (having completed a state examination (SE) in Medicine) mainly stay in the city of Regensburg, while pharmacists tend to work in more peripheral locations. Moreover, teachers and law graduates exhibit a higher propensity to stay in the Regensburg area. Comparing master's and bachelor's degrees, we observe that graduates with the former are particularly likely to remain in the city and the latter are slightly more liable to work in the wider region. Furthermore, women are more likely to stay in the city, as are those who have finished their studies with higher average grades. This indicates that Regensburg is considered an attractive place to work.

Finally, results related to firm size show that the probability of remaining in the region is higher if the individual is either working in a small- (up to 50 employee) or a very large firm (more than 1000 employees). The corresponding coefficients in Columns 4 and 5 reveal that working for a very large firm is associated with a higher probability of working in the city of Regensburg, while working for a small firm increases the probability of working in the wider region (not including the city). One can also conclude from these results that graduates who choose to work in the city of Regensburg are more often employed by very large firms, while those working in the wider region tend to be hired by very small firms; this implies, vice versa, that small firms particularly benefit from the increased availability of a highly skilled labour force.

4   Conclusion

In this paper we have taken a closer look at the economic development of Regensburg, a city located in the German state of Bavaria, which has experienced exceptional development since the 1980s. The city and its surrounding areas until that time were considered to be among Germany's crisis regions. Nowadays, by contrast, the region is one of Bavaria's economic hot-spots. We believe that a combination of different events played a decisive role in this development. The large-scale investments of high-tech and manufacturing firms and an active regional economic policy that stimulated economic activity occurred at roughly the same time as an increasing number of highly skilled workers became available as a result of the opening of the University of Regensburg in

1967. Among other aspects, this led to lasting change in Regensburg's overall appearance as diverse amenities were created, making the city increasingly attractive, especially to highly skilled people. The combination of these different events and political measures can ultimately be seen as the basis for the impressive development of Regensburg into one of the most economically dynamic locations in Germany.

Notes:
[1] From 132,200 in 1979 to 127,800 in 1987 (in 2016: 164,000) (numbers rounded). Source: City Regensburg, statistics, information and numbers, total population, long-term time series with gender (Stadt Regensburg, Statistik, Informationen und Zahlen, Bevölkerungsstand Gesamtstadt, langfristige Zeitreihe mit Geschlecht) (2019).
[2] Source: Statistics of the German Federal Employment Agency, German Federal Statistical Office (Bundesagentur für Arbeit, Statistik, Statistik nach Regionen, RD Regensburg) (2019).
[3] *Ostbayerische Technische Hochschule Regensburg* (OTH); i.e., Regensburg University of Applied Sciences.
[4] Today nearly 10,000 employees.
[5] Today Infineon Technologies AG, approx. 2,500 employees.
[6] Production ended in 2007, today only a small service unit is left.
[7] Today Continental Automotive GmbH, with approx. 8,500 employees and headquarters for two of the five corporate divisions.
[8] The BioRegio initiative was a funding initiative of the Federal Ministry of Education and Research (BMBF) that operated from 1997 to 2005 to strengthen the use of biotechnology in Germany and improve the economic implementation of the results of biotechnology research.
[9] Source: City Regensburg, statistics, information and numbers, total population, long-term time series with gender (Stadt Regensburg, Statistik, Informationen und Zahlen, Bevölkerungsstand Gesamtstadt, langfristige Zeitreihe mit Geschlecht) (2019).
[10] Employees liable to social security, the self-employed, and civil servants.
[11] Source: Statistics of the German Federal Employment Agency, German Federal Statistical Office (Bundesagentur für Arbeit, Statistik) (2019).
[12] Source: City of Regensburg (2019), Department for Economic and Research Affairs.
[13] Splines are piecewise polynomials joined together to make a single smooth curve.
[14] Intervening opportunities: Opportunities offered by locations other than Regensburg. In migration theory, Stouffer's law of intervening opportunities states that "[t]he number of persons going a given distance is directly proportional to the number of opportunities at that distance and inversely proportional to the number of intervening opportunities" (Stouffer 1940, 846).
[15] Spell = time period.

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