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How does an entrepreneurial university affect regional economic development?

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Abstract:

This paper aims to reveal the role of entrepreneurial universities in the regional economic development of Türkiye. By using spatial econometrics tools including cluster maps, namely LISA and Geary, and spatial regression models for NUTS 3 regions (81 provinces), the effect of the entrepreneurial universities on regional development indicators, i.e., gross domestic product (GDP), GDP per capita (GDPPC), and the number of enterprises is examined from 2012 to 2017. Both the number of entrepreneurial universities and their presence is effective on all three regional development indicators. Additionally, investing in education, promoting export activities, and developing physical infrastructure should be prioritized in provincial development plans to overcome regional disparities.

Keywords: Entrepreneurial university; region; development; spatial econometrics.
JEL Classification: H75; I23; L26.

¿Cómo afecta una universidad emprendedora al desarrollo económico regional?

Resumen:

Este artículo pretende revelar el papel de las universidades emprendedoras en el desarrollo económico regional de Turquía. Mediante el uso de herramientas de econometría espacial, como mapas de clústeres, como LISA y Geary, y modelos de regresión espacial para el nivel NUTS 3 (81 provincias), se examina el efecto de las universidades emprendedoras en los indicadores de desarrollo regional, a saber, el Producto Interno Bruto (PIB), el PIB per cápita (PIBPC) y el número de empresas, entre 2012 y 2017. Tanto el número de universidades emprendedoras como su presencia influyen en los tres indicadores de desarrollo regional. Además, la inversión en educación, la promoción de las actividades exportadoras y el desarrollo de infraestructura física deben priorizarse en los planes de desarrollo provinciales para superar las disparidades regionales.

Palabras Clave: Universidad emprendedora; región; desarrollo; econometría espacial.
Clasificación JEL: H75; I23; L26.

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1. Introduction

Almost in every university's mission statement, it is not surprising to see the words stressing the strategic importance of the region they are located in and how they will contribute to the local demands[1]. So, the region has a strategic importance for any university not only for accessing necessary resources but also contributing regional economic development through many ways such as the creation of new business formations (Audretsch et al., 2024). Recent evidence focuses more on the role of universities in the regional economy through building up entrepreneurial culture (Budyldina, 2018; Pugh et al., 2021). The term of the entrepreneurial university, therefore, has emerged (Clark, 1998; Etzkowitz, 1983; Etzkowitz et al., 2000) to train the qualified workforce that meets the needs of society. Relying on this mission, the role of universities is perceived as much international or national oriented while regional perspective is neglected. Accordingly, entrepreneurial universities do not necessarily have a strong regional impact (Martinelli et al., 2008).

There are some reasons for the lack of regional perspective in the earlier studies. To illustrate, universities behave reluctantly towards regionally oriented perception due to fear of loss of institutional autonomy (Chatterton and Goddard, 2000). When they follow such a policy, new regional planning that requires the involvement of various regional stakeholders should be designed to meet local needs. Contrary to this perspective, several case studies focus on the role of universities in the local economy (Bramwell and Wolfe, 2008; Casper, 2013; Etkowitz et al., 2000). Thus, universities' success in commercializing science does not only depend on factors internal to universities but also on the regional environment (more precisely, on the structure of regional social networks).

Universities have become ambidextrous organizations, especially in recent years. On the one hand, they carry out basic research and teaching activities, they lead the development of entrepreneurial culture in society on the other. Thus, it fosters the creation of new firms, transferring knowledge and expertise from industry through collaboration activities. While doing this, they introduce a new curriculum including lectures on building up a new business or developing a business plan as well as strengthening their relations with the industry through joint projects. Additionally, they have a new role as a facilitator encouraging students to create their businesses (Bergmann et al., 2016; Beyhan and Findik, 2018; Boh et al., 2016). In addition to these functions, universities consider meeting the needs of the region where they are established (Chatterton and Goddard, 2000; Goddard and Chatterton, 1999; Goddard and Vallance, 2011).

To link universities with the regional economy, various approaches such as learning region (Chatterton and Goddard, 2000), knowledge spillovers (Audretsch and Lehmann, 2005), and agglomeration (Varga, 2001) are used in the literature. Etkowitz et al. (2000) deal with the three stages of the regional innovation environment. The first one is the creation of knowledge spaces through concentrating R&D (research and development) activities in the local area (Casas et al., 2000). Secondly, creating an environment that brings people from different backgrounds together is another important dimension of regional innovation. The third stage is much related to adjusting internal to the firm to create innovation space.

Universities, the business sector, and the government form a triple helix of regional development. Universities play a key role in the regional development and entrepreneurship ecosystem of the provinces for the development of a "knowledge-based" or "knowledge-intensive" economy (Charles, 2003; Charles, 2006; Clark, 2004; Etzkowitz, 2003; Etzkowitz et al., 2000; Newlands, 2003). The influence of Stanford University and the University of California on Silicon Valley is the best example of the effect of universities on regional development (Chakrabarti and Lester, 2002). In Canada, university spin-offs' survival rate is more than 80%, which is quite high compared to other spin-offs (Clayman and Holbrook, 2003). University professors' motivation to cooperate with the business sector is to commercialize their knowledge (D'Este and Perkmann, 2011). However, these examples belong to the universities in developed countries, which already have an ecosystem equipped with the necessary resources and networks.

[1] Nevertheless, Goddard and Chatterton (2000) argue that these words remain as formal statements which cannot be translated into action.

Despite the increasing number of studies examining the role of entrepreneurial universities on regional economy has increased in recent years, those studies are limited to some specific regions and subject to time constraints (Ar et al., 2021; Feola et al., 2021; Salamzadeh et al., 2022). This study, therefore, will fill in the gap in the literature from different aspects and relevant, especially to understand the dynamics of regional development across years and provinces. For this purpose, we address an important research question in this study; how is regional economic development linked to the presence of entrepreneurial universities?

In this study, we aim to examine the new role of universities on regional development by using panel data for the years between 2012-2017 in Türkiye. This study will contribute to existing literature in at least three ways. First, we aim to reveal the effect of entrepreneurial universities on the regional economy by using multiple tools of econometric methods including spatial regression and mapping techniques. Accordingly, we measure this effect at two levels as the presence of the entrepreneurial university and the number of entrepreneurial universities in the region. The second contribution is related to the measurement of the regional economy. We use three indicators to measure regional economic development including GDP (gross domestic product), GDPPC (GDP per capita), and the number of enterprises being active in the region. The related literature on the role of entrepreneurial universities in regional economic development has mainly focused on developed economies. The third contribution of this study is that we examine this relation by using data from a developing country.

This paper is organized as follows: Section 2 briefly discusses the theoretical background. The methodology and data are explained in Section 3. Estimation results are presented in Section 4. Section 5 discusses the results' implications, and finally, concluding remarks appear in Section 6.

2. Theoretical background

In the post-1980 period, higher education institutions were affected by the new liberal trends and globalization, and these effects were also felt in Türkiye (Gül et al., 2010). In this framework, higher education in Türkiye has become more market-oriented in recent years, while the number of universities has also increased. However, regarding the structural changes in the education policy of Türkiye, the year of 2000 can be considered as the turning point which initiated a paradigm change namely globalization. Accordingly, Türkiye prepared strategic plans emphasizing the terms of human resources, innovation, and technological infrastructure (Özdemir and Karakurt, 2024). For this purpose, collaborative research efforts of universities, public sector and universities were supported in the 7th Development Plan (1996-2000) prepared by the State Planning Organization (SPO, 1995). The establishment of a national R&D network was particularly emphasized in the same report.

Notably, the 8th Development Plan (2001-2006) (SPO, 2001) was the first plan in which entrepreneurship was seriously emphasized for the first time, especially in terms of ensuring regional development. The main reason for this is that in the previous period, the private sector managed its investable funds in debt securities and deposits due to high deposit interest rates, and the manufacturing industry suffered a significant blow.

In the 2006-2010 period, the percentage share of Small and Medium-Sized Enterprises (SMEs), which constitute almost all the enterprises in Türkiye, in employment and value added decreased by 3 percentage points, while their percentage share in investments increased by 5 percentage points (10th Development Plan 2014-2018) (Ministry of Development, 2014). To increase competitiveness in the economy, to develop innovation and entrepreneurship and to create employment, SMEs need to experience productivity increase, growth and institutionalization. In the same report, higher education institutions were emphasized to transform into an output-oriented structure that attaches importance to technology production in cooperation with the industry, and income sources were to be diversified through entrepreneurial activities. Encouraging students to scientific research and entrepreneurship was also stated in the 9th Development Plan (2007-2013) (SPO, 2007).

There is a transition towards an entrepreneurial university model in which universities take an active role in the process of transforming the knowledge produced into value and in close co-operation with industry and the public sector (11th Development Plan, 2019-2023) (Ministry of Development, 2019).

During the same period, various institutions took actions to trigger an entrepreneurial economy in Türkiye. Among those, Scientific and Technological Research Council of Türkiye (TUBITAK) come to the fore who initiated a project to develop a conceptual framework for the Entrepreneurial and Innovative University Index in collaboration with various stakeholders in 2012 and since then the entrepreneurial activities of the universities are calculated. In few years later, Council of Higher Education (YOK) commenced the "Mission Distinction and Specialization Programs[2]" in 2015. The program had two main sections as "Research-Oriented Mission Distinction and Specialization[3]" and "Regional Development Oriented Mission Distinction and Specialization[4]". In the framework of this project aiming at building up competency in the fields that respond to the regional need, YOK (2020a) determined 5 universities in Türkiye. Accordingly, Bingol University and Kırşehir University are selected as a pilot institution in agriculture; Burdur University for livestock; Düzce University for the health sector; and Uşak University for textile. There have been various empirical studies examining the effect of being located in those regions. Among those, Sayın (2024) have analyzed the strategic plans of the universities included in the "Regional Development Oriented Mission Differentiation and Specialisation" project and found that universities are strong in terms of their physical and social facilities, communication and collaboration skills, technological infrastructure and its contribution to the region. Therefore, it is necessary to build up such a link with the external stakeholders to transfer knowledge created at the university (Audretsch and Lehmann, 2022).

The presence of universities is also crucial for regional development (Lenger, 2008; OECD, 2020). Accordingly, Demirdağ and Eraydın (2024) discuss the critical role of institutions in the form of normative and cultural motives in cultivating entrepreneurial spirit in the region. The presence of universities in a region, therefore, is crucial since it facilitates new business formation, in turn, increases regional economic growth. Additionally, regional economic growth is achieved with collaboration among various regional actors such as incumbent firms, academicians and university students.

Several studies deal with the link between regional development and higher education institutions (Benneworth and Fitjar, 2019; Harrison and Turok, 2017; Rantala and Ukko, 2019; Trippl et al. 2015). Considering the earlier studies, Chatterton and Goddard (2000) analyze this link in the frame of "learning region" (Florida, 2013), which refers to the regional development model based on collaboration among various stakeholders. Accordingly, the participation of academic staff in public organizations becomes the new form of transfer of knowledge from university to industry (Asheim, 2012). Contrary to the conventional university-industry regime, the learning region perspective is not based on a national funding system to sustain activities targeting regional development. Instead, it requires establishing a link between higher education institutions (research, teaching, and community service) and regional skills, innovative capabilities, and culture. In a similar vein, the new role of universities is not only teaching and research but also creating new firms that contribute to the economy (Etzkowitz et al. 2000; Guerrero and Urbano, 2012).

Some researchers approach the link between the university and the region by focusing on "agglomeration". Varga (2001) argues that the same amount of support will have different effects on the regions since the way each region conducts its economic activities is unique. He tests the effect of agglomeration on university technology transfers by using patent citations, the number of graduates working in the corresponding region, and the number of local academic knowledge spillovers. Knowledge transfer mechanisms are defined as personal networks between the university and the industry, formal networks such as technology licensing, and spillovers through physical facilities of the university. Accordingly, technological knowledge at the university results in differentiated effects for the regions. It generates larger effects for the regions where the concentration of economic activities is high.

Another stream of literature focuses on the term "knowledge spillover". Audretsch and Lehmann (2005) have found that the high knowledge capacity of the region positively affects the performance of

[2] Offical name of the program is "Misyon Farklılaşması ve İhtisaslaşma Programları".
[3] Offical name of the program is "Araştırma Odaklı Misyon Farklılaşması ve İhtisaslaşma Programı".
[4] Offical name of the program is "Bölgesel Kalkınma Odaklı Misyon Farklılaşması ve İhtisaslaşma Programı".

firms close to the universities. Bramwell and Wolfe (2008), focusing on the ICT sector in Waterloo, emphasize the multiple factors that bring regional economic success going far beyond commercialization. Universities in that region, therefore, play a dual role in the regional economy. On the one hand, they educate the people through teaching activities, they attract people from different places to contribute to local economic development on the other. Huggins and Kitawa (2012) analyze the link between the university and regional wealth creation in Scotland and Wales in which knowledge transfer from university to industry plays a key role in regional development and is facilitated through knowledge transfer funding programs. However, there are some differences between these regions in terms of economic conditions. For instance, Scotland established research excellence with the contribution of many actors such as universities in Glasgow and Edinburgh while in Wales there is only one university playing a predominant role in the regional economy and they don't have partners equipped with advanced capabilities which are necessary to build up research excellence as observed in the case of Scotland. In addition, their R&D investment level is lower than that of Scotland.

Audretsch et al. (2012) analyze the regional competitiveness of high technology start-ups in certain regions and their innovation performance. Accordingly, there is a strong positive relationship between these two factors but incentives to universities might generate crowding-out effects for other players. In other words, the local endowment generates a positive effect on the innovative behavior of the start-up firms only if the research-intensive university is located in the corresponding region. Moreover, Urbano and Guerrero (2013) emphasize the role of universities in the regional economy, especially in crisis times. They conclude that integration and collaboration with the region are crucial. Further, Casper (2013) stresses the importance of the quality of the regional environment in generating economic wealth. To illustrate, the presence of individual networks such as relationships between inventors and individuals in the industry heightens commercialization activities.

Guerrero et al. (2016), through analyzing the effect of student entrepreneurs on regional competitiveness, find that informal factors such as attitudes and role models play a greater role in student entrepreneurship than formal ones such as education and training. Hence, the contribution of student entrepreneurs to regional competitiveness can be explained through the presence of skilled human capital instead of GDP growth. Modrego et al. (2015) use the presence of new firms as a proxy for entrepreneurship and conclude that in the case of Chile where innovation activities are concentrated in large cities, triggering entrepreneurial activities has the potential to improve the conditions of the regions which lagged behind the others.

Fritsch and Kublina (2018) introduce different growth regimes and their persistencies over time. Accordingly, entrepreneurship which is proxied by the formation of a new business is crucial for sustaining economic wealth for all growth regimes. Additionally, Lehmann and Menter (2016) examine the relationship between university-led knowledge spillovers and regional wealth and consider the problem of endogeneity between regional wealth and industry-university collaboration. They find that these two terms are dependent on each other and supporting activities play an important role in the development of this relationship. Cunningham et al. (2019) focus on the role of changes in legislative processes in regional entrepreneurial activities. Accordingly, legislative changes such as improvements in the processes of intellectual capital rights of inventors generate initial positive effect on start-up activities. Espinoza et al. (2019) analyze the regional determinants of entrepreneurship in Chile where economic activities are dispersed and concentrated in metropolitan areas which creates many disadvantages for local areas. They conclude that there is a spatial dependence among districts in Chile in terms of creating a new business. In other words, the number of new firms at the district level is affected by the entrepreneurship performance of the neighboring districts. The immigrant population, the presence of universities, and local patenting capacity positively affect the role of each district in the creation of new business ventures.

Szerb et al. (2019) examine the effect of the entrepreneurial ecosystem on regional performance and used two types of entrepreneurships namely quality and quantity entrepreneurship. As for the first one, quantity entrepreneurship is measured as the ratio of new business enterprises to the total number of firms while quality entrepreneurship is measured as innovativeness of the new firms in comparison to the incumbent firms. Accordingly, quantity entrepreneurship negatively affects regional performance while quality entrepreneurship generates a positive influence on regional performance. However, when the quantity entrepreneurship interacts with the regional innovation development index variable, its impact turns positive. In other words, a healthy entrepreneurial ecosystem has a larger potential to create new business formations while regions with a weak entrepreneurial ecosystem rely on quality entrepreneurship. Bramwell and Wolfe (2008) analyze the entrepreneurial activities of the University of Waterloo in Canada which plays a dominant role in the local economy. The density of the interaction with the local firms enables the university to be the central actor in knowledge transfer in the local economy.

There is much recent evidence available in the literature regarding industry and university collaboration to cultivate entrepreneurial culture in the region (Audretsch and Belitski, 2024; Guzman et al., 2024; Henry and Lahikainen, 2024; Rossoni et al., 2024). Accordingly, knowledge exchange channels through collaborative work as observed in the case of Finnish higher education institutions which participated in various student-oriented actions targeting skill match between graduate students and the local companies. Additionally, an engine programme aimed at triggering translating research from local universities to start-ups and incumbent companies in the same regions is another case which enables shared use of the facility by all stakeholders. Based on those recent practices, we hypothesize that:

H0: The presence of entrepreneurial universities is positively associated with regional economic development

Regional development indicators are the GDP, GDPPC and the number of enterprises.

3. Research design

3.1. Methodology

Studies of regional development emphasize how areas are interconnected and share knowledge, particularly in research on innovation and entrepreneurship. Universities that focus on entrepreneurship serve as regional hubs of innovation. Their impact reaches beyond their immediate area to nearby provinces through mobile workers, academic partnerships, and cooperation between businesses and universities. This interconnected nature means we must consider these spatial spillover effects in our analysis (Anselin et al, 1997; Breschi and Lissoni, 2001). Moreover, spatial analysis tools such as LISA (Local Indicator of Spatial Association) maps, Geary's C, and spatial regression models allow us to test and visualize these interdependencies, making them essential for understanding both direct and indirect (spatial lag/spillover) impacts of university entrepreneurship on regional development indicators.

Spatial externalities are defined by Tobler's first law of geography, which is "*everything is related to everything else, but near things are more related than distant things*" (Tobler, 1970). The spatial analysis focuses on the relation between the spatial units. Spatial interactions could be formalized as spatial dependence or heterogeneity. Anselin (1988) defines spatial dependence as "*the existence of a functional relationship between what happens at one point in space and what happens elsewhere*". The second type of effect is spatial heterogeneity which can be defined as "*the lack of stability over space*" (Anselin, 1988). Also, spatial econometric analysis captures the spillover effects among the spatial units (LeSage and Pace, 2009). Standard ordinary least squares (OLS) estimates would be biased if the spatial effects are ignored (Elhorst, 2014).

The spatial econometric method differs from the standard econometric model by using the weight matrix which indicates the spatial interaction between the spatial units. The selection of the weight matrix is not straightforward (Beck et al., 2006; Gleditsch and Ward, 2001; Viton, 2010).

Cluster maps and spatial econometric analysis are utilized in this study. Cluster maps and spatial dependency tests are used to reveal whether there is a spatial dependency between regions or not. Spatial cluster mapping shows whether there are clusters in certain regions. There are two main cluster maps in the literature, namely LISA and Geary cluster maps. LISA cluster map is based on Moran's I test, while Geary cluster map is based on Geary's C test (Anselin, 1995; 2019).

Moran's I test is the correlation between the variable of interest (y) and the spatial lag of it (y_L). It is also an indicator of whether there is spatial autocorrelation or not. To use spatial econometric analysis, it is necessary to reject the null of no spatial autocorrelation. The test harnesses the error term or the standard regression. Moran's I test is (Anselin, 1988; Moran, 1950a; 1950b; Ward and Gleditsch, 2008):

$$I = \frac{n \sum_i \sum_{j \neq i} w_{ij} (y_i - \bar{y}) \, (y_i - \bar{y})}{\left(\sum_i \sum_{j=1} w_{ij}\right) \sum_i (y_i - \bar{y})^2} \tag{1}$$

Geary's C test is (Claeys and Manca, 2011):

$$C = \frac{N-1}{2S_0} \frac{\sum_i^N \sum_j^N w_{ij} (x_i - x_j)^2}{\sum_{i=1}^N (x_i - \hat{x})^2} \tag{2}$$

Here, y is the dependent variable or the variable of concern, w_{ij} is the *i-j* elements of the weight matrix, N is the number of observations, and S is the standardization factor which is equal to the sum of all elements in the weight matrix.

High and low values are demonstrated by various colors for the LISA cluster map. For instance, red colored regions indicate higher values of the variable. Additionally, higher values are assigned to their adjacent. It is represented as high-high. Blue areas, on the other hand, are low-low in the same scheme, while pale blue regions are low-high and pink areas are high-low. The dark-colored regions are therefore those that contribute significantly to a positive global spatial autocorrelation outcome, while light colors contribute significantly to a negative autocorrelation outcome. The main difference between the LISA and Geary cluster map is that Geary has only a negative spatial correlation indicator meanwhile LISA map indicates in detail with high-low and low-high regions (Anselin, 2019).

The standard panel data econometric model is (Anselin et al., 2006; Elhorst, 2014):

$$Y_{it} = \beta X_{it} + \mu_i + \epsilon_{it} \tag{3}$$

where Y is the dependent variable, X is the set of control variables and μ and ε is the error term.

In the existence of spatial autocorrelation and heterogeneity, spatial autoregressive models (SAM) and spatial error models (SEM) are used, respectively. SAM is formalized as (Anselin et al., 2006; Elhorst, 2014):

$$Y_{it} = \rho \sum w_{ij} Y_{jt} + \beta X_{it} + \epsilon_{it} \tag{4}$$

Here, w is the weighting matrix, wY is the spatial lag of the independent variable, and shows the average value of neighbors. SEM is formalized as follows (Anselin et al., 2006; Elhorst, 2014):

$$Y_{it} = X_{it}\beta + \mu_i + u_{it} \tag{5}$$

$$u_{it} = \lambda \sum w_{ij} \, u_{it} + \varepsilon_{it} \tag{6}$$

where λ is the coefficient for spatial autoregressive structure for the disturbance ϵ the white noise error term.

To choose between the SAM or SEM, spatial specification tests of spatial error LM, spatial error robust LM, spatial lag LM, and spatial lag robust LM are calculated (Larch and Walde, 2008).

3.2. Data

The dataset used in the analysis is a unique one which is constructed by the authors using various sources. These data are aggregated to province level. The dataset covers 81 provinces in Türkiye in 2012-

2017. The Entrepreneurial and Innovative University Index (EIUI) from (TUBITAK, 2017) is composed of five indicators: Scientific and Technological Research Competence, Intellectual Property Pool, Economic Contribution and Commercialization, Entrepreneurship and Innovative Culture, and Collaboration and Interaction. Each indicator with its subcomponents has the same weight (20%) on the total score. Based on the composite score, universities are ranked in terms of their entrepreneurship and innovation levels. Note that we calculate the total number of entrepreneurial universities (*entruniv*) in each province using the EIUI. Details on the variables can be found in Table 1.

Table 1.
Variables and sources

Variable	Definition and source
Dependent variables	
lngdp	Log of *gdppc* × *pop*.
lngdppc	GDP per capita (US$) in logs (TUIK, 2019).
lnenter	Total number of enterprises in logs (TUIK, 2019).
Independent variables	
entruniv	Total number of entrepreneur universities (TUBITAK, 2017).
dentruniv	1 if *entruniv*>0, 0 otherwise.
lnbuildings	Total number of buildings in logs (TUIK, 2019).
lnpop	Total population in logs (TUIK, 2019).
acadstud	Total number of academicians[a] (YOK, 2020b) to total number of students[b] (YOK, 2020b)
lnexp	Total exports (thousand US$) in logs (TUIK, 2019).
lnuniv	Total number of universities in logs (YOK, 2020b).
primary	Net primary schooling rate (TUIK, 2019).
secondary	Net secondary schooling rate (TUIK, 2019).

a Total number of professors, associate professors, assistant professors, prelectors, and research assistants.
b Total number of associate degree students, undergraduate students, master's students, and PhD students.

Summary statistics are shown in Table 2. In the period of 2012-2017, the average values for a province in Türkiye are 8,679 $ per capita income, 43,205 enterprises, 1,561 academicians, 71600 students, 1,862,614 thousand $ exports, 965,756 population, 2.39 universities and 0.62 entrepreneurial universities. Average primary and secondary schooling rates are 94.65 and 93.88, respectively. There are entrepreneurial universities in 27.8% of the provinces. The number of academicians per student is 0.04. Note that antilogs of logged variables are interpreted.

The provinces with maximum and minimum values for 2017, which is the last year in our dataset, can be summarized as follows. The province with the highest GDPPC, exports, population, number of enterprises, the total number of universities, entrepreneur universities, and buildings is İstanbul. Hakkari ranks first in the number of academics per student. Provinces with the highest schooling rates are Şanlıurfa for primary and Ardahan for secondary.

Table 2.
Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
lngdp	486	22.237	1.093	19.966	26.405
lngdppc	486	9.012	0.335	8.16	9.939
lnenter	486	9.958	1.047	7.902	13.689
entruniv	486	0.617	1.891	0	15

Table 2. cont.
Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
dentruniv	486	0.278	0.448	0	1
lnbuildings	486	6.615	1.25	3.367	9.988
lnpop	486	13.225	0.947	11.233	16.526
acadstud	486	0.04	0.015	0.001	.134
lnexp	486	11.886	2.56	0	18.223
lnuniv	486	0.34	0.7	0	4.06
primary	486	94.648	4.556	58.96	100
secondary	486	93.876	3.935	61.19	99.18

4. Empirical findings

4.1. Findings from preliminary analyses

Figure 1 demonstrates the distribution of the variables across regions in the form of quantile and percentile levels. Quantile represents the range of values the corresponding variable takes, whereas percentile represents the value below a percentage of data falls. Accordingly, dark-colored areas represent wealthy regions whereas light-colored ones indicate lower GDP levels. For instance, there is only one region in the highest percentile (99%) in terms of GDP. Additionally, the number of enterprises is high in dark-colored regions representing the western part of the country. Differences between regions in terms of GDP, GDPPC, the number of enterprises, and the number of entrepreneurial universities are much clear in the percentile map. Thus, the western part of the country is wealthier while the east is poorer.

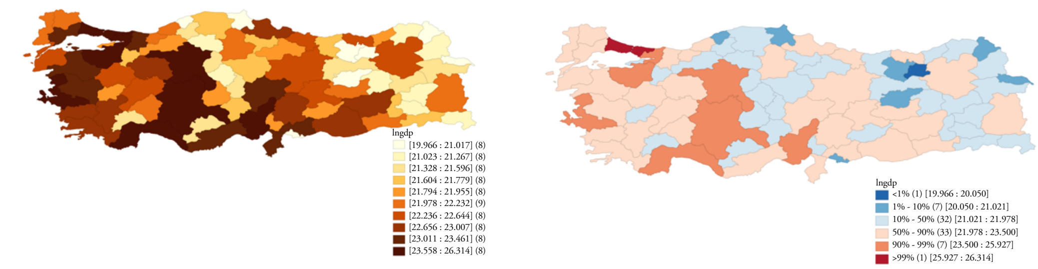
Due to the presence of the largest population (18% of the country's population), higher export volume (60% of exports), and higher GDP levels (30% of total), İstanbul ranks first in terms of regional development indicators such as GDP, GDPPC, and the number of enterprises and indicators for entrepreneurship. In 2017, 14 out of 50 entrepreneurial universities in Türkiye are in İstanbul. Also, the average GDPPC in 2017 in Türkiye is about 7,954$. In the same year, the GDPPC of İstanbul is 17,870$. In terms of GDPPC, the country is almost divided into two parts. The province with the worst condition both in terms of GDP (469 million $) and the number of enterprises (2,875) is Bayburt.

The distinction between clusters is more clearly demonstrated on the LISA cluster maps in Figure 2. While the distribution of the variables, namely GDP and the number of enterprises, is similar, GDPPC varies from one region to another. Four categories are used including High-High, Low-Low, High-Low, and Low-High. Each category itself also includes the neighboring locations. In the case of the High-High category, regions having high GDP levels are surrounded by neighbors with high GDP.

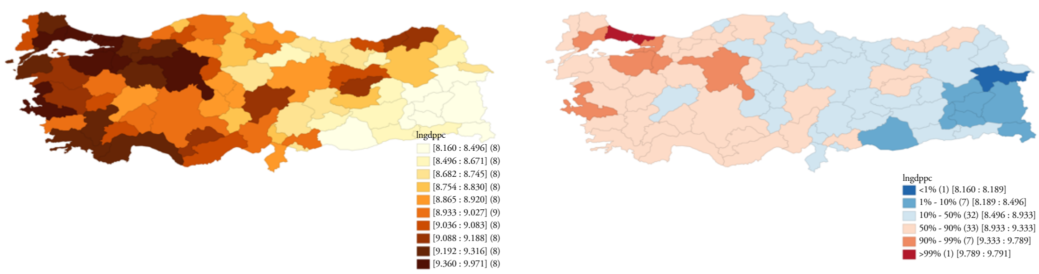
FIGURE 1.
Distribution of variables across geographical regions of Türkiye for 2017 (Quantile and Percentile)

Quantile Percentile

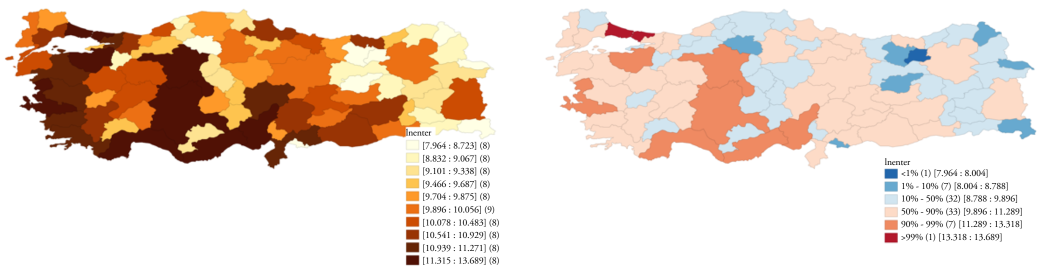
lngdp



lngdppc



lnenter



entruniv

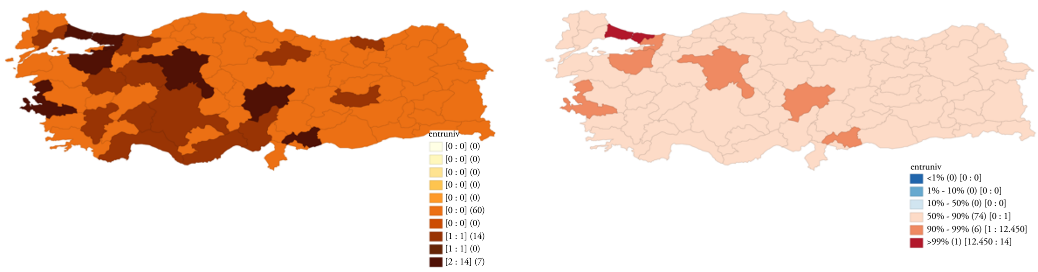
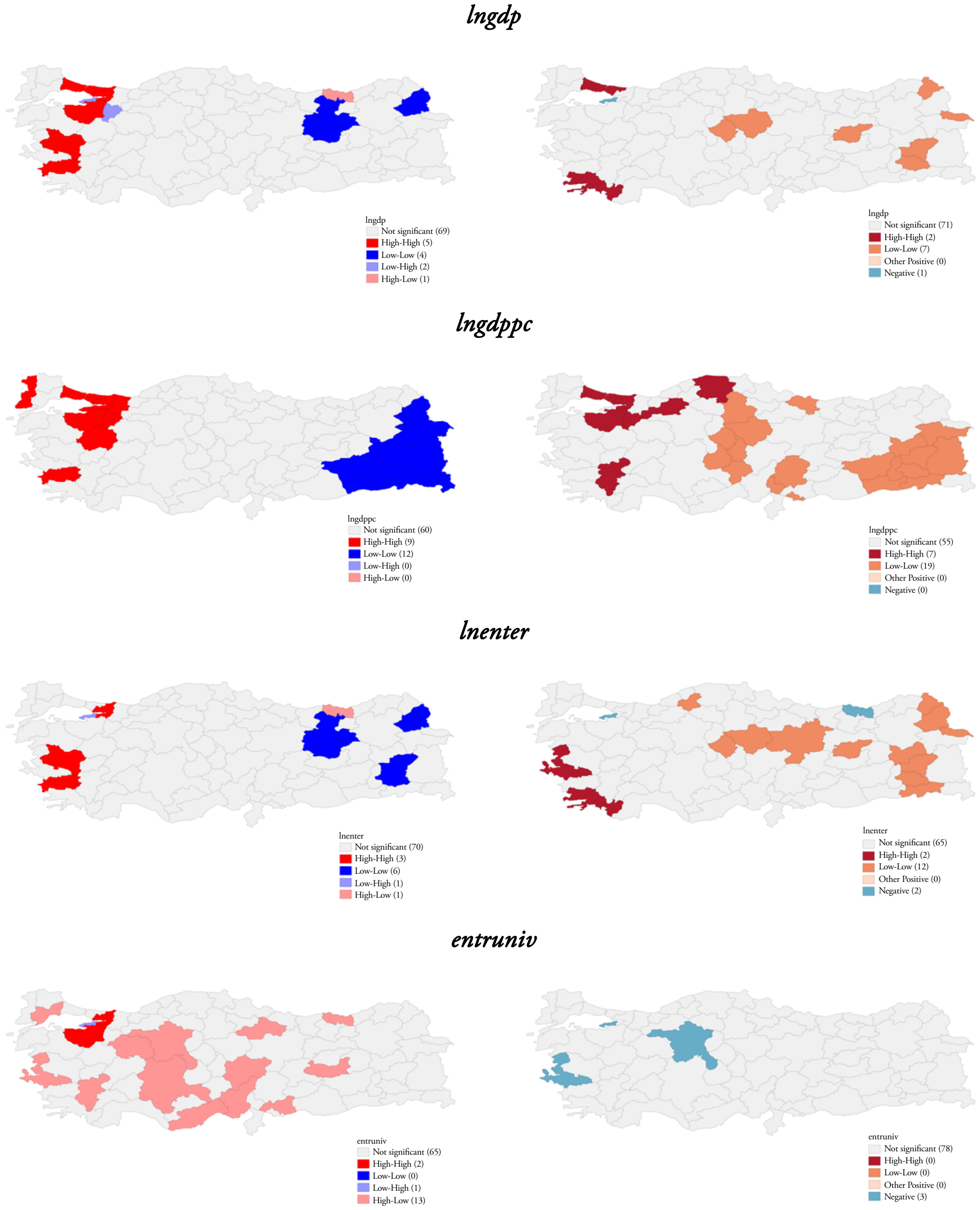


FIGURE 2.
Lisa Cluster Map ve Local Geary Cluster Map for 2017
Lisa Geary



While High-High clusters are in the western, Low-Low clusters are in the eastern regions. In both maps show the distribution of GDP and the number of enterprises, although GDPPC maps are more straightforward and evidential. The distribution of the entrepreneur universities is independent from the other three dependent variables. For the GDP and number of enterprises Trabzon is high among the low valued provinces since Trabzon is one of the economic centers with higher population density of the Black Sea Region, this result is expected. Yalova, which is in the (rich and productive) Marmara Region, has low value among the high provinces for GDP, number of enterprises and entrepreneur universities. İstanbul and İzmir, both are metropoles with higher population and production compared to other province so for all variables, they and their neighbor illustrate a High-High cluster for all variables. As far as GDPPC is concerned, we observe clear separation between the eastern and western regions of Türkiye. Contrary to regional development indicators, the High-Low category (higher provinces among the lower ones) dominates the map showing the distribution of entrepreneurial universities. Accordingly, regions with a high number of entrepreneurial universities are surrounded by regions with few entrepreneurial universities. Although the regional indicators exhibit a sharp distinction between the west (rich and more developed) and east (poor and undeveloped), this is not the case for entrepreneur universities to demonstrate a more random or centered approach for LISA maps.

Considering the results of the Geary map, we observe some overlapping categories with LISA maps concerning GDP but also very different perspectives. To illustrate, the region İstanbul and regions on the Aegean coast are in the High-High category in both maps. Geary map, on the other hand, applies a more liberal threshold in identifying cluster centers. The differentiation between the two maps becomes absolute when GDPPC is considered. Some categories such as Low-Low (eastern part of the country) remain the same but this category is also observed in Inner Anatolian regions on the Geary map. Moreover, the distribution of the number of enterprises follows a different pattern. Regions in Low-Low category are different from the categories shown in LISA map. Geary is far different for entrepreneur universities compared to the LISA map. Ankara, İzmir and Yalova exhibits a different perspective from their neighbors. Unlike LISA, there is no indicator whether it is low-high or high-low cluster. As far as LISA cluster maps are concerned, probably Ankara and İzmir is high-low cluster while Yalova is Low-High cluster.

Both cluster maps point out that for the regional indicators and entrepreneur universities, there is strong evidence for spatial autocorrelation and spatial econometric analysis.

4.2. Findings from spatial regression models

GDP, GDPPC, and the number of enterprises is used as regional economic development indicators of the provinces. While *lngdp* indicates the size of the province, *lngdppc* indicates wealth. The number of enterprises indicates the production capability of the private sector. The large impact of this variable in provinces such as Ankara where the public sector is dominant indicates that the private sector is at least as effective as the public sector. Additionally, the average size of the enterprises is as important as the number of enterprises. However, this information is not available at the provincial level. Although the number of entrepreneurial universities was initially suspected to be endogenous, the Sargan test and endogeneity tests have shown that this is not the case (see Table A2 in the Appendices). Additionally, the highest variance inflation factor (VIF) was found to be 8.80 (see Table A1 in the Appendices). Since this value is below 10 (Wooldridge, 2014, p. 86), there is no concern regarding multicollinearity.

Table 3 presents spatial regression results for the outcome variables, *lngdp*, *lngdppc*, and *lnenter* respectively. We observe that both the presence of the entrepreneurial university and the number of entrepreneurial universities in the province have a positive impact on the size and wealth of the province (see Column 1). When the control variables are added to the model, the effect of the entrepreneurial university decreases as expected. While the effect of the GDPPC is smaller than that of others, the effect of GDP and the number of enterprises numbers is similar. We observe the same results for spatial effects which are significant and over 50% for GDP while it is 5% and insignificant for GDPPC.

Although the effects of the number of entrepreneurial universities and their presence on all economic indicators are significant at 1% without control variables, we observe that the number of entrepreneurial universities for GDP and GDPPC is significant at 5% when control variables are added. The number of buildings (*lnbuildings*) was used as a proxy for the capital. For all models, its magnitude is significant. When the effect of the population is considered, we observe its positive and significant effect on all three dependent variables.

Four variables including the number of academicians per student, the number of universities for educational diversity, and schooling rates for primary and secondary levels are used as a proxy for education. All variables except the academician per student have positive and significant effects on regional development indicators. The unexpected result is that the academician per student is insignificant both for GDP and GDPPC. It is only significant for the number of enterprises with a negative sign. As the civil service is seen as an elite sector of employment (Akkoyunlu, 2018), this result can be explained by the fact that students prefer to work in the public sector instead of starting a new business. Export indicates the province's openness to the outside and its international competitiveness. This variable has a positive and significant effect on all three dependent variables.

TABLE 3.
Spatial lag (inverse distance)

	(1)	(2)	(3)	(4)	(5)	(6)
	lngdp	***lngdp***	***lngdppc***	***lngdppc***	***lnenter***	***lnenter***
lnentruniv	0.276***	0.0440***	0.0608***	0.0416***	0.238***	0.00362
	(0.0195)	(0.00767)	(0.00812)	(0.00769)	(0.0198)	(0.00631)
dentruniv	0.778***	0.0381*	0.175***	0.0368	0.729***	-0.0347*
	(0.0828)	(0.0228)	(0.0345)	(0.0230)	(0.0842)	(0.0187)
lnbuildings		0.191***		0.194***		0.180***
		(0.0164)		(0.0165)		(0.0134)
lnpop		0.693***		-0.294***		0.797***
		(0.0250)		(0.0248)		(0.0206)
acadstud		0.321		0.381		-1.290**
		(0.634)		(0.640)		(0.521)
lnexp		0.0315***		0.0295***		0.0128***
		(0.00539)		(0.00540)		(0.00443)
lnuniv		0.110***		0.111***		0.0771***
		(0.0220)		(0.0222)		(0.0181)
primary		0.0151***		0.0149***		0.00593***
		(0.00185)		(0.00187)		(0.00152)
secondary		0.00870***		0.00878***		0.0108***
		(0.000924)		(0.000932)		(0.000759)
Constant	10.48***	7.929***	8.437***	7.894***	4.027***	-3.712***
	(1.424)	(0.494)	(1.236)	(0.885)	(0.652)	(0.294)
rho	0.511***	0.0580***	0.0542	0.131	0.560***	0.0398**
	(0.0641)	(0.0186)	(0.137)	(0.0909)	(0.0656)	(0.0158)
sigma	0.688***	0.173***	0.287***	0.174***	0.700***	0.142***
	(0.0221)	(0.00554)	(0.00921)	(0.00558)	(0.0225)	(0.00455)
Observations	486	486	486	486	486	486
Moran's I	17.956***	1.192	-0.352	1.192	19.036***	-1.061
Spatial Error LM	278.431***	0.643	0.323	0.643	313.419***	1.620
Spatial Error Robust LM	158.546***	0.248	1.907	0.013	164.027***	2.188
Spatial Lag LM	129.068***	10.471***	0.201	2.934*	157.463***	6.643***
Spatial Lag Robust LM	9.184***	10.076***	1.785	2.304	8.071***	7.210***

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

To sum up, the number of entrepreneurial universities contributes to the economy of the provinces. Other factors affecting the economy of the province are education indicators, exports, and physical capital. Spatial effects are present for GDP, whereas GDPPC does not indicate any spatial effect. Spatial error, spatial fixed-effect, and spatial random-effect results can be found in Table A3, Table A4, and Table A5 in the Appendices. Considering the fixed- and random-effect results, it is concluded that the provincial effect is important, and when the effect of the province is removed, all effects become insignificant.

5. Discussion

In this study, we analyze the effect of the entrepreneurial university on the size, wealth, and production capability of the provinces in Türkiye. According to our results, the presence of an entrepreneurial university positively affects these three economic indicators. As far as the production capacity which is proxied by the number of enterprises is considered, our results confirm Espinoza et al. (2019) that there is a spatial dependence among districts. Thus, the presence of the entrepreneurial university in one province is affected by the number of enterprises in neighboring provinces and increases the production capacity of the province. From theoretical point of view, this result shows the presence of *knowledge spillover effect* across regions (Audretsch and Lehmann, 2005; 2006; 2022; Audretsch et al., 2017). This positive association indicates that business enterprises in the form of pre-incubators, incubators or accelerators in the neighboring region play a supporting role for student entrepreneurs through providing practical knowledge to them (Serpente et al., 2025).

As far as the number of entrepreneurial university is considered, we obtain a similar result with the case of Waterloo University, where the presence of entrepreneurial activity made the university a strategic actor in the regional economy (Bramwell and Wolfe, 2008), we find that not only the presence of the entrepreneurial university in a region but also the number of entrepreneurial universities is vital for the region. Notably, this result addresses the *agglomeration effect* which appears the presence of business clusters in one region. From a practical point of view, these enterprises use the common resource pool available in the same region without baring additional costs that may occur for firms located in distant areas. One important source is the human and knowledge capital. These enterprises, therefore, acquire the necessary sources from entrepreneurial universities especially when completely new product or process is the core activity (Henry and Lahikainen, 2024).

For cases where there is a disconnection between universities and peripheral entrepreneurial ecosystems, entrepreneurial activities do not generate a similar effect on the regional economy (Brown, 2016). Considering the mechanisms that explain the triggering effect of the entrepreneurial university on regional development, the presence of entrepreneurship departments, or lectures on entrepreneurship come to the fore. Pugh et al. (2021) reveal that these departments facilitate the emergence of new employment opportunities in the region. During the period investigated in this study, the number of entrepreneurial universities increased in Türkiye. İstanbul, Ankara, and İzmir are the leading provinces having highest number of universities in 2017. It is seen that the majority of universities with entrepreneurship departments in Türkiye are located in İstanbul. This situation generates new employment opportunities for students having those courses. In the framework of *learning region approach*, various stakeholders from universities and regional actors in most attractive provinces such as İstanbul create a synergy to attract student and graduate entrepreneurs through several mechanisms within and outside the campus.

In this study, we also reveal that the presence of universities in any region generates a positive effect on the regional economy. This could be related to the missions of the university such as training, research, and social engagement (Espinoza et al., 2019). According to Times Higher Education's (2021) World University Rankings in 2021, İstanbul and Ankara are two provinces having strong research potential. Çankaya University (Ankara), Koç University (İstanbul), Hacettepe University (Ankara), and Sabancı University (İstanbul) are among highest ranking universities. Koç University has the highest scores among those concerning teaching, research, citations, and industry income.

We observe similar results regarding the share of provinces in total GDP. Hence, İstanbul has the largest share in total GDP in 2017. Kocaeli, Ankara, and Izmir are the other provinces that make a large contribution to the country's economy. Our results also provide that increasing entrepreneurial activities at the university level will help these regions sustain their positions in the country's economy. As a result, it can be stated that the research hypotheses, *H0,* cannot be rejected.

6. Conclusions

The main conclusion of this study is that the number of universities as well as the existence of them affect the regional development indicators, namely GDP, GDPPC and number of enterprises. For balanced regional growth, not only entrepreneurial universities have a significant contribution but also education, export and physical capital. The findings highlight the crucial role of policy coordination between higher education institutions and regional development agencies. Effective collaboration between universities and local industries can create synergies that accelerate economic growth. This interconnected approach ensures that educational resources are aligned with regional development goals, maximizing the impact of investments in both human and physical capital.

One important result of this study is that provinces having the highest number of entrepreneurial universities are surrounded by peripheral regions with low entrepreneurial performance. To facilitate the spillover effect from high to low, several policy actions could be taken at micro, mezzo, and macro levels. The micro-level analysis includes universities in neighboring provinces. They could form a research alliance based on the exchange of star academicians in the field of entrepreneurship. Additionally, these stakeholders from the university could develop a joint project in collaboration with regional actors including industrial partners, research associations, and related non-governmental organizations to determine regional needs and university outputs. Based on the results of the need analysis, student and graduate entrepreneurs could create their new business in those regions. However, this mechanism should be supported by the activities of mezzo level actors and macro-level stakeholders. A special funding program that prioritizes the urgent needs of the disadvantaged regions could be designed in cooperation with regional development agencies and governmental counterparts. Last but not least, the graduation projects should focus on these areas of need.

Another focal result addresses the strategic role of private sector in terms of cultivating entrepreneurial culture. In addition to the existing programs encouraging industry and university collaboration, university students could be invited by business partners to receive advice about the production processes.

There are some limitations regarding the shortness of the time dimension in this study. In further studies, this problem could be eliminated by updating the dataset to improve the validity of the results drawn from this study.

References

Akkoyunlu, K. (2018). *The civil service in Brazil and Turkey: A Comparative Study*. Escola Nacional de Administração Pública Brasil.

Anselin L., Le Gallo, J., & Jayet, H. (2006). Spatial panel econometrics. In L. Matyas & P. Sevestre (Eds.), *The econometrics of panel data, fundamentals and recent developments in theory and practice* (pp. 901-969). Kluwer.

Anselin, L. (1988) *Spatial Econometrics: Methods and Models*. Kluwer.

Anselin, L. (1995). Local indicators of spatial association - LISA. *Geographical Analysis*, *27*(2), 93-115.

Anselin, L. (2019). A local indicator of multivariate spatial association: Extending Geary's C. *Geographical Analysis*, *51*(2), 133-150. https://doi.org/10.1111/gean.12164

Anselin, L., Varga, A., & Acs, Z. (1997). Local geographic spillovers between university research and high technology innovations. *Journal of Urban Economics, 42,* 422-448. https://doi.org/10.1006/juec.1997.2032

Ar, I. M., Temel, S., Dabic, M., Howells, J., Mert, A., & Yesilay, R. B. (2021). The role of supporting factors on patenting activities in emerging entrepreneurial universities. *IEEE Transactions on Engineering Management*, *70*(6), 2293-2304. https://doi.org/10.1109/TEM.2021.3069147

Asheim, B. (2012). The changing role of learning regions in the globalizing knowledge economy: A theoretical re-examination. *Regional studies*, *46*(8), 993-1004. https://doi.org/10.1080/00343404.2011.607805

Audretsch, D. B., & Belitski, M. (2024). Geography of knowledge collaboration and innovation in Schumpeterian firms. *Regional Studies*, *58*(4), 821-840. https://doi.org/10.1080/00343404.2023.2222137

Audretsch, D. B., & Lehmann, E. E. (2005). Does the knowledge spillover theory of entrepreneurship hold for regions? *Research Policy*, *34*(8), 1191-1202. https://doi.org/10.1016/j.respol.2005.03.012

Audretsch, D. B., & Lehmann, E. E. (2006). Entrepreneurial access and absorption of knowledge spillovers: Strategic board and managerial composition for competitive advantage. *Journal of Small Business Management*, *44*(2), 155-166. https://doi.org/10.1111/j.1540-627X.2006.00161.x

Audretsch, D. B., & Lehmann, E. E. (2022). The knowledge spillover theory of entrepreneurship. In C. Antonelli (Ed.), *Elgar encyclopedia on the economics of knowledge and innovation* (pp. 317-324). Edward Elgar Publishing.

Audretsch, D. B., Hülsbeck, M., & Lehmann, E. E. (2012). Regional competitiveness, university spillovers, and entrepreneurial activity. *Small Business Economics*, *39*(3), 587-601. https://doi.org/10.1007/s11187-011-9332-9

Audretsch, D. B., Khurana, I., Dutta, D. K., & Tamvada, J. P. (2024). Creating effective university innovation and entrepreneurial ecosystems: A commitment system perspective. *The Journal of Technology Transfer*, *50*, 169-191. https://doi.org/10.1007/s10961-024-10090-w

Audretsch, D. B., Lehmann, E. E., & Warning, S. (2017). University spillovers and new firm location. In D. B. Audretsch & A. N. Link (Eds.), *Universities and the entrepreneurial ecosystem* (pp. 87-96). Edward Elgar Publishing.

Beck, N., Gleditsch, K. S., & Beardsley, K. (2006). Space is more than geography: Using spatial econometrics in the study of political economy. *International Studies Quarterly*, *50*, 27-44. https://doi.org/10.1111/j.1468-2478.2006.00391.x

Benneworth, P. & Fitjar, R. D. (2019). Contextualizing the role of universities to regional development: Introduction to the special issue. *Regional Studies, Regional Science*, *6*(1), 331-338. https://doi.org/10.1080/21681376.2019.1601593

Bergmann, H., Hundt, C., & Sternberg, R. (2016). What makes student entrepreneurs? On the relevance (and irrelevance) of the university and the regional context for student start-ups. *Small Business Economics*, *30*(5), 334-343. https://doi.org/10.1007/s11187-016-9700-6

Beyhan, B., & Findik, D. (2018). Student and graduate entrepreneurship: ambidextrous universities create more nascent entrepreneurs. *The Journal of Technology Transfer*, *43*(5), 1346-1374. https://doi.org/10.1007/s10961-017-9590-z

Boh, W. F., De-Haan, U. & Strom, R. (2016). University technology transfer through entrepreneurship: Faculty and students in spinoffs. *Journal of Technology Transfer*, *41*(4), 661-669. https://doi.org/10.1007/s10961-015-9399-6

Bramwell, A., & Wolfe, D. A. (2008). Universities and regional economic development: The entrepreneurial University of Waterloo. *Research Policy*, *37*(8), 1175-1187. https://doi.org/10.1016/j.respol.2008.04.016

Breschi, S., & Lissoni, F. (2001). Knowledge spillovers and local innovation systems: A critical survey. *Industrial and Corporate Change*, *10*(4), 975-1005. https://doi.org/10.1093/icc/10.4.975

Brown, R. (2016). Mission impossible? Entrepreneurial universities and peripheral regional innovation systems. *Industry and Innovation*, *23*(2), 189-205. https://doi.org/10.1080/13662716.2016.1145575

Budyldina, N. (2018). Entrepreneurial universities and regional contribution. *International Entrepreneurship and Management Journal*, *14*(2), 265-277. https://doi.org/10.1007/s11365-018-0500-0

Casas, R., De Gortari, R., & Santos, M. J. (2000). The building of knowledge spaces in Mexico: a regional approach to networking. *Research Policy*, *29*(2), 225-241. https://doi.org/10.1016/S0048-7333(99)00062-1

Casper, S. (2013). The spill-over theory reversed: The impact of regional economies on the commercialization of university science. *Research Policy*, *42*(8), 1313-1324. https://doi.org/10.1016/j.respol.2013.04.005

Chakrabarti, A. K., & Lester, R. K. (2002). *Regional economic development: comparative case studies in the US and Finland* [Proceeding]. IEEE International Engineering Management Conference, Cambridge.

Charles, D. (2003). Universities and territorial development: Reshaping the regional role of UK universities. *Local Economy: The Journal of the Local Economy Policy Unit*, *18*(1), 7-20. https://doi.org/10.1080/0269094032000073780

Charles, D. (2006). Universities as key knowledge infrastructures in regional innovation systems. *Innovation: The European Journal of Social Science Research*, *19*(1), 117-130. https://doi.org/10.1080/13511610600608013

Chatterton, P., & Goddard, J. (2000). The response of higher education institutions to regional needs. *European Journal of Education*, *35*(4), 475-496.

Claeys, P., & Manca, F. (2011). A missing spatial link in institutional quality. *Applied Economics Letters*, *18*(3), 223-227. https://doi.org/10.1080/13504850903559542

Clark, B. R. (1998). The entrepreneurial university: Demand and response. *Tertiary Education and Management*, *4*(1), 5-16. https://doi.org/10.1007/BF02679392

Clark, B. R. (2004). Delineating the character of the entrepreneurial university. *Higher Education Policy, 17*(4), 355-370. https://doi.org/10.1057/palgrave.hep.8300062

Clayman, B. P. & Holbrook, J. A. (2003). *The Survival of University Spinoffs and Their Relevance to Regional Development*. https://www.innovation.ca/sites/default/files/pdf/clayman1.pdf

Cunningham, J. A., Lehmann, E. E., Menter, M., & Seitz, N. (2019). The impact of university-focused technology transfer policies on regional innovation and entrepreneurship. *The Journal of Technology Transfer*, *44*(5), 1451-1475. https://doi.org/10.1007/s10961-019-09733-0

D'Este, P., & Perkmann, M. (2011). Why do academics engage with industry? The entrepreneurial university and individual motivations. *Journal of Technology Transfer*, *36*, 316-339. https://doi.org/10.1007/s10961-010-9153-z

Demirdağ, I. & Eraydın, A. (2024). Regions, entrepreneurship and institutions: The role of institutions on the entrepreneurship profiles of regions. *Eastern European Economics*, *62*(6), 1-26. https://doi.org/10.1080/00128775.2024.2354752

Elhorst, J. P. (2014). *Spatial econometrics: From cross-sectional data to spatial panels*. Springer.

Espinoza, C., Mardones, C., Sáez, K., & Catalán, P. (2019). Entrepreneurship and regional dynamics: The case of Chile. *Entrepreneurship & Regional Development*, *31*(9-10), 755-767. https://doi.org/10.1080/08985626.2019.1565421

Etzkowitz, H. (1983). Entrepreneurial scientists and entrepreneurial universities in American academic science. *Minerva*, *21*, 198-233. https://doi.org/10.1007/BF01097964

Etzkowitz, H., (2003). Research groups as 'quasi-firms': The invention of the entrepreneurial university. *Research Policy*, *32*, 109-121. https://doi.org/10.1016/S0048-7333(02)00009-4

Etzkowitz, H., Schuler Jnr, E., & Gulbrandsen, M., (2000). The evolution of the entrepreneurial university. In M. Jacob & T. Hellstrom (Eds.), *The Future of Knowledge Production in the Academy* (pp. 40-60). SRHE and Open University Press.

Feola, R., Parente, R., & Cucino, V. (2021). The entrepreneurial university: How to develop the entrepreneurial orientation of academia. *Journal of the Knowledge Economy*, *12*, 1787-1808. https://doi.org/10.1007/s13132-020-00675-9

Florida, R. (2013). The learning region. In Z. Acs (Ed.), *Regional innovation, knowledge and global change* (pp. 231-239). Routledge.

Fritsch, M., & Kublina, S. (2018). Entrepreneurship, growth, and regional growth regimes. In J. Leitao, H. Alves, N. Krueger, & J. Park (Eds.), *Entrepreneurial, innovative and sustainable ecosystems* (pp. 3-34). Springer.

Gleditsch, K. S., & Ward, W. D. (2001). Measuring space: A minimum distance database and applications to international studies. *Journal of Peace Research*, *38*, 749–768.

Goddard, J. B., & Chatterton, P. (1999). Regional Development Agencies and the knowledge economy: harnessing the potential of universities. *Environment and Planning C: Government and Policy*, *17*(6), 685-699.

Goddard, J., & Vallance, P. (2011). Universities and regional development. In A. Pkie, A. Rodriguez-Pose, & J. Tomaney (Eds.), *Handbook of local and regional development* (pp. 425-437). Routledge Handbooks.

Guerrero, M., & Urbano, D. (2012). The development of an entrepreneurial university. *Journal of Technology Transfer*, *37*, 43-74. https://doi.org/10.1007/s10961-010-9171-x

Guerrero, M., Urbano, D., & Fayolle, A. (2016). Entrepreneurial activity and regional competitiveness: evidence from European entrepreneurial universities. *The Journal of Technology Transfer*, *41*(1), 105-131. https://doi.org/10.1007/s10961-014-9377-4

Gül, H., Gül, S. S., Kaya, E., & Alican, A. (2010). Main trends in the world of higher education, internationalization and institutional autonomy. *Procedia-Social and Behavioral Sciences*, *9*, 1878-1884. https://doi.org/10.1016/j.sbspro.2010.12.417

Guzman, J., Murray, F., Stern, S., & Williams, H. (2024). Accelerating innovation ecosystems: The promise and challenges of regional innovation engines. *Entrepreneurship and Innovation Policy and the Economy*, *3*(1), 9-75. https://doi.org/10.1086/727744

Harrison, J., & Turok, I. (2017). Universities, knowledge and regional development. *Regional Studies*, *51*(7), 977-981. https://doi.org/10.1080/00343404.2017.1328189

Henry, C., & Lahikainen, K. (2024). Exploring intrapreneurial activities in the context of the entrepreneurial university: an analysis of five EU HEIs. *Technovation*, *129*, 102893. https://doi.org/10.1016/j.technovation.2023.102893

Huggins, R., & Kitagawa, F. (2012). Regional policy and university knowledge transfer: perspectives from devolved regions in the UK. *Regional Studies*, *46*(6), 817-832. https://doi.org/10.1080/00343404.2011.583913

Larch, M., & Walde, J. (2008) Lag or error? - Detecting the nature of spatial correlation. In C. Preisach, H. Burkhardt, L. Schmidt-Thieme, & R. Decker (Eds.), *Data Analysis, Machine Learning and Applications*. Springer. https://doi.org/10.1007/978-3-540-78246-9_36

Lehmann, E. E., & Menter, M. (2016). University-industry collaboration and regional wealth. *The Journal of Technology Transfer*, *41*(6), 1284-1307. https://doi.org/10.1007/s10961-015-9445-4

Lenger, A. (2008). Regional innovation systems and the role of state: Institutional design and state universities in Turkey. *European Planning Studies*, *16*(8), 1101-1120. https://doi.org/10.1080/09654310802315781

LeSage, J., & Pace, R. K. (2009). *Introduction to spatial econometrics*. CRC Press.

Martinelli, A., Meyer, M., & Von Tunzelmann, N. (2008). Becoming an entrepreneurial university? A case study of knowledge exchange relationships and faculty attitudes in a medium-sized, research-oriented university. *The Journal of Technology Transfer*, *33*(3), 259-283. https://doi.org/10.1007/s10961-007-9031-5

Ministry of Development (2014). The 10th five-year development plan: 2014-2018. Ankara. https://www.sbb.gov.tr/wp-content/uploads/2022/07/The_Tenth_Development_Plan_2014-2018.pdf

Ministry of Development (2019). The 11th five-year development plan: 2019-2023. Ankara. https://www.sbb.gov.tr/wp-content/uploads/2022/07/Eleventh_Development_Plan_2019-2023.pdf

Modrego, F., McCann, P., Foster, W. E., & Olfert, M. R. (2015). Regional entrepreneurship and innovation in Chile: A knowledge matching approach. *Small Business Economics*, *44*(3), 685-703. https://doi.org/10.1007/s11187-014-9612-2

Moran, P. (1950a). Notes on Continuous Stochastic Phenomena. *Biometrika*, *37*, 17-23.

Moran, P. (1950b). A Test for the Serial Dependence of Residuals. *Biometrika*, *37*, 178-181.

Newlands, D. (2003). *The Role of Universities in Learning Regions* [Proceeding]. 43rd Congress of the European Regional Science Association: "Peripheries, Centres, and Spatial Development in the New Europe", Jyväskylä, Finland.

OECD (2020). Youth Unemployment Rate (Indicator). https://data.oecd.org/unemp/youth-unemployment-rate.html

Özdemir, A., & Karakurt, D. (2024). Current transformations in Turkish education policies in the context of global agendas and increasing interaction in education. In B. Akgün & Y. Alpaydın (Eds.), *Global agendas and education reforms: A comparative study* (pp. 195-215). Springer Nature.

Pugh, R., Lamine, W., Jack, S., & Hamilton, E. (2021). The entrepreneurial university and the region: what role for entrepreneurship departments? In P. Cooke (Ed.), *Dislocation: Awkward spatial transitions* (pp. 135-155). Routledge. https://doi.org/10.4324/9781003133551

Rantala, T., & Ukko, J. (2019). Performance evaluation to support European regional development - A university–industry perspective. *European Planning Studies*, *27*(5), 974-994. https://doi.org/10.1080/09654313.2019.1581728

Rossoni, A. L., de Vasconcellos, E. P. G., & de Castilho Rossoni, R. L. (2024). Barriers and facilitators of university-industry collaboration for research, development and innovation: A systematic review. *Management Review Quarterly*, *74*(3), 1841-1877. https://doi.org/10.1007/s11301-023-00349-1

Salamzadeh, Y., Sangosanya, T. A., Salamzadeh, A., & Braga, V. (2022). Entrepreneurial universities and social capital: The moderating role of entrepreneurial intention in the Malaysian context. *The International Journal of Management Education*, *20*(1), 100609. https://doi.org/10.1016/j.ijme.2022.100609

Sayın, Z. (2024). Bölgesel kalkınma odaklı üniversitelerin misyon farklılaşması ve ihtisaslaşma alanlarının GZFT analizleri bağlamında incelenmesi. *Üniversite Araştırmaları Dergisi*, *7*(3), 259-280. https://doi.org/10.32329/uad.1478372

Serpente, G., Bolzani, D., & Grimaldi, R. (2025). Entrepreneurial support organizations as providers of entrepreneurial education and training. *The Journal of Technology Transfer*, 1-31. https://doi.org/10.1007/s10961-024-10177-4

SPO (1995). The 7th five-year development plan: 1996-2000. Ankara. https://www.sbb.gov.tr/wp-content/uploads/2022/07/Seventh_Five_Year_Development_Plan_1996-2000.pdf

SPO (2001). Long term strategy and the 8th five-year development plan: 2001-2005. Ankara. https://www.sbb.gov.tr/wp-content/uploads/2022/07/Long-Term_Strategy_and_Eight_Five_Year_Development_Plan_2001-2005.pdf

SPO (2006). The 9th Five-year development plan: 2007-2013. Ankara. https://www.sbb.gov.tr/wp-content/uploads/2018/11/Ninth_Development_Plan_2007-2013.pdf

Szerb, L., Lafuente, E., Horváth, K., & Páger, B. (2019). The relevance of quantity and quality entrepreneurship for regional performance: The moderating role of the entrepreneurial ecosystem. *Regional Studies*, *53*(9), 1308-1320. https://doi.org/10.1080/00343404.2018.1510481

Times Higher Education (2021). World University Rankings 2021. https://www.timeshighereducation.com/world-university-rankings/2021/world-ranking

Tobler, W., (1970). A computer movie simulating urban growth in the Detroit region. *Economic Geography*, *46*(2), 234-240.

Trippl, M., Sinozic, T., & Lawton Smith, H. (2015). The role of universities in regional development: Conceptual models and policy institutions in the UK, Sweden and Austria. *European Planning Studies*, 23(9), 1722-1740.

TUBITAK (2017). *Girişimci ve yenilikçi üniversite endeksi (Entrepreneur and innovative university index)*. Retrieved December 12, 2024 from https://tubitak.gov.tr/tr/kurumsal/politikalar/girisimci-ve-yenilikci-universite-endeksi

TUIK (2019). *Bölgesel istatistikler (Regional statistics)*. Retrieved December 27, 2019 from https://biruni.tuik.gov.tr/bolgeselistatistik/

Urbano, D., & Guerrero, M. (2013). Entrepreneurial universities: Socioeconomic impacts of academic entrepreneurship in a European region. *Economic Development Quarterly, 27*(1), 40-55. https://doi.org/10.1177/0891242412471973

Varga, A. (2001). Universities and regional economic development: Does agglomeration matter? In B. Johansson, C. Karlsson, & R. R. Stough (Eds.), *Theories of endogenous regional growth* (pp. 345-367). Springer.

Viton, P. A. (2010). Notes on Spatial Econometric Models. *City and Regional Planning 870*(3), 2-17.

Ward, M. D., & Gleditsch, K. (2008). *Spatial regression models*. Sage.

Wooldridge, J. M. (2014). *Introduction to Econometrics* (Europe, Middle East & Africa Edition). CENGAGE Learning.

YOK (2020a). YÖK Başkanı Saraç, İhtisaslaşacak 5 Yeni Üniversiteyi Daha Açıkladı. Retrived from https://www.yok.gov.tr/Sayfalar/Haberler/2020/yok-baskani-ihtisaslacak-5-yeni-universiteyi-acikladi.aspx

YOK (2020b). *Yükseköğretim bilgi sistemi (Higher education information system)*. Retrieved March 23, 2020 from https://istatistik.yok.gov.tr/

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APPENDICES

TABLE A1.
Multicollinearity tests (variance inflation factors)

	lngdp	*lngdp*	*lngdppc*	*lngdppc*	*lnenter*	*lnenter*
lnpop	8.80		8.80		8.80	
lnbuildings	6.79	3.43	6.79	3.43	6.79	3.43
lnuniv	3.86	3.77	3.86	3.77	3.86	3.77
entruniv	3.38	3.29	3.38	3.29	3.38	3.29
lnexp	3.05	2.29	3.05	2.29	3.05	2.29
secondary	2.14	1.34	2.14	1.34	2.14	1.34
dentruniv	1.69	1.69	1.69	1.69	1.69	1.69
acadstud	1.46	1.42	1.46	1.42	1.46	1.42
primary	1.15	1.15	1.15	1.15	1.15	1.15
Mean VIF	3.59	2.30	3.59	2.30	3.59	2.30

TABLE A2.
Sargan statistics (overidentification test of all instruments)

Dep. var.	Instrument	Sargan statistic	Endogeneity test
lngdp	*entruniv = lnprof lnassocprof lnasstprof*	0.395	0.010
lngdp	*entruniv = acadstud*	0.000[a]	0.222
lngdppc	*entruniv = lnprof lnassocprof lnasstprof*	0.395	0.01
lngdppc	*entruniv = acadstud*	0.000[a]	0.222
lnenter	*entruniv = lnprof lnassocprof lnasstprof*	1.076	0.537
lnenter	*entruniv = acadstud*	0.000[a]	5.551**

[a] Equation exactly identified, ** p<0.05. *lnprof*: Number of professors (in logs), *lnassocprof*: Number of associate professors (in logs), *lnasstprof*: Number of assistant professors (in logs).

TABLE A3.
Spatial error (inverse distance)

	(1)	(2)	(3)	(4)	(5)	(6)
	lngdp	*lngdp*	*lngdppc*	*lngdppc*	*lnenter*	*lnenter*
entruniv	0.288***	0.0414***	0.0606***	0.0414***	0.250***	0.000617
	(0.0195)	(0.00772)	(0.00807)	(0.00772)	(0.0199)	(0.00614)
dentruniv	0.756***	0.0376	0.183***	0.0376	0.714***	-0.0411**
	(0.0827)	(0.0232)	(0.0354)	(0.0232)	(0.0843)	(0.0186)
lnbuildings		0.193***		0.193***		0.183***
		(0.0165)		(0.0165)		(0.0133)
lnpop		0.703***		-0.297***		0.825***
		(0.0255)		(0.0255)		(0.0217)
acadstud		0.324		0.324		-1.159**
		(0.640)		(0.640)		(0.521)

TABLE A3. CONT.
Spatial error (inverse distance)

	(1)	(2)	(3)	(4)	(5)	(6)
	lngdp	*lngdp*	*lngdppc*	*lngdppc*	*lnenter*	*lnenter*
lnexp		0.0303***		0.0303***		0.00846*
		(0.00551)		(0.00551)		(0.00447)
lnuniv		0.113***		0.113***		0.0765***
		(0.0222)		(0.0222)		(0.0180)
primary		0.0149***		0.0149***		0.00572***
		(0.00189)		(0.00189)		(0.00149)
secondary		0.00874***		0.00874***		0.0110***
		(0.000933)		(0.000933)		(0.000759)
Constant	21.83***	9.109***	8.924***	9.109***	9.584***	-3.649***
	(0.114)	(0.336)	(0.0142)	(0.336)	(0.121)	(0.288)
lambda	0.727***	0.160	-0.124	0.160	0.738***	-0.644*
	(0.0719)	(0.193)	(0.218)	(0.193)	(0.0697)	(0.382)
sigma	0.676***	0.174***	0.287***	0.174***	0.689***	0.142***
	(0.0218)	(0.00559)	(0.00921)	(0.00559)	(0.0222)	(0.00459)
Observations	486	486	486	486	486	486

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE A4.
Spatial fixed-effect panel estimation (inverse distance)

	(1)	(2)	(3)	(4)	(5)	(6)
	lngdp	*lngdp*	*lngdppc*	*lngdppc*	*lnenter*	*lnenter*
entruniv	-0.00328	0.00571	-0.0201	0.00571	0.0229***	0.00261
	(0.0139)	(0.0104)	(0.0164)	(0.0104)	(0.00811)	(0.00476)
dentruniv	0.0225	-0.00522	0.0481**	-0.00522	-0.0441***	-0.00674
	(0.0199)	(0.0151)	(0.0235)	(0.0151)	(0.0116)	(0.00688)
lnbuildings		-0.000776		-0.000776		0.00763
		(0.0107)		(0.0107)		(0.00484)
lnpop		0.846***		-0.154		0.485***
		(0.113)		(0.113)		(0.0494)
acadstud		0.581		0.581		-0.594***
		(0.378)		(0.378)		(0.171)
lnexp		0.0101***		0.0101***		-0.00271*
		(0.00320)		(0.00320)		(0.00148)
lnuniv		0.0131		0.0131		-0.0255***
		(0.0174)		(0.0174)		(0.00803)
primary		0.0137***		0.0137***		-0.00190***
		(0.000835)		(0.000835)		(0.000376)
secondary		0.000859		0.000859		0.00253***
		(0.000549)		(0.000549)		(0.000250)

TABLE A4. CONT.
Spatial fixed-effect panel estimation (inverse distance)

	(1)	(2)	(3)	(4)	(5)	(6)
	lngdp	***lngdp***	***lngdppc***	***lngdppc***	***lnenter***	***lnenter***
Constant	23.61***	9.723***	9.007***	9.723***	11.37***	4.291***
	(0.0273)	(1.699)	(0.0323)	(1.703)	(0.0161)	(0.743)
lambda	-1.032***	-1.425***	-0.652*	-1.425***	-0.101	-0.494
	(0.399)	(0.426)	(0.360)	(0.426)	(0.307)	(0.336)
sigma	0.0572***	0.0422***	0.0678***	0.0422***	0.0339***	0.0196***
	(0.00187)	(0.00141)	(0.00219)	(0.00141)	(0.00109)	(0.000631)
Observations	486	486	486	486	486	486

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

TABLE A5.
Spatial random-effects panel estimation (inverse distance)

	(1)	(2)	(3)	(4)	(5)	(6)
	lngdp	***lngdp***	***lngdppc***	***lngdppc***	***lnenter***	***lnenter***
entruniv	0.00951	0.00428	0.00236	0.00428	0.00803*	0.00408
	(0.00754)	(0.00685)	(0.00719)	(0.00685)	(0.00418)	(0.00357)
dentruniv	-0.00818	-0.00306	-0.000696	-0.00306	-0.0137**	-0.0103**
	(0.0109)	(0.00992)	(0.0104)	(0.00992)	(0.00605)	(0.00517)
lnbuildings		-0.0131*		-0.0131*		0.00649*
		(0.00756)		(0.00756)		(0.00390)
lnpop		0.735***		-0.265***		0.494***
		(0.0746)		(0.0770)		(0.0397)
acadstud		0.268		0.268		-0.0406
		(0.259)		(0.259)		(0.135)
lnexp		-0.000412		-0.000412		-7.29e-05
		(0.00221)		(0.00221)		(0.00115)
lnuniv		-0.00113		-0.00113		-0.00843
		(0.0117)		(0.0117)		(0.00610)
primary		0.000780		0.000780		0.00286***
		(0.00113)		(0.00113)		(0.000590)
secondary		0.00231***		0.00231***		0.00170***
		(0.000695)		(0.000696)		(0.000363)
Constant	23.62***	12.78***	9.052***	12.78***	11.32***	3.689***
	(0.0153)	(1.138)	(0.0146)	(1.174)	(0.00848)	(0.607)
lambda	-0.272	-0.737*	-0.765**	-0.737*	-0.547	-0.803**
	(0.330)	(0.380)	(0.367)	(0.380)	(0.374)	(0.387)
sigma	0.0312***	0.0280***	0.0296***	0.0280***	0.0172***	0.0146***
	(0.00100)	(0.000907)	(0.000959)	(0.000907)	(0.000557)	(0.000474)
Observations	486	486	486	486	486	486

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.