Atıf: Tuysuz, S., Altuğ, F. (2022). Regional determinants and spatial differentiation of innovation in Turkey. *Coğrafi Bilimler Dergisi/ Turkish Journal of Geographical Sciences*, 20 (1), 45-66, doi: 10.33688/aucbd.1041133

Coğrafi Bilimler Dergisi

Turkish Journal of Geographical Sciences

e-ISSN:1308-9765

Regional Determinants and Spatial Differentiation of Innovation in Turkey

Türkiye'de İnovasyonun Bölgesel Belirleyicileri ve Mekansal Farklılaşması

Suat Tuysuz*[a], Fatih Altuğ[b]

Makale Bilgisi

Makale Türü

DOI: 10.33688/aucbd.1041133

Makale Geçmişi:
Geliş: 24.12.2021
Kabul: 08.04.2022

Anahtar Kelimeler:
İnovasyon
Mekansal belirleyiciler
Coğrafi ağırlıklandırılmış regresyon analizi

Öz

Bu çalışma, Türkiye'de inovasyonun mekansal dağılımını ve bölgesel belirleyicilerini incelemektedir. Araştırmada global (GR) ve coğrafi ağırlıklı regresyon (GWR) olarak adlandırılan regresyon analizleri uygulanmıştır. GR'ye dayalı olarak elde edilen bulgular, beşerî sermaye ile ihracatın/dışa açıklığın inovasyonu yordadığını göstermektedir. GWR analizine dayalı bulgular ise söz konusu yordayıcıların her bölgede inovasyon üzerinde aynı etkiye sahip olmadığını göstermektedir. Kullanılan bu yöntem çalışmayı literatürdeki diğer çalışmalardan farklılaştırmaktadır. Bu bulgular, politika yapıcılar tarafından uygulanan yukarıdan aşağıya inovasyon politikalarına ek olarak yerel ve bölgesel dinamiklerin de dikkate alınmasının gerekliliğini ortaya koymaktadır. Buradan hareketle bu çalışma, inovasyon politikasında yer temelli yaklaşımlara ihtiyaç olduğunu ampirik olarak ortaya koymaktadır.

Article Info

Article Type

DOI: 10.33688/aucbd.1041133

Article History:
Received: 24.12.2021
Accepted: 08.04.2022

Keywords:
Innovation
Spatial determinants
Geographically weighted regression

Abstract

This study investigates the spatial distribution and regional determinants of innovation in Turkey. In this study, we applied regression analysis which is called global (GR) and geographically weighted regression (GWR). The empirical analyses show that human capital as an internal resource and export as an external resource/openness are the determinants of innovation in the Turkish case. GWR showed that these predictors do not affect innovation in every region. Our method differentiates us from other studies in the literature. The research depicted an important image reflecting the policymakers' urging to take the local and regional dynamics into account and their top-down policies on innovation. The present study proves empirically that place-based approaches are needed in innovation policy.

***Sorumlu Yazar/Corresponding Author:** suattuysuz@gmail.com
[a] Erzincan Binali Yıldırım University, Department of Geography, Erzincan/Turkey, http://orcid.org/0000-0002-6598-0746
[b]Ondokuz Mayıs University, Department of Geography, Samsun/Turkey, http://orcid.org/0000-0001-9163-6116

1. Introduction

The role of innovation, which is the basis of capitalist economic development, in economic growth was first introduced by Schumpeter (1911). Following the crisis of Fordism, innovation was brought back to its central position among the models of economy and development (Kebir et al., 2017). The changes that occurred in the production systems after the crises of the 1970s and the geographical restructuring process of the global economy have led the old industrial regions to lose their competitive advantages to the innovative regions such as Silicon Valley, Route 128, Emilia Romagna, and Cambridge, and on this basis, the regional development based on innovation has begun to occupy more of the agenda (Gordon and McCann, 2005). The empirical studies on regional economics, regional science, and economic geography related to these regions that developed in accordance with innovation during the 1980s (Dorfman, 1983; Harris, 1988; Meir, 1981; Oakey, 1984; Oakey, Thwaites, and Nash, 1982; Saxenian, 1983, 1985, 1989, 1990) pointed the importance of spatial patterns in the initiation and maintenance of innovation (Krugman, 1991; Maskell and Malmberg, 1999). Many researchers have begun to explore the geographical side of innovation (Buesa et al., 2010; Crescenzi et al., 2007; Crescenzi and Rodríguez-Pose, 2017; Tan et al., 2017; Yang and Lin, 2012; Zemtsov et al., 2016). The emphasis placed on the relationship between place and innovation has increased, and spatial dynamics have begun to be used as an important variable (Boschma and Martin, 2010).

Especially, the studies conducted on the SMEs (Small and Medium-Sized Enterprises) have shown that the economic and non-economic factors have an influence on the innovation performance of the firms, and these factors are related to the dynamics of the regions where the firms are located (Bougrain and Haudeville, 2002; Cooke and Morgan, 1994; Cornish, 1997; Hansen, 1990; Keeble, 1997; Keeble and Wilkinson, 1999; Maskell and Malmberg, 1999; Morgan and Cooke, 1998). Indeed, spatial dynamics are an intrinsic feature of a knowledge-based and innovation-oriented economy (Baycan, Nijkamp, and Stough, 2017). Traditional spatial dynamics in innovation are discussed in the concepts of new industrial spaces (Storper and Scott, 1988), cluster (Malmberg and Maskell, 2002; Maskell, 2001; Porter, 1990), learning region (Morgan, 1997), innovative milieu (Asheim, 1996), etc. This traditional literature related to innovation was widely just focused on a location's specific dynamics. This literature is called territorial innovation (Moulaert and Sekia, 2003). All these are highlighted the importance of human capital (quality of the population), institutional infrastructure (like hard institutions [the existence of universities, the presence of R&D centers, government agencies, etc.] and soft institution [social capital which based on trust and quality of network and collective learning culture in a region]) on innovation.

Another stream of literature emphasizes added extra local dynamics to local dynamics with the concepts such as global pipeline (Bathelt, Malmberg, and Maskell, 2004), temporary cluster (Bathelt and Schuldt, 2008; Maskell, Bathelt, and Malmberg, 2006; Rinallo and Golfetto, 2011; Torre and Rallet, 2005), which based on international/transnational effect on knowledge flows which are possible to give rise to generate innovation (Bathelt and Henn, 2014; Bathelt and Li, 2013; Bathelt et al., 2004; Dicken et al., 2001; Humphrey and Schmitz, 2002). And the proximity concepts such as cognitive, organizational, social, and institutional proximity also give us some clues about recognizing the extra-local dynamics (except for geographical proximity) (Boschma, 2005; Capello and Varga, 2013; Torre and Rallet, 2005).

To sum up, briefly, we have two kinds of literature. In the first one, local dynamics play a significant role in innovation, and the second one points out extra-local dynamics. Both first and second-stream literature are rarely studied together. Our research will combine both of this literature. This is one of the originalities of the present study.

The studies on innovation at the regional level have been conducted over patent application (PA) (Cantner, Meder and Ter Wal, 2010; Oakey et al., 1982) and/or R&D expenditure data, either as dealing with the distribution of innovation activities within the country or comparing some selected countries according to certain criteria over the same data (Audretsch and Feldman, 1996; Feldman and Florida, 1994; Fischer, Goncalves and Almeida, 2009; Guerro and Sero, 2011; Lim, 2003; Scherngell and Jansenberger, 2009; Sun, 2000; Tan et al., 2017). There are studies in the literature based on the regional dynamics of innovation (Buesa et al., 2010; Crescenzi et al., 2007; Crescenzi and Rodríguez-Pose2017; Tan et al., 2017; Zemtsov et al., 2016); however, these studies focus only on the regional determinants of innovation. In other words, they do not include the uniqueness of the regional determinant of innovations for each region. Therefore, even if the data are obtained on a regional scale, the results include the determination of the dynamics that affect the national innovation performance. It is seen that studies based on spatial analysis, in which empirical analysis of these dynamics are made for each region, and the effects of internal and external factors on the innovation performance of each region are not sufficiently discussed in the literature.

At the same time, it should be noted that, in the context of Turkey, the studies on innovation activities are also far from the perspectives mentioned above (Elçi, Karataylı and Karaata, 2008; Işık and Efe Can, 2011; Şahinli and Kılınç, 2013). Most of these studies are also far from the geographical perspective, and their aim is yet to discover and understand the general dynamics of innovation activities in the country. On the other hand, the studies reveal the impact of innovation on national performance through external factors (Kuştepeli et al., 2013) and studies on the importance of proximity types in the dissemination of innovation on a sectoral scale (Altuğ, 2021; Altuğ and Yılmaz, 2018; Kaygalak and Reid, 2016) are important for the development of national literature.

As we will show in the next section, innovation is spreading as well as rising throughout Turkey. But some regions are still more innovative than the others in Turkey. In this context, the research has three main purposes. The first one is to put together a region's internal (local) and external (international/transnational) dynamics having on innovation. In this way, we will go beyond the traditional concept which is mentioned above. The second one is to reveal the spatial dynamics affecting innovation in Turkey. The last one is to find out whether these dynamics exhibit the same effect in every region spatially. This means the study reveals the spatial uniqueness of innovation activity. In this respect, the research differs from the other studies.

2. Description of Spatial Distribution and Temporal Change of Innovation in Turkey

In the beginning, the historical and spatial pattern of innovation activities in Turkey is described in this part of the study. It has been observed that the innovation activities in Turkey developed in a stable until the early 2000s (Figure 1). There has been a significant increase in the number of PAs since the beginning of the 2000s. This situation becomes clearer when the increase in the number of PAs is examined periodically. It has been observed that the increase in the total number of PAs was 123% between 1995 and 2001, 136% between 2002 and 2006, 146 % between 2007-2012, and 91% between 2012 and 2017.

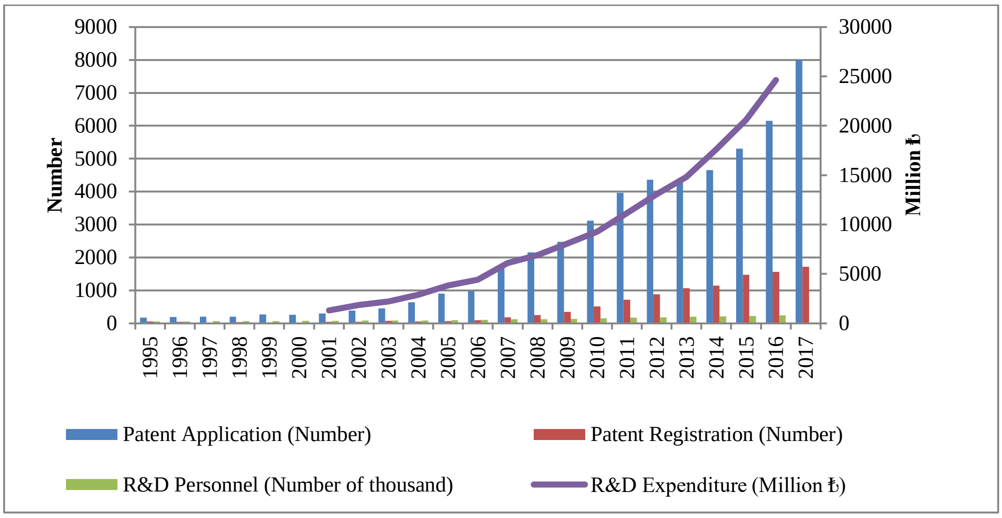

Figure 1. Patent and R&D in Turkey.

The increase in the number of PAs in Turkey can also be explained by the fact that the government attaches more importance to innovation policies. Within these policies, it is necessary to put emphasis, especially on R&D expenditures and incentives for R&D personnel, Development Agencies, KOSGEB (Small and Medium Enterprises Development Organization of Turkey), university research funds, and legal arrangements1. It can be said that R&D expenditures and R&D personnel incentives have turned into an effective policy instrument. As a matter of fact, when the data obtained from the Turkish Statistical Institute (TURKSTAT) is examined; while the total R&D expenditure in 2001 was approximately 1.3 billion TL (Turkish Liras) and its ratio to Gross Domestic Product (GDP) was 0.53%, the total R&D expenditure in 2016 increased to 24.6 billion with a GDP ratio of 0.94%. Although the R&D expenditures are rather low when compared to developed countries, it seems to be on an upward trend (OECD, 2018). However, it is seen that the total R&D expenditure in the last fifteen years has increased by about eighteen times and its GDP ratio by about two times (Figure 1 and 2).

A similar situation has been identified in the number of R&D researchers. According to TURKSTAT, the human resource employed in R&D was 51,193 in 1995, which later increased to 76.074 in 2000 and to 242.213 in 2016 in Turkey. Accordingly, the number of R&D personnel has also increased by three times in the last 15 years. Therefore, it can be stated that responding positively to the applied policies, the increase in PAs has gained momentum. These increases were not only numerical but also proportional. As a matter of fact, while the ratio of total R&D expenditures to GNP was 0.53%

in 2001, it increased to 0.95% in 2017. Similarly, the share of the number of R&D personnel in the total population increased from ‰1,70 to ‰3.30 between 2007 and 2017, respectively (Figure 2). This increase was also reflected in the spatial expansion (Figure 3). Considering the breaking points that occurred in the temporal change of patent application data, it is possible to examine the spatial development of innovation activities in four periods. Taking into account the possibility that the current figures can hide the aforementioned reflection and change, the number of patents per one hundred thousand population has been used. In order to compare the changes between the periods, four categories were determined by taking into account the data of the last period and their natural breakdowns and were used jointly in all periods (0,00-0,99, 1,00-4,99, 5,00-9,99, 10,00 -14,99, 15,00+), (Figure 3).

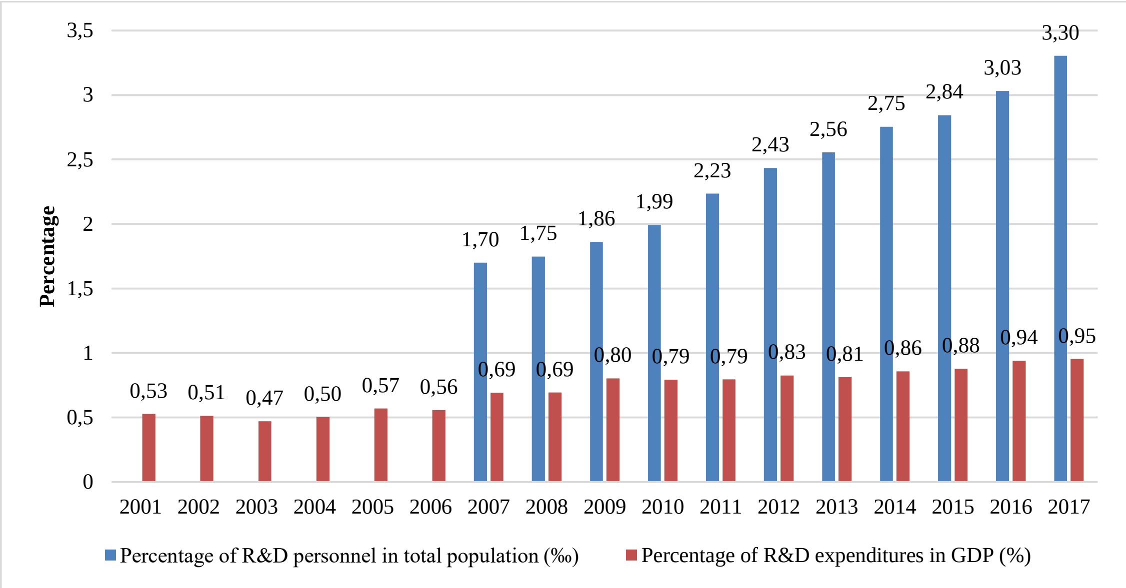

Figure 2. The Percentage of R&D Expenditures to GNP and The Percentage of R&D Personnel to Total Population.

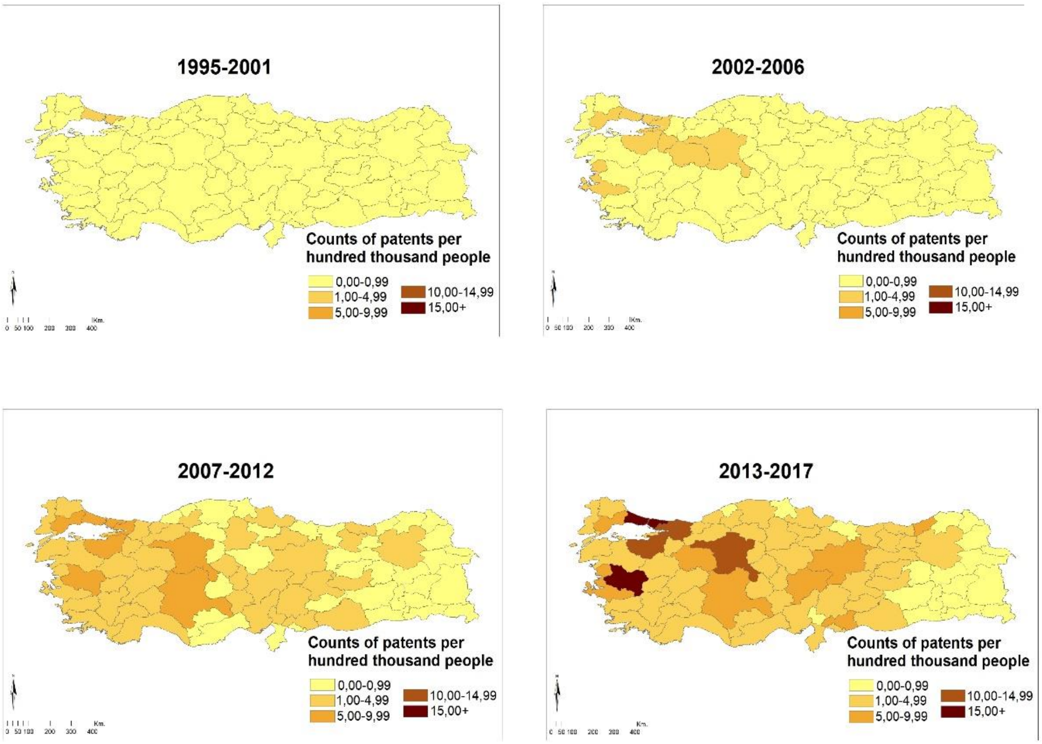

Figure 3. Spatial and temporal development of innovation activities in Turkey.

Considering the number of patents per hundred thousand people in the first period covering the years 1995-2001, it is seen that innovation activities are concentrated in Istanbul. During the second spatial development period covering the years 2002-2006, it is seen that Ankara, İzmir, Eskişehir, Bursa, Kocaeli, Sakarya, and Tekirdağ regions have risen to a higher category. These regions also correspond to the regions where the heart of the Turkish economy beats. The third period, covering the years 2007-2012, is the period when innovation activities spread the most spatially. In the period covering the years 2013-2017, it is seen that the spatial spread continues even slightly, while other regions, in turn, have increased to the upper category. As we can follow from the map, innovation activities are spreading from the oldest industrial regions of the country, such as Istanbul, Ankara, and Izmir, to the periphery of these provinces. There has been a significant increase in innovation activities in provinces such as Kocaeli, Bursa, and Tekirdağ located on the periphery of Istanbul; Eskişehir, Konya, Kayseri located on the periphery of Ankara; Manisa, located on the periphery of İzmir, and Gaziantep. In addition to Istanbul, Ankara, and Izmir, these provinces are also "New Industrial Spaces" where the industry is developing in Anatolia called "Anatolian Tigers" (Eraydın, 2002).

3. Theoretical Framework

3.1. Internal and External Assets in Innovation

The inclusion of spatial perspective into innovation studies has increased the significance of innovation in regional development and thus, helped it become an important political instrument in regional and national development. Innovation is a process that requires a symbiotic relationship rather than an activity just alone. This symbiotic relationship involves the interoperability of internal and external resources together (Baycan et al., 2017). In other words, innovation often takes place in symbiotic networks, which are not only necessarily local, but also global connections (Capello, 2017; Larsen, 2014; Miguelez and Moreno, 2018; Smith and Thomas, 2017).

Economic development and innovation studies take into consideration the role of local assets like human capital and institutional infrastructure involving universities, research, and technology centers, government agencies, associations, etc., which we used most of them as data (Baycan et al., 2017; Crescenzi and Rodriquez-Pose, 2017; Feldman and Florida, 2004; Sayili, 2020; Zamtsov et al., 2016). Especially, human capital is widely accepted as a crucial source of creating knowledge. As Faggian (2005, p. 362) stated, human capital refers to 'knowledge, skills and competencies embodied in individuals that increase their productivity. Despite the fact that human capital is a crucial role in innovation, Riccardo Crescenzi and Rodríguez-Pose (2017) suggest that innovation can be a result of different forces and mechanisms. Of course, in a globalizing world, the source of innovation is impossible, embedded just in human capital. As Baycan et al. (2017) stated that in a globalizing world, cities and regions turned from 'islands of isolation'. That is why in the globalizing world needs extra-local assets, too. The extra-local assets can also be a driving force of development and innovation studies. For example, transnational networks can facilitate innovation activity (Crescenzi and Rodríguez-Pose, 2017) or knowledge transfer which generates innovation (Henn, 2012; Müller and Franz, 2019). In this context, exporting and foreign direct investment are considered as one of the dynamics of innovation, which is called openness (Andersson and Johansson, 2008; Andersson and Lööf, 2009; Fassio, 2017; Lopez-Bazo and Motellon, 2018; Salomon and Shaver, 2005; Yang and Li, 2012).

As a result, the innovation process develops under different parameters, and these parameters are in relation to each other. So, comparing the innovation processes of Turkey and South Korea, Erciş and Ünalan (2016) attributed the widening of the development gap between the two countries with equal GNP in the 1980s to innovation parameters. For this reason, in order for Turkey to close this gap, it is necessary to increase the amounts of R&D centers, researchers, and research funds, strengthen human capital, increase the number and quality of universities, change the technology level of the product pattern it is has recommended developing parameters such as. In fact, it has been shown empirically that these parameters increase innovation performance and competitiveness at the firm scale (Seyfettinoğlu et al., 2020).

3.2. Parameters Used in Innovation Measurement

With respect to measuring innovation activity, this activity is generally measured by the number of PAs in the relevant literature. PAs have seen the impact of innovation on national and regional development. The reason is that the PAs are regarded as the output of the total effectiveness of a region or country in innovation activities (Acs et al., 2002; Griliches, 1998; Smith, 2005). On the other hand, the data also provide convenience in terms of indicating the distribution of the innovation between regions and countries and enabling comparisons.

It can be said that the studies that investigate the regional distribution of innovation activities are generally exploratory studies, and the parameters affecting the distribution provide a general framework in terms of comprehending the subject. As a matter of fact, Sun (2000), in his research in which he studied the spatial distribution of patents in China, found that the innovation systems were weakening in the eastern industrial regions such as Beijing, Shanghai, and Tianjin while the new and fast-growing regions such as Guangdong, Shandong, Zhejiang, and Fujian were pointed to be more creative. However, there has been no evidence for the spatial causes of the factors that lead to this situation. Ricardo Crescenzi and Jaax (2017) investigated the relationship between regional R&D expenditure and patenting in regional innovation performance. In Russia, they found that R&D expenditure, human capital, multinational enterprises (MNEs), and other determinants affect regional innovation performance. But they didn't examine all region's level effects of these determinants. In another study on the Russia case, it was revealed that human capital investment is more effective in creating innovation than investment in R&D. In other words, without qualified human capital, the investment in R&D cannot produce the expected effect (Zemtsov et al., 2016). Lim (2003) studied the spatial distribution of innovation in metropolitan regions in the United States, and he found that the intensity of innovative activity in a metropolitan region was spatially related to the innovative activity of neighboring metropolitan regions. In his work in which he used exploratory spatial data analysis, he did not specify what parameters affect innovation activities in metropolitan regions or which ones provide the relationship between metropolitan regions. However, in another study, it was revealed that the innovation capacity of the periphery region weakened as the metropolitan regions attracted the qualified workforce in the periphery (Tan et al., 2017). Quatraro's (2009) research revealed that public expenditure on R&D in the diffusion of knowledge between regions was more important than private-sector spending. The study conducted by Gonçalves and Almeida (2009) is partly different from these studies. In that study, in which they tried to explore the parameters that influence the innovation performance of micro-regions in Brazil, it was discovered that the multinational presence of firms in the regions, urban density, and university activities all affected the innovation performance of the regions. Unlike the spatial distribution of innovation activities, this study, important in determining the dynamics affecting the distribution, analyses the parameters affecting the innovation performance of the regions on the macro level and does not provide any evidence of regional differentiation.

On the other hand, there are also studies that compare the innovation performance of countries by using the PA data and even ones that demonstrate the intensification of innovation among the regions of the countries that are compared. In a study in which Jung and Imm (2002) compared Korea and Taiwan's both domestic and international PA performances, it was found that US-based grant rates and methods affected the performance of countries. In another study in which Liu and Sun (2009) compared the spatial distribution of innovation in China and the United States, they realized that China's innovation activities had increased rapidly in recent years while there had been a relative slowdown in the United

States. It was found that innovation activities in both countries concentrated on coastal regions, and the spatial differentiation of patents in China was found to be more prominent than in the United States. In their study in which they examined the geographical localization of knowledge diffusion in Europe, Fischer et al. (2009) used the patent data in the high-tech sectors and concluded that inside the national boundaries were more influential of knowledge spillovers. Thus, the flow of knowledge among technologically close regions within European countries could go beyond national boundaries. These studies, like the others, which compare the performance of innovation among countries, focused more on spatial distributions rather than explaining the factors that cause spatial differentiation in innovation activities.

In addition to these studies, analyzing the spatial and regional differentiation of innovation activities through patent data, there are also studies that analyze this differentiation through R&D activities (Audretsch and Feldman, 1996; Crescenzi and Rodríguez-Pose, 2013; Rodríguez-Pose and Crescenzi, 2008; Tan et al., 2017; Yokura et al., 2013). The common point of these studies is that they all deal with the R&D processes -an important variable for innovation activities-knowledge production -a part of R&D processes-and knowledge diffusion on a regional basis. However, the spatial change of innovation and knowledge diffusion arising as a result of R&D activities is not analyzed in these studies.

On the other hand, besides the local factors that cause innovation, the number of researches on understanding the transnational effect has been increasing in recent years (Fassio, 2017; López-Bazo and Motellón, 2018; Miguelez and Moreno, 2018). However, it has not been found which of these variables have a specific effect on the regions.

As a result, these studies trying to establish the connection of the innovation with the region focused on showing the spatial distribution of innovation activities. While indicating the distribution of activities in the place is one of the basic tools of geography science, it is also crucial to explain the factors that cause this distribution and to address these explanations in such a way as to create spatial uniqueness in each region's basis. From this point of view, this research is also aimed to fill the gap in the literature.

4. Data

In this study, data were obtained from secondary sources at the NUTS 3 level (81 provinces). We used the data as dependent and independents. The dependent variable of the study consists of the PA2 data. In innovation studies, data on PAs are frequently used as innovation indicators (Cantner et al., 2010; Fischer et al., 2009; Gonçalves and Almeida, 2009; Gordon and McCann, 2005; Makkonen, 2012; Miguelez and Moreno, 2018; Oslo-Kılavuzu, 2006; Piergiovanni and Santarelli, 2001; Quatraro, 2009; Reiffenstein, 2009). We used the PA data that covers the totality from 2012 to 2017. In order to remove the misleading effect of the one-year grant, the number of five-year PAs covering 2012 to 2017 was taken as the basis. And then, the totality of 2012-2017 PA data was calculated to the population of 2017. So, we created the PA per person as a dependent variable, which we called INNOV (see Table 1).

As it is shown in Table 1, we used fourteen independent variables. The variables consist of two external and twelve internal resources, which have four sections human capital, wealth and entrepreneurship, technological capabilities, and institutional infrastructure. We used export3 and the number of foreign capital investment companies per person as external resources. As discussed above, export and FDI are one of the factors that feed innovation (Andersson and Johansson, 2008; Andersson and Lööf, 2009; Fassio, 2017; Lopez-Bazo and Motellon, 2018; Salomon and Shaver, 2005; Yang and Li, 2012). External resources also show the openness of a region. In innovation studies, the variables such as external resources (Andersson and Lööf, 2009; Fassio, 2017; Giuliani, 2011; López-Bazo and Motellón, 2018; Miguelez and Moreno, 2018; Smith and Thomas, 2017) and internal resources like human capital, entrepreneurship and institutional infrastructure (Capello and Lenzi, 2013; Crescenzi and Rodriquez-Pose, 2017; Feldman and Florida, 1994; Goncalves and Almeida, 2009; Guerro and Sero, 2011; Hu, 2008; Martin et al., 2005; Sun, 2000; Zamtsov et al., 2016) frequently used in the literature. Another stream of the literature emphasized a clustering tendency for innovation. This can be called as technological capabilities of a region. These pieces of literature reveal that because innovation is the key to the success of high-tech industries, high-tech industries tend to have more clusters in a specific region. This kind of clustered region at a specific technological level is more innovative than others because of benefiting from reciprocal technology spillovers (Florida and Kenney, 1988; Fosfuri and Rønde, 2004; Nazari et al., 2020; Xie et al., 2011). We used location coefficients to measure clustering at a certain technology level. We used location quotient (LQ) to measure clustering at a certain technology level. We called it the technological capabilities and cluster tendency of a region. All of the data we used are described in Table 1.

Table 1. Definitions of dependent and independent variables used in regression analysis.

<table>
<tr><th></th><th></th><th>Variables</th><th>Literature</th><th>Code</th><th>Descriptions and period of data</th><th>Source of data</th></tr>
<tr><td colspan="2"></td><td colspan="5">Dependent Variable</td></tr>
<tr><td colspan="2"></td><td>DV1- Patent application per person</td><td>Acs et al., 2002; Goncalves and Almeida, 2009; Makkonen, 2012; Lim, 2003; Tan et al., 2017; Crescenzi and Rodriquez-Pose, 2017</td><td>INNOV</td><td>The ratio of the total number of patents between 2012-2017 to the city population in 2017</td><td>TPTO[4]</td></tr>
<tr><td colspan="2"></td><td colspan="5">Indepented Variables</td></tr>
<tr><td rowspan="2" colspan="2">External resources/openness</td><td>ER1-Export per person (thousand $)</td><td>Salomon and Shaver, 2005; Andersson and Johansson, 2008; Andersson and Lööf, 2009; Yang and Li, 2012; Fassio, 2017; Lopez-Bazo and Motellon, 2018</td><td>EXP</td><td>The ratio of the total export betw 2012-2017 to the city population 2017</td><td>TURKSTAT</td></tr>
<tr><td>ER2-Amount of foreign investment per person</td><td>Smith and Thomas, 2017; Bathelt and Li, 2013; Kuştepeli et al., 2013; Müller and Franz, 2019</td><td>FDI</td><td>Total amount of foreign investment between 2012-2017 to the city population in 2017</td><td>TOBB[5]</td></tr>
<tr><td rowspan="10">Internal resoruces</td><td rowspan="3">Human capital</td><td>HC1-The number of academic staff per person</td><td rowspan="3">Baycan et al., 2017; Sayili, 2020; Zamtsov et al., 2016; Crescenzi and Rodriquez-Pose, 2017</td><td>ASTF</td><td>The ratio of the number of academic staff in 2017 to the city population in 2017</td><td>CHE[6]</td></tr>
<tr><td>HC2-The number of employees in R&D and design centre per person</td><td>RDPER</td><td>The ratio of the employees in R&D and design centre in 2018 to the city population in 2017</td><td>MIT[7]</td></tr>
<tr><td>HC3-Postgraduate population</td><td>PGP</td><td>The ratio of postgraduate population to city population over 15 years of age in 2017</td><td>TURKSTAT</td></tr>
<tr><td rowspan="3">Wealth and entrepreneurship</td><td>WE1-GDP (per capita) ($)</td><td rowspan="3">Zamtsov et al., 2016; Sayili, 2020; Tan et al., 2017</td><td>GDP</td><td>Average of GDP per capita between 2012-2017</td><td>TURKSTAT</td></tr>
<tr><td>WE2-Employment rate (%)</td><td>EPR</td><td>Employment rate in 2013</td><td>TURKSTAT</td></tr>
<tr><td>WE3- The number of entrepreneurial initiative per person</td><td>ENIPP</td><td>Average of the number of entrepreneurial initiative per person between 2012-2016</td><td>TURKSTAT</td></tr>
<tr><td>Technological capabilities/cluster trndency</td><td>TC-1- Technological level (low, medium-low, medium-high, high)</td><td>Florida and Kenney, 1988; Fosfuri and Rønde, 2004; Xie et al, 2011; Nazari et al, 2020</td><td>TECHLQLOW
TECHLQMLOW
TECHLQMHIGH
TECHLQHIGH</td><td>Location quotient of technological level 2013-2017 (technological level was classified by OECD technology classification)</td><td>TURKSTAT</td></tr>
<tr><td rowspan="2">Institutional infrastructure</td><td>II1-The number of R&D and design centre per person</td><td rowspan="2">Feldman and Florida, 1994; Crescenzi and Rodriquez-Pose, 2017</td><td>NRDC</td><td>The ratio of the number of R&D and design centre in 2018 to the city population in 2017</td><td>MIT</td></tr>
<tr><td>II2- Schooling rate in secondary school (%)</td><td>SREDU</td><td>Average of schooling rate in secondary school between 2012-2017</td><td>TURKSTAT</td></tr>
</table>

5. Method

As it is known, regression analysis is performed to predict the effect of independent or influencing variable(s) on dependent or affected variable(s). The regression method is also referred to as the global regression (GR) model as it does not take spatial differences into account (Fotheringham et al., 2002). In this regard, the model to be estimated in the study is as follows:

LnINNOV= α + β1LnEXP + β2Ln ASTF+ β3Ln RDPER + β4Ln PGP + β5Ln GDP+ β6Ln EPR + β7Ln ENIPP + β8Ln FDI + β9Ln TECHLQLOW+ β10Ln TECHLQMLOW+ β11Ln TECHLQMHIGH+ β12Ln TECHLQHIGH+β13 Ln NRDC + β14 Ln SREDU+ ε

We conducted the analysis in three stages. In the first part of the study, the variables that predict the innovation will be determined with the global regression (GR) model established above, and in the second part, using the information obtained from GR, an analysis which is sensitive to spatial differences and expressed as geographically weighted regression (GWR) will be conducted. In this view, it will be understood how the dynamics that predict innovation are spatially differentiated. And the last stage, we try to understand what the reason for this differentiation is. For this purpose, we focused on the technology level of the regions according to OECD classification (low, medium-low, medium-high, high).

It should be noted that the analysis was conducted based on the 41 provinces, not all the 81 provinces of the NUTS level 3 in Turkey. The reason that it is conducted 41 provinces is due to the absence of R&D or design centers in all 81 provinces. Thus, 40 provinces without R&D or design centers were excluded from the analysis.

6. Findings

Our findings will be presented in three stages. In the first step, we will perform the regression analysis to determine the internal and external factors that affect innovation. In the second step, we will try to understand that these factors do not have the same effect in each region by GWR analysis. In the next section, we will discuss the findings obtained by GWR analysis. In this section, we will try to make sense of GWR results.

6.1. Findings Obtained by Regression Analysis

As there were multiple variables used in this study, multiple linear regression analysis was applied. The results of the test subjects shown in Table 2 and Table 3 are among the accepted values in terms of the validity of the analysis. The subject matter is important in terms of the possibility that it provides for a generalization. The D-W values between 1.5 and 2.5 indicate that there is no autocorrelation; hence, this is the range of values that must be considered for the analysis to be valid (Küçüksille, 2017). As shown in Table 2, with 2,116, D-W values are among the accepted values. Another test to check the validity of the analysis is the VIF test. If the VIF value is equal to 1, there is no multiple linear dependencies. There is a moderate multiple linear dependence if $1 < VIF \leq 5$; a high level of multiple linear dependence if $5 < VIF \leq 10$; and a high level of multiple linear dependence if $VIF > 10$ (Küçüksille, 2017; Özdamar, 2009: 523-524). From this point, if the VIF is between 1 and 5, the analysis is statistically valid. As seen in Table 3 VIF value is 1,264 in our analysis. Therefore, the VIF test also confirmed that the analysis is statistically valid.

As known, in regression analysis, the prediction effect of the independent variables on dependent variables is provided through creating a model. There are two commonly used methods to create that model. One is the 'enter', and the other is the 'stepwise' method. The stepwise method is preferred in this study as it is automatically set by the software. In this method, all variables considered to be related to the dependent variable are cultivated, and the variables that have the effect of prediction on the dependent variable are automatically selected by the software based on their order of importance. When there are a large number of independent variables, the stepwise method-based regression model is the only method that gives the best regression model that maximizes R2 while minimizing the number of independent variables (Clark and Hosking, 1986, p. 419).

After providing the assumptions of regression analysis, the software created two models as a result. In this research, the second model is taken into consideration as it is the model with the highest description effect (74 %).

As known, ANOVA is the first table to be taken into consideration in regression analysis. The ANOVA table is important in that it shows whether the analysis is significant or not. The ANOVA results show that the analyze is statistically significant at p <0.000.

Table 2. Model summary of regression analysis.

Model Summaryc										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	,786 a	,617	,607	,49167	,617	62,870	1	39	,000	
2	,861b	,741	,728	,40955	,124	18,208	1	38	,000	2,116

a.Predictors: RDPER
b. EXP
c. Dependent Variable: INNOV

On the other hand, the table of model summary and the table of coefficients give the regression coefficients and their significance levels which are used for the regression equation. The description effect of each model on the dependent variable is best understood through adjusted R2 value, the contribution level of the variable to the model through t value, the prediction level of the independent variable on the dependent variable through β value. Accordingly, the results of the model are as follows.

There are two independent variables in the model that predict the dependent variable (patent per person/INNOV): the number of employees in R&D and design centers (RDPER) export per person (EXP). The R2=.728 value of the model indicates that the model reveals 73% of the effect on the innovation. The three variables that predict innovation all have a high level (p=,000) and positive significance (Tables 2 and 3). The t values indicating the level of effect of these three independent variables on innovation are very close to each other. This effect appears to be (t=6,514) in RDPER, (t=4,267) in the EXP. These results showed that human capital has to effect the patent activity much more than export. This means internal resources are more important than external ones in patent activity.

The regression coefficients in the model are as follows: in the RDPER (β=,605), in the EXP (β=,396). As evidenced by the beta values, it is estimated that any 1% increase in the human capital of a region can increase the innovation by an additional of %0,605, any 1% increase in the export by an additional 0.396% (see Table 3).

Table 3. Coefficient results of regression analysis.

Coefficients[a]												
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95,0% Confidence Interval for B		Correlations			Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Zero-order	Partial	Part	Tolerance	VIF
(Constant)	-8,123	,903		-8,996	,000	-9,951	-6,295					
RDPER	,346	,053	,605	6,514	,000	,238	,453	,786	,726	,538	,791	1,264
EXP	,170	,040	,396	4,267	,000	,090	,251	,672	,569	,352	,791	1,264
Dependent Variable: INNOV												

The findings of the analysis are compatible both with the literature that shows the positive impact that human capital has on innovation (Iqbal et al., 2011; Kanama and Nishikawa, 2017; Riccardo Crescenzi and Rodríguez-Pose, 2013; Sayili, 2020; Tan et al., 2017) and with the literature that shows the positive impact that the export has on innovation (Andersson and Lööf, 2009; Fassio, 2017; López-Bazo and Motellón, 2018; Movahedi et al., 2017; Rodil et al., 2016; Salomon, 2006; Salomon and Shaver, 2005) learning (Andersson and Lööf, 2009) and productivity (Andersson et al., 2008).

6.2. Findings Obtained by Geographically Weighted Regression (GWR) Analysis

Regression analyses are place-blind analyses that take into consideration the place is flat, which does not take the spatial differentiation into account. In other words, it is assumed that the models created according to the regression analysis will give the same results in each region. However, in the real world, the place is rough. In this sense, while regression analysis is defined as 'global' because of its blindness to differentiation of place, GWR analysis is sensitive to place. That is to say, and the GWR analysis reveals that the prediction results of the global regression analysis cannot have a similar effect in each region (Fotheringham et al., 2002; Longley et al., 2011, pp. 356-360). The following maps generated according to GWR analysis results show that the predictors in the global regression model are spatially differentiated.

The predictive variables (like RDPER and EXP) obtained by the global regression model are subjected to GWR analysis. The GWR results about these variables are shown in Figures 4 and 5. It is seen that the number of personnel working in R&D and design centers per person (it means human capital called RDPER), one of the predictors, does not have the same standard deviation everywhere, as shown in Figure 4. For instance, the effect of the human capital in the cities indicated by yellow on the dependent variable is close to the values in the global regression model. This shows that the human capital in the cities colored in yellow has close predictive power to that in the global regression. There are seen negative deviations in the prediction of innovation of human capital towards the blue colors and positive deviations towards the red colors. This indicates that the human capital's ability to predict innovation is moving away from the average in the blue and red provinces (Figure 4).

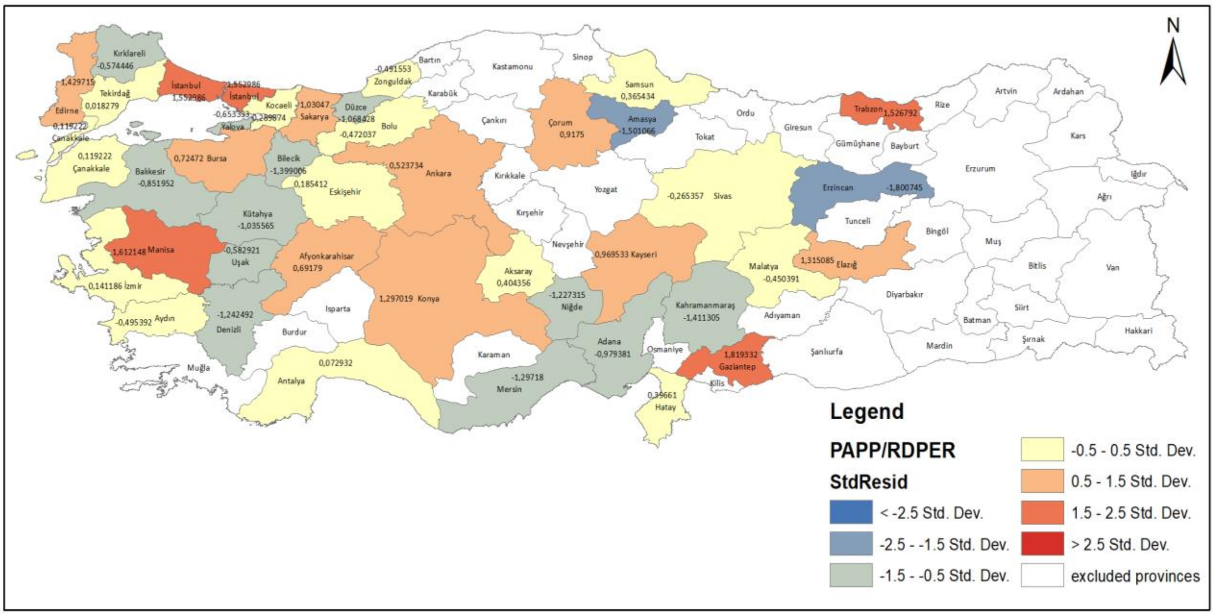

Figure 4. GWR map of spatial determinants of innovation. Dependent variable: INNOV; Independent variable: Number of personnel working in R&D and design centres (RDPER).

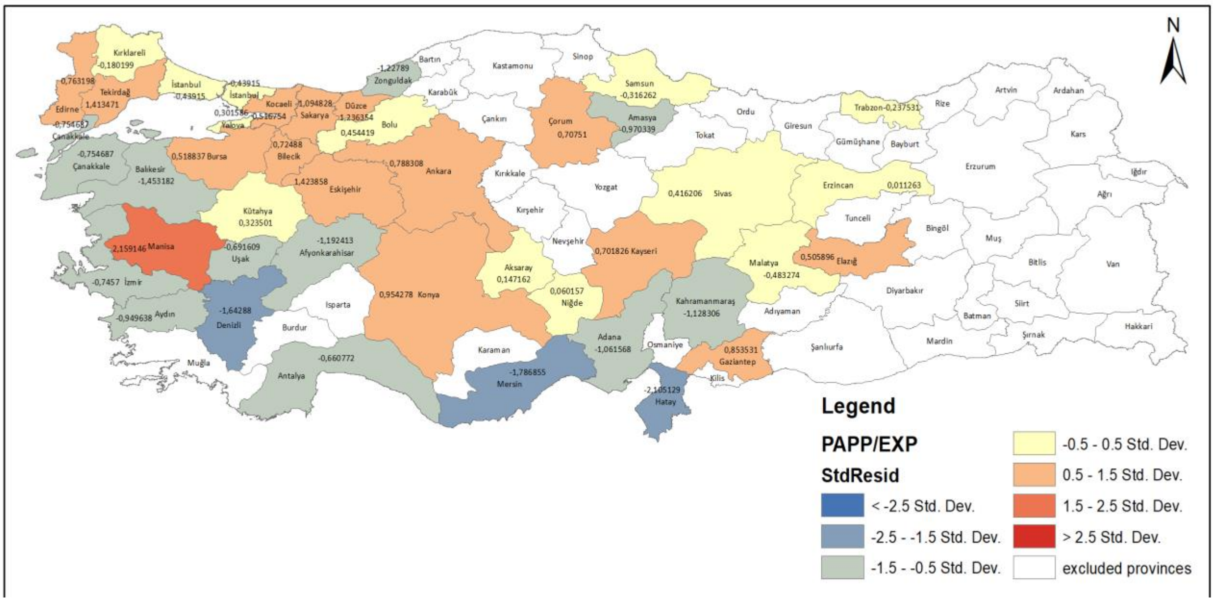

Figure 5. GWR map of spatial determinants of innovation. Dependent variable: (INNOV), Independent variable: Export per person (EXP).

Based on the GR model, another predictor variable that contributed to the increase in innovation was determined as export per person (EXP). As seen in Figure 5, the spatial response of this predictor also differs. While the EXP in yellow regions are an important variable that predict the innovation, the standard deviation of the variable gains positive or negative values from orange to red or from grey to blue and the predictability of this independent variable over innovation is becoming increasingly insignificant. GWR results show that the independent variables predicting innovation differ regionally.

7. Discussion and Conclusion

In this study, spatial determinants of innovation in Turkey are modeled statistically. As it is shown in Figure 3, the innovative regions of Turkey are concentrated. The concentration tendency of innovative regions is the same as other regional innovation studies in the literature (Crescezni et al., 2012; Goncalves and Almeida, 2009; Guerro and Sero, 2011; Lim, 2003; Quatraro, 2009; Tan et al., 2017). Knowledge spillovers have spilt from the innovation pioneers such as Istanbul, Ankara, and Izmir to the new industrial regions in the neighborhood thanks to the advantages of geographical proximity, and as a result, the innovation capabilities of these regions have increased rapidly in twenty years. This means the new innovative milieu has absorbed knowledge from its more innovative neighbours. The findings of the spillover effect are similar to those of Crescenzi and Jaax (2017). However, this does not mean that former industrial regions have lost their innovation capabilities. This finding contradicts the findings of Sun (2000) in China.

Although innovation is a development that is spreading throughout Turkey, it is also seen that the differentiation between regions is evident. As previously emphasized, the focus of this study is also to reveal the dynamics that create the differentiation. As a result of the regression analysis conducted on NUTS Level 3 to determine the factors affecting the distribution of innovation activities within the country. It is seen in the model resulting from the analysis that the number of personnel working in R&D and design centers per person (RDPER), which we can call it as human capital, and export per person (EXP), which we call it external source, is the determinant on the innovation activities in Turkey. When we evaluate both variables in their contexts, we encounter two different situations. Results showed that the influence of human capital in innovation activities in Turkey is efficient. This result shows that internal dynamics are important for innovation activity. The importance of human capital based on our findings is consistent with the following literature (Baycan et al., 2017; Crescenzi and Rodriquez-Pose, 2017; Sayili, 2020; Tan et al., 2017; Zemtsov et al., 2016). On the other hand, export’s impact on innovation activities can be related to external knowledge flows (Andersson and Johansson, 2008; Andersson and Lööf, 2009; Fassio, 2017; Lopez-Bazo and Motellon, 2018; Salomon and Shaver, 2005; Yang and Li, 2012). In fact, the global pipelines Bathelt et al. (2004) created by exports provide the formation of knowledge pathways.

The abovementioned studies about the spatial dynamics of innovation are presented in a generalist understanding, with no focus on regional uniqueness. To demonstrate this uniqueness, the GWR model, which has never been used before in innovation studies, was used. Using the GWR analysis to figure out the uniqueness of the determinant is a methodical innovation that this study adds to the innovation studies.

According to the GWR results in which the effect levels of the two parameters (the components of the model resulting from the regression analysis) for each region on NUTS Level 3 are analyzed, it is found that these two variables do not have the same level of effect on each region (Figures 4 and 5). According to the results of the GWR analyses, the spatial dynamics with the highest impact on innovation in Turkey are sequential as follows: The number of personnel employed in R&D and design centers per person and export per person. The effect of this variable on each region (province) is flexible.

As you will see in Figure 4, the human capital on innovation activities has not the same effect in each region. For instance, in the regions whose yellow colours, human capital (RDPER) is important, as the GR model, but in the other regions, the human capital does not have the same effect on innovation as the yellow ones. In the regions except for yellow ones, where the effect of human capital is found to be relatively small, on the innovation performance of the regions.

On the other hand, it has been seen in Figure 5 export per person (EXP) has not had the same effect on innovation, either. As a result, human capital and openness are important factors for innovation, but they do not have the same effect on innovation in every region. In order to understand why the factors affecting innovation do not have the same level of impact in each region, more focus is needed on the structure of each region.

As Barca et al. (2012) and Capello and Lenzi (2013) already stated, our empirical findings from GWR show the need to take into account place-based approaches. Because the same variables do not have the same effect on every region as we mentioned above.

These findings showing the distribution of innovation activities and the regionally differing factors that cause regional differentiations set this study apart from the other researches and serve as an original finding. Therefore, even within the same country, different spatial dynamics have been found to have an impact on innovation activities. It should be noted that these spatial dynamics are complementary to each other.

In conclusion, this study indicates that different spatial dynamics are effective on the innovation performance of the regions, mentions that these dynamics can differ from region to region even within the same country, and puts the emphasis on the fact that future studies to focus on the dynamics that provide spatial differentiation. The research also depicted an important image reflecting the urging the policymakers to take the local and regional dynamics into account in addition to their top-down policies on innovation. It can be said that the research has the qualities that can give policy ideas that will increase the efficiency of innovation-based policies in Turkey. To get a deep understanding of innovation and its spatial differences qualitative research should be the address for future research agenda.

Notes

1. Law on Supporting Research, Development and Design Activities, (see. Official Journal, Date: 12.03.2008; Law number: 5746; Issue: 26814).
2. Because patent registration, patent application and utility model data have very strong correlation to each other, we preferred just using the patent application data as a dependent variable, which is frequently used in the literature.
3. We think that imports may also be an external resource. However, it was excluded from the regression analysis because the import had a high correlation with export.
4. Turkish Patent and Trademark Office
5. The Union of Chambers and Commodity Exchanges of Turkey
6. Council of Higher Education.
7. Ministry of Industry and Technology

References

Acs, Z. J., Anselin, L., Varga, A. (2002). Patents and innovation counts as measures of regional production of new knowledge. *Research Policy*, 31(2002), 1069-1085. doi: 10.1016/S0048-7333(01)00184-6

Altuğ, F., Yılmaz, M. (2018). Farklı bilgi tabanlarına sahip sektörlerde yakınlık türlerinin bilgi, öğrenme ve yenilik/inovasyon süreçlerine etkisi: Eskişehir örneği. *Ankara Üniversitesi Dil ve Tarih-Coğrafya Fakültesi Dergisi*, 58(1), 844-881. doi: 10.33171/dtcfjournal.2018.58.1.40

Andersson, M., Lööf, H. (2009). Learning-by-exporting revisited: The role of intensity and persistence. *Scandinavian Journal of Economics*, 111(4), 893-916. https://www.jstor.org/stable/40587817

Andersson, M., Johansson, B. (2008). Innovation ideas and regional characteristics: product innovations and export entrepreneurship by firms in Swedish regions. *Growth and Change*, 39(2), 193-224. https://www.econbiz.de/Record/innovation-ideas-and-regional-characteristics-product-innovations-and-export-entrepreneurship-by-firms-in-swedish-regions-andersson-martin/10003713384

Andersson, M., Lööf, H., Johansson, S. (2008). Productivity and international trade: Firm level evidence from a small open economy. *Review of World Economics*, 144(4), 774-801. https://link.springer.com/article/10.1007/s10290-008-0169-5

Asheim, B. r. T. (1996). Industrial districts as 'learning regions': a condition for prosperity. *European Planning Studies*, 4(4), 379-400. doi: 10.1080/09654319608720354

Audretsch, D. B., Feldman, M. P. (1996). R&D spillovers and the geography of innovation and production. *The American Economic Review*, 86(3), 630-640. https://www.jstor.org/stable/2118216

Barca, F., McCann, P., Rodríguez-Pose, A. (2012). The case for regional development intervention: place-based versus place-neutral approaches. *Journal of Regional Science*, 52(1), 134-152. doi: 10.1111/j.1467-9787.2011.00756.x

Bathelt, H., Henn, S. (2014). The geographies of knowledge transfers over distance: toward a typology. *Environment and Planning A*, 46(6), 1403-1424. doi: 10.1068/a46115

Bathelt, H., Li, P.-F. (2013). Global cluster networks—foreign direct investment flows from Canada to China. *Journal of Economic Geography*, 14(1), 45-71. doi: 10.1093/jeg/lbt005

Bathelt, H., Malmberg, A., Maskell, P. (2004). Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation. *Progress in Human Geography*, 28(1), 31-56. doi: 10.1191/0309132504ph469oa

Bathelt, H., Schuldt, N. (2008). Between luminaires and meat grinders: International trade fairs as temporary clusters. *Regional Studies*, 42(6), 853-868.

Baycan, T., Nijkamp, P., Stough, R. (2017). Spatial Spillovers Revisited: Innovation, Human Capital and Local Dynamics. *International Journal of Urban and Regional Research*, 41(6), 962-975. doi: 10.1111/1468-2427.12557

Boschma, R. (2005). Proximity and innovation: a critical assessment. *Regional Studies*, 39(1), 61-74. doi: 10.1080/0034340052000320887

Boschma, R., Martin, R. (2010). The aims and scope of evolutionary economic geography. https://ideas.repec.org/p/egu/wpaper/1001.html

Bougrain, F., Haudeville, B. (2002). Innovation, collaboration and SMEs internal research capacities. *Research Policy*, 31(5), 735-747. doi: 10.1016/S0048-7333(01)00144-5

Buesa, M., Heijs, J., Baumert, T. (2010). The determinants of regional innovation in Europe: A combined factorial and regression knowledge production function approach. *Research Policy*, 39(6), 722-735. https://ideas.repec.org/a/eee/respol/v39y2010i6p722-735.html

Cantner, U., Meder, A., Ter Wal, A. L. (2010). Innovator networks and regional knowledge base. Technovation, 30(9-10), 496-507.

Capello, R. (2017). Towards a new conceptualization of innovation in space: territorial patterns of innovation. *International Journal of Urban and Regional Research*, 41(6), 976-996. doi: 10.1111/1468-2427.12556

Capello, R., Lenzi, C. (2013). Territorial patterns of innovation: a taxonomy of innovative regions in Europe. *The Annals of Regional Science*, 51(1), 119-154. doi:10.1007/S00168-012-0539-8

Capello, R., Varga, A. (2013). Knowledge creation and knowledge diffusion in space and regional innovation performance: introductory remarks. *The Annals of Regional Science*, 51(1), 113-118. https://link.springer.com/article/10.1007/s00168-013-0569-x

Clark, W. A. E., Hosking, P. L. (1986). Statistical Methods for Geographers. New York: John Wiley and Sons.

https://www.wiley.com/en-us/Statistical+Methods+for+Geographers-p-9780471818076

Cooke, P., Morgan, K. (1994). Growth regions under duress: renewal strategies in Baden-Württemberg and Emilia Romagna. Globalization, institutions, and regional development in Europe, 91-117.

Cornish, S. (1997). Product innovation and the spatial dynamics of market intelligence: Does proximity to markets matter? *Economic Geography*, 73(2), 143-165. doi: 10.1111/j.1944-8287.1997.tb00065.x

Crescenzi, R., Jaax, A. (2017). Innovation in Russia: The Territorial Dimension. *Economic Geography*, 93(1), 66-88. doi: 10.1080/00130095.2016.1208532

Crescenzi, R., Rodríguez-Pose, A. (2017). The Geography of Innovation in China and India. *International Journal of Urban and Regional Research*, 41(6), 1010-1027. doi:10.1111/1468-2427.12554

Crescenzi, R., Rodríguez-Pose, A. (2013). R & D, Socio-Economic Conditions, and Regional Innovation in the U. S. Growth and Change, 44(2), 287-320. doi: 10.1111/grow.12011

Crescenzi, R., Rodríguez-Pose, A., Storper, M. (2007). The territorial dynamics of innovation: a Europe–United States comparative analysis. *Journal of Economic Geography*, 7(6), 673-709. doi: 10.1093/jeg/lbm030

Crescenzi, R., Pose, A., R., Storper, M. (2012). The Territorial Dynamics of Innovation in China and India. *Journal of Economic Geography*, 12, 1055-1085. https://www.jstor.org/stable/26158632

Dicken, P., Kelly, P. F., Olds, K., Wai-Chung Yeung, H. (2001). Chains and networks, territories and scales: towards a relational framework for analysing the global economy. *Global Networks*, 1(2), 89-112. doi: 10.1111/1471-0374.00007

Dorfman, N. S. (1983). Route 128: the development of a regional high technology economy. *Research Policy*, 12(6), 299-316. doi: 10.1016/0048-7333(83)90009-4

Eceral, T. Ö. (2016). Türk Savunma Sanayinin Küresel ve Yerel Dinamikleri: Ankara ve Eskişehir Bölgelerinde Mekânsal Yığılma, Üretim Organizasyonu, Bilgi Ağları ve Yönetişim. Retrieved from Ankara: https://trdizin.gov.tr/publication/projectDetail.xhtml

Eceral, T. Ö. (2017). Türk Savunma ve Havacılık Sanayisinin Küresel, Ulusal ve Yerel Dinamikleri: Ankara Örneği. *Gazi Akademik Bakış*, 11(21), 87-106. doi: 10.19060/gav.379581

Elçi, Ş., Karataylı, İ., Karaata, S. (2008). Bölgesel İnovasyon Merkezleri: Türkiye İçin Bir Model Önerisi. TUSİAD Yayınları.

Eraydın, A. (2002). Yeni sanayi odakları: Yerel kalkınmanın yeniden kavramlaştırılması. Ankara: ODTÜ Mimarlık Fakültesi.

Erciş, A., Ünalan, M. (2016). Innovation: A comparative case study of Turkey and South Korea. *Procedia-Social and Behavioral Sciences*, 235, 701-708. doi: 10.1016/j.sbspro.2016.11.071

Faggian, A. (2005). Human Capital. In R. Caves (Ed.), Encyclopaedia of the city. New York, NY.: Routledge.

Fassio, C. (2017). Export-led innovation: the role of export destinations. *Industrial and Corporate Change*, 27(1), 149-171. doi: 10.1093/icc/dtx028

Feldman, M. P., Florida, R. (1994). The geographic sources of innovation: technological infrastructure and product innovation in the United States. *Annals of the Association of American Geographers*, 84(2), 210-229. doi: 10.1111/j.1467-8306.1994.tb01735.x

Fischer, M. M., Scherngell, T., Jansenberger, E. (2009). Geographic localisation of knowledge spillovers: evidence from high-tech patent citations in Europe. *The Annals of Regional Science*, 43(4), 839. doi:10.1007/s00168-009-0300-0

Florida, R. L., Kenney, M. (1988). Venture capital, high technology and regional development. *Regional Studies*, 22(1), 33-48. doi: 10.1080/00343408812331344750

Fosfuri, A., Rønde, T. (2004). High-tech clusters, technology spillovers, and trade secret laws. *International Journal of Industrial Organization*, 22(1), 45-65. http://www.sciencedirect.com/science/article/pii/S0167-7187(03)00123-1

Fotheringham, A. S., Brunsdon, C., Charlton, M. (2002). Geographically weighted regression: The analysis of spatially varying relationships. Hoboken: John Wiley and Sons, Ltd. https://www.worldcat.org/title/geographically-weighted-regression-the-analysis-of-spatially-varying-relationships/oclc/51520402

Giuliani, E. (2011). Role of technological gatekeepers in the growth of industrial clusters: Evidence from Chile. *Regional Studies*, 45(10), 1329-1348. doi: 10.1080/00343404.2011.619973

Goncalves, E., Almeida, E. (2009). Innovation and Spatial Knowledge Spillovers: Evidence from Brazilian Patent Data. *Regional Studies*, 43(4), 513-528. doi: 10.1080/00343400701874131

Gordon, I. R., McCann, P. (2005). Innovation, agglomeration, and regional development. *Journal of Economic Geography*, 5(5), 523-543. doi: 10.1093/jeg/lbh072

Griliches, Z. (1998). Patent statistics as economic indicators: a survey. In R&D and productivity: the econometric evidence (pp. 287-343): University of Chicago Press.

Guerro, D., C., Sero, M., A. (2011). Spatial Distribution of Patents in Spain: Determining Factors and Consequences on Regional Development. *Regional Studies*, 31(4), 381-390. doi: 10.1080/00343409750132982

Hansen, N. (1990). Innovative regional milieux, small firms, and regional development: Evidence from Mediterranean France. *The Annals of Regional Science*, 24(2), 107-123. https://ideas.repec.org/a/spr/anresc/v24y1990i2p107-23.html

Harris, R. I. D. (1988). Technological change and regional development in the UK: evidence from the SPRU database on innovations. *Regional Studies*, 22(5), 361-374. doi: 10.1080/00343408812331345050

Henn, S. (2012). Transnational entrepreneurs, global pipelines and shifting production patterns. The example of the Palanpuris in the diamond sector. *Geoforum*, 43(3), 497-506. doi: 10.1016/j.geoforum.2011.10.009

Hu, T. S. (2008). Interaction among high-tech talent and its impact on innovation performance: A comparison of Taiwanese science parks at different stages of development. *European Planning Studies*, 16(2), 163-187. doi: 10.1080/09654310701814462

Humphrey, J., Schmitz, H. (2002). How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies*, 36(9), 1017-1027. doi: 10.1080/0034340022000022198

Iqbal, M. J., Rasli, A., Heng, L. H., Ali, M. B. B., Hassan, I., Jolaee, A. (2011). Academic staff knowledge sharing intentions and university innovation capability. *African Journal of Business Management*, 5(27), 11051-11059. doi: 10.5897/AJBM11.576

Işık, N., Efe Can, K. (2011). Bölgesel Kalkınma'da Ar-Ge ve İnovasyonun Önemi: Karşılaştırmalı Bir Analiz. *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 6(2). https://dergipark.org.tr/tr/download/article-file/65513

Jung, S., Imm, K.-Y. (2002). The patent activities of Korea and Taiwan: a comparative case study of patent statistics. *World Patent Information*, 24(4), 303-311. doi: 10.1016/S0172-2190(02)00069-8

Kanama, D., Nishikawa, K. (2017). Does an extrinsic reward for R & D employees enhance innovation outcomes? Evidence from a J apanese innovation survey. *R&D Management*, 47(2), 198-211. doi: 10.1111/radm.12165

Kaygalak, I., Reid, N. (2016). Innovation and knowledge spillovers in Turkey: The role of geographic and organizational proximity. *Regional Science Policy & Practice*, 8(1-2), 45-60. doi: 10.1111/rsp3.12072

Kebir, L., Peyrache-Gadeau, V., Crevoisier, O., Costa, P. (2017). Introduction: Sustainability, innovative milieus and territorial development. In L. Kebir, O. Crevoisier, P. Costa, & V. Peyrache-Gadeau (Eds.), *Sustainable Innovation and Regional Development* (pp. 1-24): Edward Elgar Publishing.

Keeble, D. (1997). Small firms, innovation and regional development in Britain in the 1990s. *Regional Studies*, 31(3), 281-293. doi: 10.1080/00343409750134692

Keeble, D., Wilkinson, F. (1999). Collective learning and knowledge development in the evolution of regional clusters of high technology SMEs in Europe. *Regional Studies*, 33(4), 295-303. doi: 10.1080/00343409950081167

Krugman, P. (1991). Geography and trade. Cambridge, MA: MIT Press. https://mitpress.mit.edu/books/geography-and-trade

Kuştepeli, Y., Balkir, C., Akgüngör, S., Gülcan, Y., Beyzatlar, M. A., Kalaycıoğlu, Ş. G. (2013). Turkish-German economic relations via foreign direct investment and patents. *Journal of Entrepreneurship and Innovation Management*, 1(2), 23-50. https://dergipark.org.tr/en/pub/jeim/issue/52617/692665

Küçüksille, E. (2017). Çoklu Doğrusal Regresyon Modeli. In E. Kalaycı (Ed.), SPSS Uygulamalı Çok Değişkenli İstatitik Teknikleri (pp. 237-254). Ankara: Dinamik Akademi.

Larsen, H. B. (2014). Governance, quality conventions, and product innovation in a value chain: the case of the Spanish salted fish market. *Growth and Change*. 45(3), 412-429. doi: 10.1111/grow.12052

Lim, U. (2003). The Spatial Distribution of Inovative Activitiy in U.S. Metropolitan Areas: Evidence from Patent Data. *The Journal of Regional Analysis & Policy*, 33(2), 97-126. https://jrap.scholasticahq.com/article/9388

Liu, F., Sun, Y. (2009). A Comparison of the Spatial Distribution of Innovative Activities in China and the U.S. *Technological forecasting & Social Change*, 76, 797-805. doi: 10.1016/j.techfore.2008.12.002

Longley, P. A., Goodchild, M. F., Maguire, D. J., Rhind, D. W. (2011). Geographic information systems and science. Hoboken: John Wiley & Sons.

López-Bazo, E., Motellón, E. (2018). Firm exports, innovation and the regional dimension in Spain. *Regional Studies*, 52(4), 490-502. doi: 10.1080/00343404.2017.1332406

Makkonen, T. (2012). Geography of innovation in Europe and Finland: Empirical studies on innovation indicators and regional development. (Dissertation). University of Helsinki Department of Geosciences and Geography, Retrieved from http://urn.fi/URN:ISBN:978-952-10- 8298-6

Malmberg, A., Maskell, P. (2002). The elusive concept of localization economies: towards a knowledge-based theory of spatial clustering. *Environment and Planning A: Economy and Space*, 34(3), 429-449. doi: 10.1068/a3457

Martin, C., Granados, C., M., Sanz, I. (2005). Spatial Distribution of R&D Expenditure and Patent Aplications Across EU Regions and Its Impact on Economic Cohesion. *Investigaciones Regionales*, 6, 41-61.

Maskell, P. (2001). Towards a knowledge-based theory of the geographical cluster. *Industrial and Corporate Change*, 10(4), 921-943. doi: 10.1093/icc/10.4.921

Maskell, P., Bathelt, H., Malmberg, A. (2006). Building global knowledge pipelines: The role of temporary clusters. *European Planning Studies,* 14(8), 997-1013. doi: 10.1080/09654310600852332

Maskell, P., Malmberg, A. (1999). Localised learning and industrial competitiveness. *Cambridge Journal of Economics*, 23(2), 167-185. https://www.jstor.org/stable/23599582

Meir, A. (1981). Innovation diffusion and regional economic development: The spatial diffusion of automobiles in Ohio. *Regional Studies*, 15(2), 111-122. doi: 10.1080/09595238100185131

Miguelez, E., Moreno, R. (2018). Relatedness, external linkages and regional innovation in Europe. *Regional Studies*, 52(5), 688-701. doi: 10.1080/00343404.2017.1360478

Morgan, K. (1997). The Learning Region: Institutions, Innovation and Regional Renewal AU - Morgan, Kevin. *Regional Studies,* 31(5), 491-503. doi:10.1080/00343409750132289

Morgan, K., Cooke, P. (1998). The associational economy: firms, regions, and innovation.

Moulaert, F., Sekia, F. (2003). Territorial innovation models: a critical survey. *Regional Studies,* 37(3), 289-302. doi: 10.1080/0034340032000065442

Movahedi, M., Shahbazi, K., Gaussens, O. (2017). Innovation and willingness to export: Is there an effect of conscious self-selection? *Economics: The Open-Access, Open-Assessment E-Journal,* 11(2017-25), 1-22. doi: 10.5018/economics-ejournal.ja.2017-25

Müller, P., Franz, M. (2019). Transnational labour migration and the offshoring of knowledge-intensive business services within global production networks: The case of a German automotive company in Turkey. *Environment and Planning A: Economy and Space,* 51(6), 1350-1369. doi: 10.1177/0308518X18811353

Nazari, F., Anaraki, A. R., Taghavi, S. S., Ghasemi, B. (2020). The relationship among knowledge-based dynamic process capabilities, innovation processes and innovation performance: an empirical study of knowledge-based high-tech companies in Iran. Kybernetes. doi: 10.1108/K-03-2020-0147

Oakey, R. (1984). Innovation and regional growth in small high technology firms: evidence from Britain and the USA. *Regional Studies*, 18(3), 237-251. doi: 10.1080/09595238400185231

Oakey, R., Thwaites, A., Nash, P. (1982). Technological change and regional development: some evidence on regional variations in product and process innovation. *Environment and Planning A,* 14(8), 1073-1086. doi: 10.1068/a141073

OECD. (2011). OECD Directorate for Science, Technology and Industry Economic Analysis and Statistics Division. In ISIC Rev. 3 Technology Intensity Definition: OECD.

OECD. (2018). Gross domestic spending on R&D. Retrieved from https://data.oecd.org/rd/gross-domestic-spending-on-r-d.htm

Oslo-Kılavuzu. (2006). Yenilik verilerinin toplanması ve yorumlanması için ilkeler. çev. TÜBİTAK. https://www.worldcat.org/title/oslo-klavuzu-yenilik-verilerinin-toplanmas-ve-yorumlanmas-icin-ilkeler/oclc/66899435

Özdamar, K. (2009). Paket Programlar İle İstatistiksel Veri Analizi. Kaan Kitabevi, Eskişehir. https://www.kitapyurdu.com/kitap/paket-programlar-ile-istatistiksel-veri-analizi-1/72412.html

Piergiovanni, R., Santarelli, E. (2001). Patents and the geographic localization of R&D spillovers in French manufacturing. *Regional Studies,* 35(8), 697-702. doi: 10.1080/00343400120101434

Porter, M. E. (1990). The competitive advantage of nations. New York: Free Press. https://hbr.org/1990/03/the-competitive-advantage-of-nations

Quatraro, F. (2009). Diffusion of Regional Innovation Capabilities: Evidence from Italian Patent Data. *Regional Studies,* 43(10), 1333-1348. doi: 10.1080/00343400802195162

Reiffenstein, T. (2009). Specialization, Centralization, and the Distribution of Patent Intermediaries in the USA and Japan. *Regional Studies,* 43(4), 571-588. doi: 10.1080/00343400701874255

Rinallo, D., Golfetto, F. (2011). Exploring the knowledge strategies of temporary cluster organizers: A longitudinal study of the EU fabric industry trade shows (1986–2006). *Economic Geography*, 87(4), 453-476. doi: 10.1111/j.1944-8287.2011.01127.x

Rodil, Ó., Vence, X., del Carmen Sánchez, M. (2016). The relationship between innovation and export behaviour: The case of Galician firms. *Technological Forecasting and Social Change*, 113, 248-265. doi: 10.1016/j.techfore.2015.09.002

Rodríguez-Pose, A., Crescenzi, R. (2008). Research and development, spillovers, innovation systems, and the genesis of regional growth in Europe. *Regional Studies*, 42(1), 51-67. doi: 10.1080/00343400701654186

Salomon, R. M. (2006). Spillovers to foreign market participants: assessing the impact of export strategies on innovative productivity. *Strategic Organization*, 4(2), 135-164.

Salomon, R. M., Shaver, J. M. (2005). Learning by exporting: New insights from examining firm innovation. *Journal of Economics & Management Strategy*, 14(2), 431-460. doi:10.1111/j.1530-9134.2005.00047.x

Saxenian, A. (1983). The genesis of silicon valley. *Built Environment* (1978-), 7-17.

Saxenian, A. (1985). Silicon Valley and Route 128: regional prototypes or historic exceptions. *Urban Affairs Annual Reviews*, 28, 81-105.

Saxenian, A. (1989). The Cheshire cat's grin: innovation, regional development and the Cambridge case. *Economy and Society*, 18(4), 448-477. doi: 10.1080/03085148900000022

Saxenian, A. (1990). Regional networks and the resurgence of Silicon Valley. *California Management Review*, 33(1), 89-112. doi: 10.2307/41166640

Sayili, K. (2020). Retaining skilled employees: A human capital model with innovation and entrepreneurship. *Managerial and Decision Economics*, 41(6), 911-923. doi: 10.1002/mde.3147

Smith, N., Thomas, E. (2017). Regional conditions and innovation in Russia: the impact of foreign direct investment and absorptive capacity. *Regional Studies*, 51(9), 1412-1428. doi: 10.1080/00343404.2016.1164307

Storper, M., Scott, A. (1988). The Geographical Foundations and Social Regulation of Flexible Production Complexes. In W. J. and D. M. (Eds.), The Power of Geography. London: Allen & Unwin. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315819457-8/geographical-foundations-social-regulation-flexible-production-complexes-michael-storper-allen-scott

Sun, Y. (2000). Spatial Distribution of Patents in China. *Regional Studies,* 35(5), 441-454. doi: 10.1080/00343400050058693

Şahinli, M. A., Kılınç, E. (2013). İnovasyon ve inovasyon göstergeleri: AB ülkeleri ve Türkiye Karşılaştırması. *Sosyal Ekonomik Araştırmalar Dergisi,* 13(25), 329-356. https://atif.sobiad.com/index.jsp?modul=makale-goruntule&id=AWWPqWszHDbCZb_mQuJm

Tan, D., Cheng, C., Lei, M., Zhao, Y. (2017). Spatial Distributions and Determinants of Regional Innovation in China: Evidence from Chinese Metropolitan Data. *Emerging Markets Finance and Trade*, 53(6), 1442-1454. doi: 10.1080/1540496X.2017.1283215

Torre, A., Rallet, A. (2005). Proximity and localization. *Regional Studies,* 39(1), 47-59. doi: 10.1080/0034340052000320842

Seyfettinoğlu, Ü. K., Arık, Ş., Çağatay, S. (2020). Determinants of Industry and Region Based Open Innovation in Turkey. *Istanbul Business Research*, 49(1), 1-35. doi: 10.26650/ibr.2020.49.0029

Xie, X. M., Zeng, S. X., Tam, C. M. (2011). Towards continuous innovation for regional high-tech industrial clusters. *Innovation*, 13(3), 361-375. doi: 10.5172/impp.2011.13.3.361

Yang, C. H., Lin, H. L. (2012). Openness, absorptive capacity, and regional innovation in China. *Environment and Planning A*, 44(2), 333-355. doi:10.1068/a44182

Yokura, Y., Matsubara, H., Sternberg, R. (2013). R&D networks and regional innovation: a social network analysis of joint research projects in J apan. *Area,* 45(4), 493-503. doi: 10.1111/area.12055

Zemtsov, S., Muradov, A., Wade, I., Barinova, V. (2016). Determinants of Regional Innovation in Russia: Are People or Capital More Important? *Foresight and STI Governance,* 10(2), 29-42. doi: 10.17323/1995-459X.2016.2.29.42