Research Article GU J Sci, Part B, 9(1): 43-59 (2021)

Gazi University

Journal of Science

PART B: ART, HUMANITIES, DESIGN AND PLANNING

http://dergipark.gov.tr/gujsb

What is The Role of Techno-Parks on Regional Innovation in Turkey?

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Article Info

Received: 28/07/20
Accepted: 27/03/21

Keywords

Regional Innovation
Techno-Parks
Patent Statistics
Turkey

Abstract

Techno-parks/science parks took their place in many developing countries' agenda with the successful performances that developed countries put forth. Techno-parks that have initially emerged as a result of university-industry cooperation encourage R&D firms to be located close to the university, to contribute to knowledge production, develop centers of technology and knowledge spill-over and support national and regional economic growth. Since 2001, techno-parks in Turkey have been founded initially in industrialized cities with well-established universities and the potential of human capital. While the numbers of techno-parks have increased in Turkey, the roles and efficiency of the increasing number of techno-parks that also have the goal of regional innovation and development is a subject of debate. This paper aims to discuss the role of techno-parks on regional innovation in Turkey. Therefore, the innovation performance of regions is analyzed related to techno-parks as a base of geographically localized networks and cooperation with the universities, and other endogenous characteristics by two multiple regression models. Results mainly point out the significance of agglomeration economies along with the role of structural changes in the manufacturing industry, leading firms and performance of the universities on innovation performance of regions.

1. INTRODUCTION

According to Schumpeter, growth would occur throughout the changes and inventions on production, consumption, and behaviour of entrepreneurship. The neo-Schumpeterian perspective points out that innovation is an outcome of the commodification of new knowledge [1]. It is known that the outcomes of technological innovation are very much related to the attempts of capital to increase its profits within the capitalist process. In the new economic system, firms have to develop new products to be more competitive and productive, while economic development has to be seen as a process of qualitative change driven by innovation [2], [3], Meanwhile, investments in research and development as a cumulative process of existing knowledge stock have been essential for innovation [4]. The competitiveness of the firms would directly affect the regional competitive advantage due to innovation. Most of the studies examining the relationship between innovation and regional dynamics at both macro and micro levels have used patent data. As the study of Pakes and Griliches [5] points out, there is a strong relationship between research and development and the number of patents across firms and industries. Nooteboom and Stam [6] identified empirical measures of innovation, whereas patents, publications, licences sold, trademarks, prototypes are taken as output. Therefore, patents have long been significant indicators of economic analysis [7], [8], [9], [10], [11], while the study of Jaffe [12] - on academic research emphasizes that knowledge spillovers are facilitated by the geographic coincidence of university and research labs within the states of the US. Furthermore, patents have been used by economic historians to study regional patterns of economic growth and agglomeration, [13]. Therefore, the importance of space for innovation has become one of the most interesting research topics [14]. According to Simmie [15], local agglomeration economies are still

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important; city size provides assets that are required by innovative firms. O'Huallachain [16] found that the largest metropolitan areas in the US were the most innovative, although rank-size relationships vary by region. The study of Qi and Lui [17] indicates that education, foreign capital, the concentration of physical and human capital, international networks and institutional supports have a positive impact on the innovation performance of regions in China using patent data. Porter and Stern [18] point out that national knowledge stock and the R&D sector employment induced the innovation capacity in 17 OECD countries during the 20 years. Moreover, most of the studies from different geographies prove that especially R&D activities and incentives induce the number of patents [10], [19], [20], [21], [22], [23]. Kaygalak and Reid [24] indicate that spatial and organizational proximity among the firms enhances the innovation capacity of different geographies and sectors in Turkey using the patent data.

In the 1990s, the National Innovation System took place and innovation was identified as a process of interactions and networking among all components considering the proximities, path dependency and capacity within the system [25], [26], [27]

Since innovation is not linear, rather it is a dynamic and complex system, and geographically localized, the new approach with the concept of a regional innovation system has become significant. It is expected that RIS should be conducted regarding the regional characteristics and needs, contrary to a national innovation system. Asheim and Gertler [28], identify RIS as the culture of networking considering the role of local actors. As stated by Cooke [29], and Löfsten et al. [30], the existence of human capital stock and entrepreneurship is determinant in the formation of networks in the regional innovation system. The importance of localized networks and cooperation for innovation has mostly been related to the success story of Silicon Valley. Saxenian [31], explains that innovation was a must for firm competitiveness, while a dynamic innovation system should require cooperation among firms and other related actors. Cooke [29] identifies a regional innovation system with five key concepts: the concept of the region as a meso political unit, the concept of innovation as the process of new knowledge, the concept of network, learning, and interactions. It is known that RIS not only concentrates on firms and factor conditions but more on localized public-private networks [32]. Furthermore Rodríguez -Pose and Hardy [33] emphasize the distinctive features of regions that accumulate knowledge, while they highlight the importance of understanding territorial innovation systems and the nature of local economic development.

Regional aspects of innovation could be realized as converging the experiences of clusters regarding the benefits of agglomeration economies and a regional innovation system as localized networks. Technology clusters have been identified as clusters that include the sectors/firms that are research-based and their knowledge as the main outcomes. The triple helix approach is grounded on the idea that innovation is the outcome of an interactive process involving different spheres of actors such as public and private sectors and universities. Meanwhile, the role of universities in the new economy has been evolving beyond knowledge production and providing human capital to the entrepreneurial university that supports the start-ups [34]. Although as Florax [35] points to the role of universities as engines of growth, it is not uniformly confirmed by empirical studies. Several studies indicate a significant and positive effect of the presence of universities on the location of high-tech production, new start-ups and R&D facilities [36], [37]. On the other hand, it is stated that R&D investments are significantly based on existing knowledge and path dependency [38]. Furthermore, Grasmik [39] pointed out that even within the same region, the cooperation and intensity of networking with business differ according to the role and performance of universities.

However, techno-parks (science parks) are mostly regarded as key elements of the research-based regional development policy. The success stories of the developed countries are not always valid for other countries and regions, especially regarding the role of entrepreneurial universities. Castells and Hall [40] point out that there have been three main motivations for the establishment of techno-parks: reindustrialization, regional development, and the creation of synergies. Existing knowledge stock, engagement in the innovation of the firms, entrepreneurial mission of the universities and supports for start-ups, national and regional innovation policies for cooperation among the actors are the determinants of innovation [28], [40], [41], [42], [43].

However, spatial proximity matters for innovation, as a debate, has been going on about to what extent [44], [45], [46], [47], [48] it matters. The study on thirty-five techno-parks in the UK, Westhead and Storey [49] denotes that firms would be more competitive if there is a strong relationship with the university, and the firms in the techno-parks have more opportunity to do that. In the case of the Western Australian Technology Park, Phillimore [50] points out that the role of techno-parks is significant especially for the technology-based small firms. Bakouros et al. [51] emphasize that science parks in Greece have not been established by pioneering universities, but with government support, and initial investments have been solely made by the government. The study of Albahari et al [52], focus on the heterogeneity of twenty-five science and technology parks in Spain, while they consider that techno-parks provide a supportive environment for new knowledge-based firms.

Techno-parks have been formed as a home for co-location of firms and the research institutions, and their interactions, having the advantages of spatial proximities. Although there have been several studies on innovation using the patent data or analyzing the performance of techno-parks, studies looking at the role of techno-parks on innovation performance of the regions have been limited. Therefore, this paper aims to examine what are the factors that affect the innovation capacity of the regions (provinces) in Turkey, as mainly looking for the impact of techno-parks (as one of the important tools in Turkey since 2001) in addition to the other determinants of local characteristics.

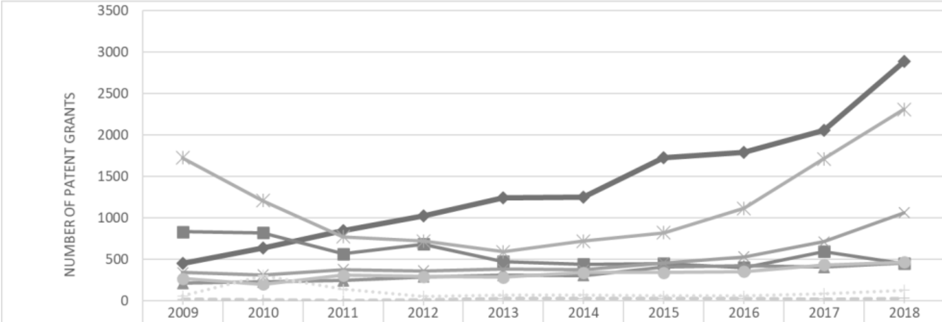
2. FACTS AND FIGURES: INNOVATION POLICIES AND TECHNO-PARKS IN TURKEY

National innovation capacities and policies play a dominant role in the adaptation of countries to the global system, competitiveness and the production of new technologies today. Castells and Hall [40] refer to the role of states at the beginning of the "information age" by forming innovation politics, strategies and pioneering institutions. In this context, national innovation systems have become an important part of science and technology policies.

Regional potentials related to key innovation actors as well as national policies and strategies are also important. Actors such as firms and networks, R&D institutions and supportive institutions shape "national innovation capacities" in the process. One of the key innovation indicators used to measure national innovation capacities and cross-country comparisons is patents. More than 84% of all patent applications in 2019 occurred in the offices of China, the U.S., Japan, the Republic of Korea and the European Patent Office while China accounted for more than 40% of the world total [53]. Turkey ranks (49th) on the Global Innovation Index 2019, while the number of patents is lagging [54]. Özkaya [89] states in his study covering the data between 2001-2013 that Turkey is behind the developed countries with its annual patent activity which remained below 100 patents. While the Turkish economy has been growing rapidly within the post-2000 era, the dynamics and content of this growth have been one of the main interests for the researchers. An increase in value-added production and structural change is expected. Although low-technology sectors are still the main employment generators in the manufacturing sector, there has been an increasing trend in the medium-low and medium-high-technology sectors, especially in exports[1].

Furthermore, the increase in the importance given to regional capacities and institutions for innovation systems in the 1990s have also provided positive outcomes after the 2000s. The increasing trend of patent numbers as the main indicator for innovation supports the contribution of policies in development. Furthermore, Turkey is also one of the countries with an increasing trend in the number of patents per years, in newly industrialized countries (NICs).

[1] Eurostat classification [55] on high-technology, medium high-technology, medium low-technology and low-technology economic activities of the manufacturing industry is given in the appendix.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Turkey	456	642	847	1025	1244	1251	1730	1794	2055	2887
South Africa	833	822	567	685	474	445	453	403	595	451
Mexico	213	229	245	290	312	305	410	423	407	457
Brazil	341	314	380	365	385	374	460	533	714	1066
India	1725	1208	776	722	594	720	822	1115	1712	2311
Malaysia	270	200	310	295	288	344	344	355	437	469
Philippines	22	13	6	11	30	27	30	27	25	33
Thiland	59	306	143	57	68	73	62	61	88	128

Figure 1. *Number of Patents of Newly Industrialized Countries (NICs)[2], 2009-2018 (Source: [56], [57]).*

The state's role in the emergence of Turkey's innovation policies has been shaped within the historical context of economic growth. Throughout this process, TÜBİTAK (1963), YÖK and ÜAK (1980) and TÜBA3 (1993) were the principal national actors to direct National Innovation Policies. These institutions especially support innovation activities at the regional level by encouraging cooperation between universities and industry. In 1983, the "Supreme Council for Science and Technology (BYTK)" was established. Today, it is the supreme institution that leads the national innovation system. In the post-1990s' development policies, the focus shifted to R&D, innovation and technology. The first organization were established in 1992 in relation to "TEKMER" the Middle East Technical University and transformed into Turkey's first techno-park in 2000. Science and technology development projects were prepared as *Vision 2003* and *Vision 2023* under the coordination of BYTK in the 2000s (Fig. 2). In parallel to the development goals of the country, "*motivation of local resources, regional development and support of research and development institutions*" are among the strategies of these projects. In this context, support has also been important for establishing R&D centers for the private sector on a sectoral basis. In this period, the MAR-TEK techno-park was established as a research center affiliated with TÜBİTAK. Science and technology strategies implemented in Turkey, play a significant role in the formation of *techno-parks*, R&D activities, knowledge spillovers, new products/services - similar to international practice.

The first cases of the techno-parks were established in the 2000s in the cities/regions where industrial production, high-rank universities and human capital are concentrated. The total number of techno-parks in 2005 was 28 within 13 provinces, and the number increased to 64 within 44 provinces in 2016, also 86 within 55 provinces in 2020 [58]. The maps (Fig. 3) indicate that there has been a similar pattern when the performance of techno-parks, the performance of universities and a concentration of medium-high technology employment are considered. Ankara, Istanbul and Izmir as the main metropolitan cities in Turkey have many public and private universities, research institutes and organizations having the highest values for entrepreneurial university indices. Patents, universities and medium-high technology industry relatively concentrated in the west and developed provinces. Although techno-parks have shown a relatively more dispersed pattern with establishing new techno-parks, there has still been a concentrated pattern regarding the performance of techno-parks.

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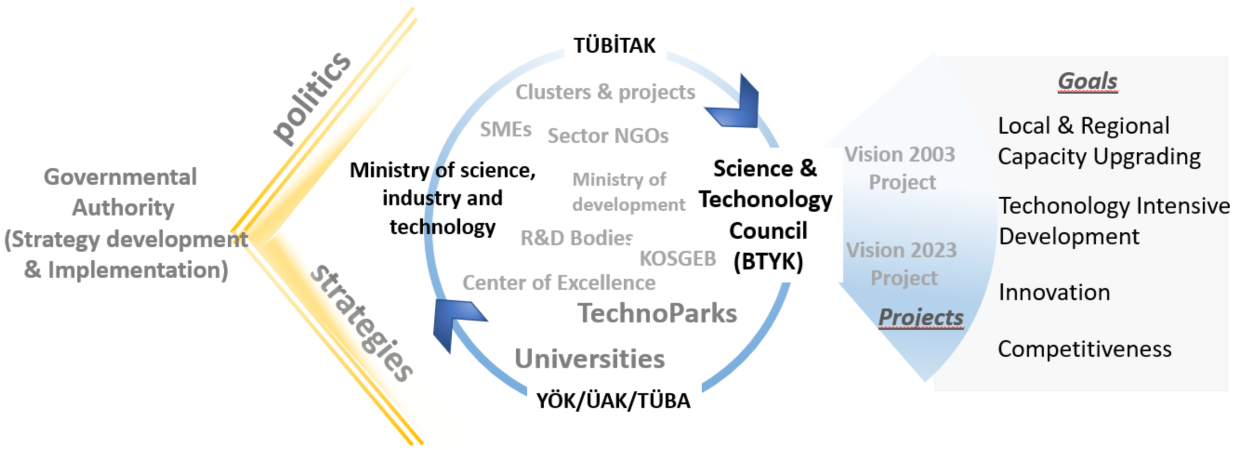
[2] Patent data of China and Indonesia which are Newly Development Countries (NICs) are not included in the figure because of the range of data.

[3] **TÜBİTAK:** The Scientific and Technological Research Council of Turkey, **YÖK:** Council of Higher Education, **ÜAK:** Council of Universities, **TÜBA:** Turkish Academy of Sciences,



MSIT: Ministry of Science, Industry and Technology, **TÜBİTAK:** The Scientific and Technological Research Council of Turkey, **YÖK:** Council of Higher Education, **ÜAK:** Council of Universities, **TÜBA:** Turkish Academy of Sciences, **TECHCEN:** Technology Center, **KOSGEB:** Small& Medium Enterprises Development Org.

Figure 2. *National Innovation System of Turkey (Source: Author's own).*

However, the patents indicate the dominance of three metropolitan cities and their neighbouring provinces (Fig. 3). These three metropolitan cities constitute 70% of the total number of patents in Turkey, while Istanbul having patent dominance with a rate of 53%. The patent dominance of the first three provinces at the national level remained in the same order between 2005-2016 when we just take into account the provinces which have techno-parks. On the other hand, Bursa and Eskişehir are the provinces that are positively shifting ranks. Both provinces have the advantages of being neighbour to the metropolitan cities and bases of the medium-high-tech manufacturing industry. Furthermore, Konya, Tekirdağ and Sakarya have appeared in the first 10 ranks due to the number of patents as being close to the metropolitan cities and the base of the manufacturing industry (Fig. 4). However, 15 of 28 provinces that have at least one techno-park, could take out less than 10 patents during the 10 years.

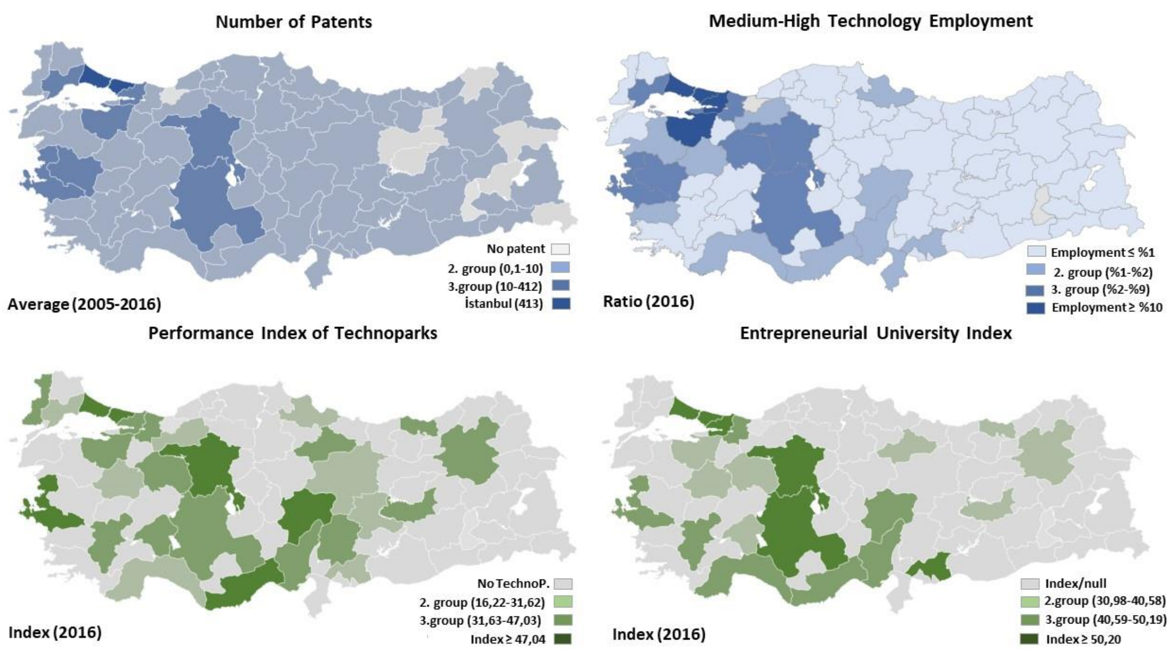


Figure 3. *Main indicators of regional innovation potentials (Source: Produced by the authors using data of TPO Statistics [57] and MSIT Statistics[58]).*

Numerous researches on the roles and activities of techno-parks, which are increasing in number in widespread geography, have been lacking in studies that consider local/regional characteristics. Turkish Science Policy documents and the post-2000s Development Plans have identified techno-parks as foreground tool to increase the share of R&D activities in the GNP. Meanwhile, the institutional structure has been reorganized to ensure technological progress and structural change in the industry, and knowledge production. Eyyüboğlu and Aktaş [59] indicate that techno-parks in Turkey are seen as a public policy tool for contributing to economic growth, especially in developing regions, and this situation brings together various opportunities and problems in terms of the performance of both techno-parks and the firms within techno-parks. Pekol and Erbaş [60] indicate that spatial proximity and co-operation with the university increase the production of innovation by examining the four techno-parks with the highest number of patents. Therefore, this paper is not only trying to explore the regional determinants of innovation, but also trying to explore the role of techno-parks and other regional determinants on innovation

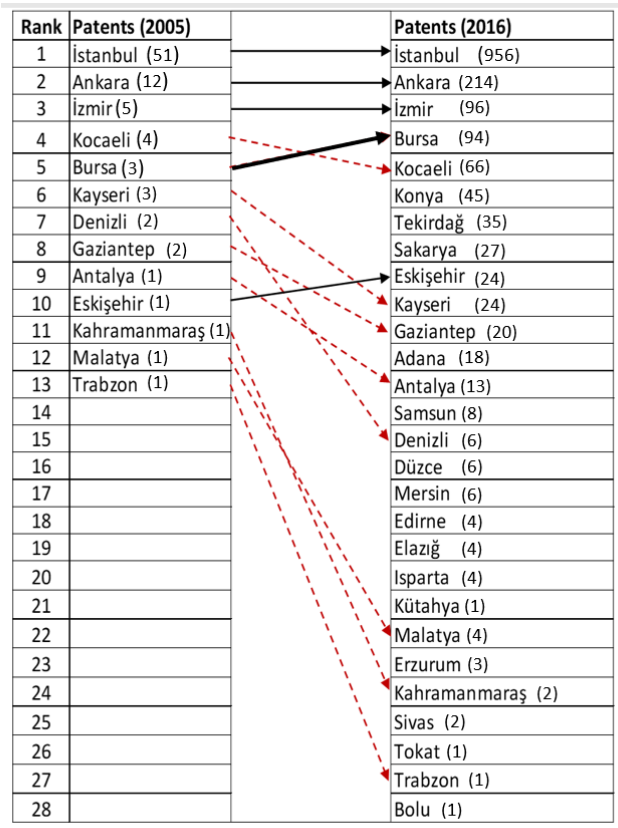


Figure 4. *Rank of the provinces due to the number of patent grants in Turkey (2005-2016)*[4] *(Source:[58]).*

3. METHODOLOGY AND DATA

The role of techno-parks on innovation, as a base of geographically localized networks and cooperation with the universities, is the main interest of this research. Concerning this, two different models are estimated. Since one of the main interests of research is to find out the role of techno-parks on innovation performance of the regions, the first model tests the role of techno-parks on innovation in all provinces (81 provinces) either have a techno-park or not. The second model only includes 28 provinces, which the Techno-park Performance Index is available by the Ministry of Science, Industry and Technology. Thus, cross-sectional analyses have been conducted by using data for 81 provinces based on the presence of techno-park and in the second stage for 28 provinces based on the performance of techno-park.

Patent data have been utilized as economic indicators, whereas Griliches [61] and Anselin et al. [37] identified patents as an output of the knowledge production function. Whereas Jaffe [62] focuses on

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[4] The rank is based on the provinces which have techno-parks in 2005 and 2016. However the number of technoparks is 64 within 44 provinces in 2016, Techno-park Performance Index (TPERIN) has been developed by the Ministry of Science, Industry and Technology, is only available for 28 provinces.

academic research, Griliches [7] points out that despite difficulties, patent statistics remain a unique resource for the analysis of the process of technological change. Since firms and industries vary in their technology regimes [63], the micro-level analysis would give more detailed information about the innovation process. However, regarding the difficulties to get the micro-data for innovation performance of regions in Turkey due to their endogenous local characteristics, this paper structured as displaying stylized facts.

However, since the patent data of Turkey is not normally distributed, the data of the utility model[5] have been decided to be taken into account as well, concerning the conceptual framework of the research. The rationale for using the utility model is the majority of small and medium-sized firms in the whole production of Turkey. Since the patent system does not cover minor or incremental innovations, the utility model is especially beneficial for developing countries with short term protection (10 years), and it provides a relatively cheaper and lower threshold for the inventive step. The study of WIPO [64] acknowledges that other intellectual property rights, in particular as utility models, industrial designs and trademarks may play a bigger role than patents in providing a competitive edge to SMEs. Beneito [65] states that patents and utility models represent significant and incremental innovations, respectively. Also, Brynjolfsson et al. [66] highlight the significance of the utility model as they not only contribute directly to final innovation but also, facilitate complementary innovations. Therefore, the dependent variable is identified as a combination of those two variables and mean values between 2005 and 2016 for each province to represent all inventions. Thus, the analysis prevents the instabilities which might occur during this period. Since the range of the data is big, logarithm transformation is applied.

Table 1. *Definition of variables.*

Dependent Variable	**Variables**	**Year**	**Source**
Innovation	**Combination of Patent and Utility Model**	2005-2016	Turkish Patent & Trademark Office
Independent Variables			
Human Capital **UNIAC**	Academic staff	2005-2016	Council of Higher Education
	University graduates	2005-2016	Council of Higher Education
Entrepreneurship **NFIRM**	New Firm-start ups	2009-2016	The Union of Chambers & Commodity Exchanges of Turkey
Firm Size **1000LARGE**	First 1000 large firms	2016	Istanbul Chamber of Industry
Agglomeration Economies **MHTEMP**	Medium-high technology employment	2016	Turkish Statistical Institute
Foreign Trade **IMEX**	Import/export	2005-2016	Turkish Statistical Institute
Techno-Parks **TPERIN**	Performance Index[6]	2016	Ministry of Science, Industry &Technology
Entrepreneur University **ENTUNI**	Entrepreneur University Index[7]	2016	The Scientific &Technological Research Council of Turkey

5 The utility model can be given for all products with technical improvement which may be subject to patents except chemical substances and methods provided that they are new products.
[6] Technopark Performance Index consist of 6 key indicators: (1)Financing, Incentives and Infrastructure; (2) R&D Activity; (3) Incubation Activity; (4) Cooperation Activity; (5) Intellectual property; (6) R&D Results and Internationalization.
[7] Entrepreneur University Index consist 19 indicators under 4 key indicators: (1) Scientific and Technological Research Competence; (2) Intellectual Property; (3) Economic Contribution and Commercialization; (4) Cooperation and Interaction

Although most of the studies from different geographies prove that especially R&D activities and incentives induce the number of patents, there is a data limitation on R&D expenditures and employees in Turkey. Therefore, considering the literature on knowledge production function and a regional innovation system, the exogenous variables are identified due to these data limitations.

Since one of the main interests of research is to find out the role of techno-parks on innovation performance of the regions, the Techno-park Performance Index (TPERIN) is utilized. 2016 Techno-park Performance index has been developed by the Ministry of Science, Technology and Industry (BTSB) based on different criteria[8,9]. For the provinces that have more than one techno-park, the value of the techno-park, which displays the highest performance has been taken into account. The performance of the techno-park is considered a proxy for mainly industrial R&D activities [37]. Also, the Entrepreneurial University Index (ENTUNI)[10] has been identified to examine the role of universities [67].

$$\log(inovvation) = \alpha + \beta_0 TPERIN + \beta_1 ENTUNI + \varepsilon_{i,t} \quad (1)$$

The variables for exogenous local characteristics are identified as follows:

The ratio of university graduates and academic staff (human capital - UNIAC) is considered as a proxy for human capital [1],[17] following the studies of O'Huallachain [16]. The ratio of medium-high tech employment within total employment (agglomeration economies - MHTEMP) and new firms/ start-ups (entrepreneurship - NFIRM) is identified as proxy to capture agglomeration economies [37],[68]. The number of the first 1000 large firms (firm size - 1000LARGE) is a proxy to access the effect of firm scale [37],[69]. The ratio of import and export (foreign trade – IMEX) has been identified as a proxy for external linkages of the regional production since empirical studies and theory have increasingly emphasized the importance of global networks [17].

$$\log(inovvation) = \alpha + \beta_0 TPERIN + \beta_1 ENTUNI + \beta_2 UNIAC + \beta_3 NFIRM + \beta_4 1000LARGE + \beta_5 MHTEMP + \beta_6 IMEX + \varepsilon_{i,t} \quad (2)$$

4. RESULTS OF THE ANALYSIS

Two models are conducted with the same variables, however, the number of observations as provinces is different. In the first model, observations are 81 provinces and the model examine which factors have a significant impact on the innovation performance of the regions. Multiple regression analysis is applied, and Model 1 is significant ($< a = 0.05$), with 75% explanatory power ($R^2 = 0.75$) which is very powerful and an acceptable rate for social sciences. No assumption violation exists.

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8 Technopark Performance Index consist of 6 key indicators: (1)Financing, Incentives and Infrastructure; (2) R&D Activity; (3) Incubation Activity; (4) Cooperation Activity; (5) Intellectual property; (6) R&D Results and Internationalization [58].

9 The most up-to-date data for the performance index can be accessed in 2018. Only a few techno-park started to operate from 2016 to 2018. Therefore, this will not cause a significant change in the results.

10 Entrepreneur University Index consist 19 indicators under 4 key indicators: (1) Scientific and Technological Research Competence; (2) Intellectual Property; (3) Economic Contribution and Commercialization; (4) Cooperation and Interaction [58].

Table 2. *Model Summary and ANOVA.*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,869[a]	0,755	0,731	0,34003

Anova (a)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	25,942	7	3,706	32,054	0,000[b]
	Residual	8,440	73	0,116		
	Total	34,382	80			

a: Dependent Variable:log(innovation)

Afterwards, stepwise regression is applied to find the most effective variables on the innovation performance of the regions. The stepwise method was preferred in this study because it also prevents the multicollinearity problem in the regression model. The regression model indicates how much the coefficients of the dependent variable will change when the independent variable increases by 1 unit. Accordingly, Table 3. showing the coefficients, the ratio of medium-high tech employment, techno-park performance, university performance and the first 1000 large firms are significant independent variables and have a positive effect on innovation in the regions. According to a standardized coefficient, the most effective variables are the first 1000 large firms, university performance, the ratio of medium- and high-tech employment and techno-park performance, respectively. Firm size has long been a significant indicator for studies on productivity or innovation. Ellison et al [70] argue the importance of firm size diversity with respect to agglomeration economies, while Agrawal et al [71] highlight that regional innovation would be enhanced with the complementarity between small and large firms. However, since Schumpeter, there has been a kind of consensus on the power of larger firms, that they have an advantage in innovation activities regarding the cost of R&D [72],[73],[74]. Furthermore, larger firms might have a leading role to access external knowledge [75],[76],[77]. On the other hand, the role of the structural changes in the manufacturing industry, and the agglomeration effects of medium-high technology industries make significant contributions to the innovation performance of the regions. Gezici et al. [78] put forward that high- and medium-high technology sectors are mainly concentrated in the western part of Turkey and prefer to locate where there is already an existing concentration of industrial activity. Thus, agglomeration economies are still very important, not only for productivity but innovation as well.

Meanwhile, the role of universities in the new economy has been evolving beyond knowledge production and providing human capital to the entrepreneurial university that supports the start-ups [34]. Collaboration between firms and university has become significant for accelerating the need for new knowledge to firms and financing for university research. Considering this collaboration among the co-located agents, techno-parks were initially conceived as innovation and competitiveness enhancing regional policy instrument [79]. The result of the analysis proves the positive impact of techno-parks and universities on the innovation performance of the regions. However, they should be taken into account concerning their distinctive features, not only due to the park management, size or age, but also their ecosystems and local/regional characteristics.

Table 3. *Regression results for log (innovation) in 81 provinces.*

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	0,528	0,053		9,922	0,000		
	ENTUNI	0,56	0,053	0,764	10,523	0,000	1	1
2	(Constant)	0,524	0,049		10,792	0,000		
	ENTUNI	0,426	0,058	0,582	7,301	0,000	0,691	1,448
	1000LARGE	0,005	0,001	0,327	4,098	0,000	0,691	1,448
3	(Constant)	0,395	0,052		7,623	0,000		
	ENTUNI	0,35	0,055	0,478	6,379	0,000	0,626	1,599
	1000LARGE	0,005	0,001	0,328	4,606	0,000	0,691	1,448
	MHTEMP	1,75	0,386	0,288	4,536	0,000	0,871	1,148
4	(Constant)	0,358	0,052		6,881	0,000		
	ENTUNI	0,209	0,076	0,285	2,761	0,007	0,307	3,262
	1000LARGE	0,005	0,001	0,317	4,597	0,000	0,688	1,454
	MHTEMP	1,709	0,372	0,281	4,591	0,000	0,869	1,15
	TPERIN	0,169	0,064	0,252	2,62	0,011	0,354	2,828

a: Dependent Variable:log(innovation)

The second model is applied to 28 provinces having techno-parks, which performance index is available, beyond the presence of techno-park. Model 2 is also significant (< a =0.05) as R^2 is 0.827 and the explanatory power is higher than the first model. No assumption violation exists.

Table 4. *Model Summary and ANOVA.*

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0,909[a]	0,827	0,767	0,34847

Anova (a)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11,623	7	1,660	13,674	,000[b]
	Residual	2,429	20	0,121		
	Total	14,052	27			

a: Dependent Variable:log(innovation)

The result of stepwise regression indicates that R^2 is 0.81 and the model is significant (< a =0.05). As shown in the coefficients table, the significant explanatory variables are the first 1000 large firms, university performance and the ratio of medium- and high-tech employment.

Table 5. *Regression results for log (innovation) in 28 provinces.*

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	0,650	0,156		4,18	0,000		
	ENTUNI	0,518	0,096	0,728	5,415	0,000	1,000	1,000
2	(Constant)	0,631	0,113		5,577	0,000		
	ENTUNI	0,396	0,074	0,556	5,354	0,000	0,886	1,128
	1000LARGE	0,006	0,001	0,511	4,918	0,000	0,886	1,128
3	(Constant)	0,487	0,116		4,183	0,000		
	ENTUNI	0,31	0,075	0,436	4,163	0,000	0,711	1,406
	1000LARGE	0,006	0,001	0,52	5,545	0,000	0,885	1,13
	MHTEMP	1,782	0,69	0,256	2,584	0,016	0,79	1,265

a. Dependent Variable: log(innovation)

The second model excludes the provinces that do not have techno-parks and also available performance index value. In this model, techno-parks (with their performance index value) do not indicate any significant impact on the innovation performance of regions. In the first model, their impacts are more clear, since all the provinces which have techno-park or not, are included in the model. Rather than techno-parks, other significant variables are the same as the first model, however, their impact levels are increasing. The findings prove the evidence from the earlier studies which emphasize the positive impact of dynamic manufacturing industry and performance of universities on regional innovation. Löfsten et al. [30] and Hommen et al. [80] emphasizes the importance of the entrepreneurial university in industry-university cooperation. Also, according to the study of Altuğ and Hocaoğlu [81] in the Aegean University Technology Development Zone in İzmir, the knowledge transfer channels established with the university, the cooperation among the firms and information networks contribute to the innovative production process. Furthermore, Westhead and Storey [81], in their research on 35 techno-parks in England, reveal that the probability of firms to survive in a competitive region is higher if they establish strong ties with the university. On the other hand, according to Hart [83], the developed technological infrastructure of the regions and the involvement of large industrial companies in the development of new technologies has seen as an advantage in terms of innovation systems. Once again, the results highlight that the large firms in Turkey play leading roles especially by the advantages of R&D expenditure and accessing to external knowledge.

5. CONCLUSION

In the new economic system, innovation has become an outcome of the commodification of knowledge. On the other hand, the role of techno-parks on innovation performance of the firms and also the regions have long been a research interest. From that point, the conceptual framework of this research is constructed to explore the determinants of innovation performance of the regions (provinces) in Turkey, especially considering the role of techno-parks. Techno-parks have been developed as important policy instruments with respect to the success of technological clusters, which are focused on not only the co-operations among the firms but other related actors, especially universities with their third mission as well.

In Turkey, techno-park has also become one of the significant policy tools regarding innovation and regional development. Therefore, the number of techno-parks has increased to 86 in 55 provinces, since

2001. However, it is known that increasing numbers of established techno-parks does not indicate specific improvements yet, since the performances vary across the country. Although techno-parks should provide an environment for knowledge and technology-based firms, we know that there is no consensus on the effectiveness of science/ techno-parks [52].

Considering the results of our analysis, the performance of the universities and having a dynamic manufacturing industry are the main determinants of innovation for regional success. Thus, this result indicates both the science and market push for innovation, while the strong linkage of firms to the market would increase the innovation capacity. According to our model, we did not get any significant impact of human capital on regional innovation performance, however, we consider that universities are the main institutions for skilled labour in their region. The provinces/regions that already have the advantages of agglomeration economies, especially for human capital, higher-technology manufacturing activities, business services and top rank universities would have more performance on innovation is not surprising. Furthermore, the case of Turkey highlighted the importance of structural changes in the manufacturing industry to increase regional innovation. Although the low-technology sectors are still the main employment generators in the manufacturing sector, especially exports in medium-low and medium-high-technology sectors have been increasing since the end of the 20th century [78], [84]. Also, policy suggestions of Kleiner-Schäfer and Liefer's study [85], which is conducted in the Turkey case, highlighted that newly created policies should support different incentive systems at the national and regional level for firms with different input factors and different technological capabilities.

We utilized the performance level of each techno-parks as an independent variable; however, we do not include the age of techno-parks which also may affect the results. Therefore, while the locations of techno-parks have indicated a relatively more dispersed pattern, it is certainly hard to evaluate the performance of techno-parks that are quite young and especially the ones that are located in lagging regions. However, Rodríguez -Pose and Hardy [33] point out that techno-parks would be instruments to provide local reference points to lagging regions, whereas Herves-Oliver and Albors-Garrigos [86] consider techno-parks as gatekeepers in lagging regions. So, it is especially important to see the outcomes of techno-park investments in relatively less- developed regions in Turkey, not only to trigger the innovation activities in those regions but also to assess the efficiency of the policy. Furthermore, expectations from the universities as institutions for research and technological progress, and the potential for spin-offs, should also be considered with respect to the university policy in Turkey. Moreover, it still needs to explore the ecosystems of techno-parks considering their heterogeneity. Mian and Hulsink [87] pointed out that knowledge ecosystems are far from being standardized, while Rodríguez -Pose and Hardy [33] and Moulaert and Sekia [88] emphasized the concept of territorial innovation systems and the nature of local development. Thus, further research should be conducted to explore the dynamics and ecosystems of techno-parks and endogenous local characteristics, which they are located, by considering varying systems of techno-parks in different locations.

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APPENDIX

Eurostatat classification [55] on high-tech, medium-high tech, medium-low tech and low-tech economic activities of the manufacturing industry according to technological intensity and based on NACE Rev. 2:

High-tech industry: Manufacture of basic pharmaceutical products and pharmaceutical preparations, computer, electronic and optical products, air and spacecraft and related machinery.

Medium-high tech industry: Manufacture of chemicals and chemical products, weapons and ammunition, electrical equipment, machinery and equipment n.e.c., motor vehicles, trailers and semi-trailers, other transport equipment excluding building of ships and boats and excluding manufacture of air and spacecraft and related machinery, medical and dental instruments and supplies.

Medium-low tech industry: Reproduction of recorded media, manufacture of coke and refined petroleum products, rubber and plastic products, other non-metallic mineral products, basic metals, fabricated metal products, except machinery and equipment excluding Manufacture of weapons and ammunition, building of ships and boats, repair and installation of machinery and equipment.

Low-tech industry: Manufacture of food products, beverages, tobacco products, textiles, wearing apparel, leather and related products, wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, paper and paper products, printing and reproduction of recorded media excluding Reproduction of recorded media, furniture, other manufacturing excluding Manufacture of medical and dental instruments and supplies.