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Innovation, Relatedness and Complexity in Turkey: A Regional Analysis for 1978-2017

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Abstract

The paper aims to explore innovations and smart specialization opportunities in Turkey's regions. Patent applications measure innovations. Relatedness density and regional complexity measure prospects for smart specialization. The data is from OECD RegPat data (January 2020) for the 1978 – 2017 period. Following the approach outlined in smart specialization literature, the paper demonstrates geographic distribution of patents, average relatedness density and complexity of Turkey's regions.

There are four main results of the paper. Firstly, patent applications in Turkey during the 1978-2017 period are mostly low-tech products. Secondly, regional distribution of patent applications and relatedness density is uneven. Thirdly, regional knowledge complexity index became uniform over time, indicating that creating unique regional positions became harder. Fourthly, the potential of regions for smart specialization is higher in west of Istanbul-Ankara-Adana axis.

JEL Codes: R10, R11, R58

Keywords: Relatedness, complexity, smart specialization, patents, Turkey.

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Türkiye'de Yenilik, İlişkililik ve Karmaşıklık: 1978-2017 için Bölgesel Bir Analiz

Öz

Bu makalenin amacı, Türkiye'de bölgesel yenilik ve akıllı uzmanlaşma fırsatlarını ortaya koymaktır. Yenilikler, patent başvuruları ile ölçülmüştür. Akıllı uzmanlaşma fırsatları ise, ilişki yoğunluğu ve bölgesel karmaşıklık değişkenleri ile ölçülmüştür. Veriler, 1978–2017 dönemi için OECD RegPat'den (Ocak 2020) alınmıştır. Çalışma, akıllı uzmanlaşma literatürü yaklaşımı çerçevesinde Türkiye bölgelerinde patent başvurularını, ilişki yoğunluğunu ve karmaşıklığını göstermektedir.

Makalede dört ana sonuca varılmaktadır. İlk olarak, 1978-2017 döneminde Türkiye'deki patent başvuruları çoğunlukla düşük teknolojili ürünlerdir. İkinci olarak, patent başvuruları ve ilişki yoğunluğu düzensiz bir bölgesel dağılım göstermektedir. Üçüncü olarak, bölgesel bilgi karmaşıklığı endeksi zamanla bölgeler arasında tek tip hale gelmiş ve rekabet eden bölgeler arasında özgün konumlar yaratmak zorlaşmıştır. Dördüncü olarak, bölgelerin akıllı uzmanlaşma potansiyeli İstanbul-Ankara-Adana ekseninin batısında daha yüksektir.

JEL Kodları: R10, R11, R58

Anahtar kelimeler: ilişkililik, karmaşıklık, akıllı uzmanlaşma, patentler, Türkiye

1. Introduction

The distribution of innovative activities is not equal in space (Dosi, 1988; Feldman, 1994). Innovation is a major driver of regional development where innovative capacity of the firms and policies that encourage innovative investments are key notions (Antonelli, 2003; Stehr, 2007; Pekkarinen & Harmaakorpi, 2006). Regional innovation systems with close links and networks are essential for regional competitiveness and development (Cooke, 2005a).

Geographical distribution of innovations and industrial districts as well as spatial innovation networks has been a topic of particular interest by the scholars working on innovative milieu (Camagni, 1991; Cooke and Morgan, 1994) and regional innovation systems (RIS) (Cooke et al., 1997). Place-based innovation strategies bring out the importance of the notion of creating clusters for high-value added and innovative investments that require intensive amount of cumulative knowledge (Widuto, 2019). Knowledge creation and use of knowledge is significant in enhancing the capabilities of the regions to create sustainable competitiveness. When creating regional capabilities, it is imperative to consider uniqueness of each region, as the regions possess dissimilar capabilities and knowledge bases (Asheim et al., 2011). There is heterogeneity of knowledge bases and distribution of innovative activities across the regions. Stehr (2007) points out that technological innovations happen in regions where the firms are able to create their own technologies, adopt new technologies or apply original ideas (innovation) for economic growth.

In addition to regional distribution of innovations, a vital question is whether the regions are flexible enough to create innovations and at the same time maintain their competitiveness concerning their technological competencies. Balland et al. (2019) demonstrates that two variables, relatedness and complexity, help us understand the regions' potential to attract new and related technologies and at the same time create a unique position among competing regions. Recent work on smart specialization and place based policy (Boschma, 2014) draws from the regional diversification literature (Hidalgo et al., 2018; Neffke et al., 2011), economic complexity literature (Hidalgo & Hausman, 2009) and smart specialization literature (Foray et al., 2009 and 2011).

Overall, the literature shows a significant relationship between regional innovations and regional economic development around the world as well as in Turkey (Adak, 2015; Yılmaz, 2019; Yavan, 2011; Şahin & Altuğ, 2017). Recent work on regional innovativeness in Turkey indicate that spatial and organizational proximity enhances regional innovation capacity (Kaygalak & Reid, 2016). Özkaya (2014) studies patent data for the 2001-2013 period and concludes that Turkey lags behind developed countries with its annual patent activity remaining below 100 patents. The studies point out that low technology sectors constitute majority in the manufacturing sector with growing trend towards medium-low and medium-high-technology sectors particularly in export products (Gezici et al., 2021).

Furthermore, Kaygalak (2013), in his study on clusters, contends that none of the identified clusters includes high-tech sectors. Kaygalak & Reid (2016) and Gezici et al. (2017) demonstrate that majority of sectoral agglomerations are in medium-low and medium-high technology sectors. Additionally, Çelik, Akgüngör & Kumral (2019) demonstrate that Turkey's industrial clusters include industries whose technologies do not demand high skills, knowledge and sophistication.

In relation to patents as an indicator of innovativeness, Özkaya (2014) points out that Turkey is among the newly industrialized countries (NICs) with increasing trend in the number of patent applications per year. Türkcan & Çelik (2020) further demonstrate uneven distribution of technological progress in manufacturing industry across Turkey's regions whereas Oğuz (2019) analyzes smart specialization capacities of the clusters based on innovation capacities, innovation outputs and openness and shows uneven distribution of regional capabilities for smart specialization.

Although the studies above focus on the regional spread of the technology level and innovations, there is little knowledge concerning how regional innovativeness in Turkey have evolved in the long run. There is also limited knowledge on how regions in Turkey have diversified over time into related technologies as well as how complexity of the regions has changed.

Understanding the evolution of patterns of innovative activities in regions is imperative in the design of smart specialization policies. It is also important to understand the regions' potential to attract new and related technologies that are comparable to their knowledge base. Relatedness shows potential for regions' branching opportunities into new and related technologies. Related technologies could be a source for creating and developing innovations. Similarly, complexity of knowledge indicates that regional capabilities are unique and hard to imitate in other regions, thus creating source of regional competitiveness.

There are two aims of the paper: The first aim is to map innovations in Turkey's regions for the 1978-2017 period using patent applications as an indicator of innovative activity. The second aim is to demonstrate developments of the regions' ability to attract innovations (relatedness) and regions' ability to stay unique in economic activities (complexity) for Turkey's regions for the 1978-2017 period.

2. Turkey's Regional Innovation Policies

Turkey's development plans (initiated in 1963) show changes regarding Turkey's regional policies (Lenger, 2008). Dulupcu & Govdere (2005) document regional economic policy elements of the plans. Until 1990s, the plans speak of "regional economic integration", "diffusion of economic development to regions", "focusing on population problems due to rapid urbanization", "removing regional differences", "development of some underdeveloped regions", "mobilization of resources for regional problems", "accelerating development by rationalizing resource allocation in less developed and potentially suitable regions". More recently, particularly after the 1990s, the plans shifted their emphasis to "overall consideration of social, administrative and financial dimensions for policy introduction", "the harmonization of regional statistics in accordance with international standards, especially with EU", "the integration of sectoral and spatial studies", "sectoral specialization of provinces", "city planning", "enhancing competitiveness". Recent plans emphasize "participatory planning", "sustainability", "more efficiency in resource allocation", and "adjustment to EU regional policy" as general principles. Recent plan (11th development plan) that covers the period of 2019 to 2023 focuses on R&D and innovation capabilities of the Turkish manufacturing industry and provides an innovation- based support structure (Kleiner-Schäfer & Liefner, 2021). Report on "National Strategy on Regional Development: 2014-2023" by Republic of Turkey Ministry of Development (currently Republic of Turkey, Presidency of Strategy and Budget) emphasizes importance of smart specialization strategies for regional development (T.C. Kalkınma Bakanlığı, 2014)

Regional development policies in Turkey started in the early years of the Turkish Republic, and most were centrally planned (Lagendijk et al., 2009). Especially in the first half of the young republic's life, development efforts were within the control of the government where State Planning Organization (SPO) was the institution in charge. The centralized mindset started to change with Turkey's candidacy to the European Union (Lagendijk et al., 2009). The policies started to decentralize with recognition that regional governance is important to help development efforts reach even the most remote areas of the country. In the beginning of 2000s, 26 Regional Development Agencies across Turkey's NUTS2 regions started to be active in regional development policies and projects. In 2011, the duties of the "State Planning Organization" were transferred to the "Republic of Turkey Ministry of Development" and then to the "Office of Strategy and Budget".

Supreme Council of Science and Technology (SCST) is the main body for science and technology policy in Turkey. Scientific and Technical Research Council (TUBITAK) is the secretariat of the SCST. TÜBİTAK's responsibility is to implement Turkey's science and technology policies as the major funding agency. Other actors that are active in research and technology policies are the Turkish Academy of Sciences (TÜBA), the Council of Higher Education (YÖK) and the Interuniversity Board (ÜK). The Technology Fund of Turkey (TTGV) operates as a funding agency for industrial research as well as seed capital provision, loans and grants (European Commission, 2006).

3. Smart Specialization Policies in Turkey

As the smart specialization policies began to unfold as successful outcomes for discovering innovation potentials and making the most efficient use out of the capabilities of regions towards production of knowledge, many other regions in the periphery of the EU started to integrate smart specialization policies into their innovation frameworks. To this end, initial steps started to emerge towards deepening cooperation for smart specialization policies between the EU and many Enlargement and Neighborhood countries, including Turkey (Gómez Prieto et al., 2019). Turkey is one of the associate countries of the Horizon 2020 program and a participant to the Horizon Europe program. Being able to take active part in the European research programs is a significant opportunity for Turkey in relation to its alignment with EU smart specialization strategies (European Commission, 2017; European Commission, 2021).

Turkey's national support system for smart specialization bases its principles on Turkey's 2003-2023 Strategy Document (TUBITAK, 2004). Since then, 10 agencies/regions among 26 developed their regional innovation strategies based on smart specialization (Şahin & Ertürk, 2021). Regional development agencies started to work on principles of smart specialization strategies (Kumral & Güçlü, 2018). Additionally, there are 10 Universities with a defined mission of regional development and specialization under the program initiated by Council of Higher Education (YÖK) in Turkey (Akgüngör, Kuştepeli & Gülcan, 2021).

TUBITAK in its 2010 report on "National Science, Technology and Innovation Strategy 2011-2016" emphasizes the importance of a triple helix cooperation model for accelerating technological sophistication in Turkey's regions. The plan introduced establishment of technology transfer centers (TTO) in universities and initiated entrepreneurial university concept. Republic of Turkey Ministry of Industry and Technology in 2015 prepared an action plan to establish an infrastructure for Public-University partnership. Technology Transfer Accelerator (TTA) as an initiative of European Investment Fund (EIF) provides support to university industry collaboration in Turkey and managed by the Ministry of Industry and Technology (Technology Transfer Accelerator, 2021).

At the heart of the smart specialization policies is the idea of creating "clusters" by enabling cooperation between regions with similar expertise (Foray & Ark, 2007). Therefore, clusters are building blocks of the smart specialization concept (Hassing & Gong, 2019). There are studies on industry clusters in Turkey with a general focus on smart specialization with an emphasis on technological composition of clusters (Çelik, Akgüngör & Kumral, 2019) as well as innovation capacities, innovation outputs and openness of clusters (Oğuz, 2019). Moreover, OECD (2013) suggests Turkey's East Marmara region as an example of an automotive cluster with smart specialization potential concerning its production volume, employment creation, and number of manufacturer and supplier companies. The region's close interaction with free zones, techno-parks, research institutions, public institutions and Organized Industrial Zones are significant indicators of its integrity as a cluster. Another area suitable for the implementation of the smart specialization policies and creation of clusters in Turkey is the agro-food industry. For example, Middle Black Sea Region of Turkey takes part in agro-food thematic partnerships of the EU's S3P Agro-food platform (Stancova & Cavicchi, 2017).

Nevertheless, as stated above, few studies exist in Turkey in which smart specialization concepts such as technological relatedness and complexity are included. For example, Lo Turco & Maggioni (2017) study technological relatedness and proximity of firms and conclude that firms with high technological relatedness to foreign firms have higher potential to engage in knowledge production. Kuştepeli, Gülcan & Akgüngör (2013) confirm that related variety is a major driver of economic growth in Turkish regions. Furthermore, Akgüngör, Kuştepeli & Gülcan (2021) study smart specialization potential of İzmir by exploring technological relatedness and complexity of industrial activities in İzmir by using patent data (OECD Regpat database) and demonstrate that food chemistry, biotechnology and environmental technology are potential industries as good candidates for smart specialization in Izmir. Abay & Akgüngör (2021) display Turkey's knowledge space and demonstrate high number of patent applications in electrical engineering with strong network ties across electrical engineering field with other technology fields, such as mechanical engineering, instruments and other fields. Abay & Akgüngör (2021) further demonstrate that there is considerable heterogeneity across the cities in relation to patent applications and regions' relatedness density has a positive impact on regional innovativeness as measured by patent applications. However, there is a need for further knowledge that systematically presents the regional distribution of patents and regional relatedness and complexity over time. In order to provide better understanding of Turkey's regional smart specialization opportunities and the evolution of smart specialization opportunities over time, this study aims to demonstrate the profile of patents as well as relatedness and complexity since 1978. The paper is descriptive in nature and aims to provide background knowledge for the design of Turkey's smart specialization policies.

The following section demonstrates the conceptual framework on smart specialization based on the work by Balland et al., (2019) with roots from regional diversification literature (Hidalgo et al., 2018; Neffke et al., 2011) and economic complexity literature (Hidalgo & Hausmann, 2009). The argument is that key concepts of spatial policies are relatedness and knowledge complexity (Boschma, 2014). The theory is consistent with the view that regional advantage depends on the conditions on the use of regions' core knowledge and competencies.

4. Conceptual Framework

4.1. Regional Innovativeness

Innovations relate closely with regional competitive advantage and patents are good proxies for innovation capabilities (Griliches, 1990; Jaffe et al., 1993). Patents are compatible with other measures of innovation (Hagedoorn & Cloodt, 2003) and are reliable measures of innovative activity (Acs, Anselin & Varga, 2002; Guerrero & Sero, 1997; Narin et al., 1987). The paper follows the concept that activities related to technological innovations are key (Stoehr, 1988), application of original ideas (innovation) for economic growth are closely correlated with patenting activities where patents are significant indicators of innovations (Griliches, 1998; Siegel, Westhead & Wright, 2003; Ejermo, 2009; Buerger, et.al., 2012).

A commonly used measure to explore the distribution of innovations across regions is regional dispersion of patents (Basberg, 1987). Patents are good indicators of technological progressiveness as they encourage the promotion and spread of innovations across regions (Breschi & Malerba, 1997; Encaoua et al., 2006). Kroll (2015) states that regional innovation systems have four structural features with possibility of analysis through patent analysis. The first is the level of general technological activity, the second is the role of the state and private sector in patenting, the third is technological specialization and sectoral focus, and the fourth is the outward orientation. In his study, he examined whether the increasing patent applications were the true reflection of technological development and found that most of the technological inventions of the regions were politically encouraged. Evidence on significant relationship between GDP growth and patenting is presented in literature (see, for example, Carvalho, Beijo & Salgado (2020), Raghupathi & Raghupathi (2017)) as well as relationship of patents and regional development (Guerrero & Sero, 2010). Ginarte & Park (1997) further argue that countries greatly benefit from strong protection of patent rights.

4.2. Smart specialization: Relatedness and Complexity

A stream of literature with a special emphasis on innovations is smart specialization. Smart specialization builds upon the idea that it will be more beneficial for a country or region to invest in research areas that are complementary to its existing capabilities rather than allocating their resources to a broad range of unrelated fields. Therefore, an efficient innovation strategy should aim to increase regions' expertise around a specific scientific field by encouraging research activities in areas related to their yielding competencies (Foray & Van Ark, 2007; Foray et al., 2009).

Shortly after its development, the concept of smart specialization became the basis of the EU's innovation policies. In fact, the primary objective of the smart specialization - smart, sustainable and inclusive growth- are well integrated into the EU's "EU 2020

Agenda". For the application of these objectives, a platform of Services, European Commission established the platform on "Research and Innovation Strategies for Smart Specialization" (RIS3) (Foray et al., 2011; OECD, 2013).

The smart specialization framework draws from regional innovation systems (RIS) literature (Freeman, 1995; Cooke et al., 1997) and learning regions literature (Morgan, 1997; Lundvall & Johnson, 1994). In regional innovation system approach, Cooke, 2005b) points out that innovation is the process of new knowledge through means of networks, learning, and interactions. Cooke (1994) defines RIS as, "RIS is what determines the effectiveness and the efficiency of regional knowledge building/ transfer among the different integrating parts of the system, including individual firms, sectoral/value-chain clusters business consultants, technology centers, R&D centers, University departments, laboratories, technology transfer and utilization of R&D centers, development agencies."

Recently, Löfsten et al. (2020) highlight the significance of human capital and entrepreneurship within the networks of the regional innovation system. In another stream of literature of regional innovation, Kleiner-Schäfer & Liefner (2021) mention the significance of firm-level attributes (Ernst & Kim, 2002; Henderson & Clark, 1990; Malecki, 1991; Zeschky et al., 2011). Control of internal capabilities of the firms are important to increase their absorptive capacities (Lin et al., 2002).

Boschma (2014) proposes that relatedness concept corresponds to the idea that knowledge creation is the combination of existing ideas. Foundations of knowledge and innovation are re-construction of the components of core ideas and therefore an evolutionary process. Frenken & Boschma (2007) further argue that diversification of the economic activities is a branching process and the emergence of new technologies is not random and rather depend on past knowledge. Innovations and new technologies come from existing set of capabilities (Boschma, 2017).

In addition to the significance of relatedness for branching opportunities, regions tend to have competitive advantage when the technologies are unique and hard to copy. What is highly valuable for sustainable regional growth is the ability to create knowledge that tends to be complex. Knowledge complexity resulting from valuable and tacit knowledge is difficult to imitate and access by others (Hidalgo & Hausmann, 2009). Balland & Rigby (2017) demonstrate that complexity correlates with the long run patterns of economic performance and innovativeness where regions develop based on their existing knowledge cores.

5. Data and Methods

5.1. Data

To identify technological fields and compute measures of relatedness and knowledge complexity, we use OECD-REGPAT database January 2020 Edition. OECD-REGPAT contains patent data for regions with information on addresses of the applicants and inventors. Regional patent data covers more than 5500 regions across OECD countries. In this study, we use patent data for the years 1978-2017.[1] We cleaned and grouped the data according to World Intellectual Property Organization (WIPO) technology classification "New concept of technology classification, update May 2008" (Schmoch, 2008). According to May 2008 classification, IPC codes form 5 technology classes and 35 sub-technology classes. We use the latest version (July 2019) of WIPO IPC-Technology Concordance Table to group IPC codes of the patents into WIPO technology classes.

5.2. Methods

5.2.1. Measuring relatedness

We measure *relatedness* using the method following Boschma et al. (2015) and Rigby (2015). The method counts the number of patent claims for a given period that contains a co-class pair of technologies, i and j. The method then standardizes this count by the total number of patents that contain i and j. Relatedness between technologies i and j (φ_{ij}) is a standardized measure of the frequency with which two IPC classes appear on the same patent. This paper follows the method outlined in Balland et al. (2019). We use Balland (2017) EconGeo R package.

We demonstrate relatedness across space by the knowledge structure of Turkey's NUTS3 regions. Following the method demonstrated in Balland et al. (2019) and use of EconGeo R package, we calculate the density of technology production near individual technologies i for each NUTS3 region (r) in Turkey. Relatedness density operationalizes the relatedness of the regions.

As specified in Balland et al. (2019), the relatedness density of industry i, in region r at time t is presented below:

$$RD_{i,r,t} = \frac{\sum_{j \epsilon r, j \neq i} \varphi_{ij}}{\sum_{j \neq i} \varphi_{ij}} * 100$$

$RD_{i,r,t}$ is the relatedness density of technology i to all other technologies j where the region r has relative technological advantage (RTA) at time t. φ_{ij} is technological relatedness of technology i with technology j. RTA is a binary variable that takes the value 1 when the region has higher share of patents in technology i in comparison to the share of patents in technology i in the country; and 0 otherwise (similar to the notion of location quotient).

Relatedness density is therefore the technological relatedness of technology i to all other technologies j in which the region has relative technological advantage (RTA),

[1] 2017 was the latest complete data available for Turkey in the OECD REGPAT database during the time of data download (OECD, REGPAT database, January 2020)

divided by the sum of the technological relatedness of technology i to all other technologies in Turkey at time t.

We use *average relatedness density* variable to measure regions' potential for branching into new and related technologies. Average relatedness density of regions represents technological flexibility (the structure of the knowledge base) of the regions as demonstrated in Balland, Rigby & Boschma (2015) with calculation procedures outlined in EconGeo Package (Balland, 2017). Average relatedness density (technological flexibility) represents the average relatedness of the technologies present in the region to all technological classes that are not yet in the city. Using average relatedness density variable, we are able to develop a variable that measures regions' branching opportunities and potential to diversify into new and related technologies in Turkey's NUTS3 regions.

5.2.2. Measuring complexity

Complexity measures the quality of the knowledge created in the region. Knowledge is valuable if it is difficult to replicate outside the geography. Knowledge that is tacit and sticky in the field is a source for competitive advantage in regions.

This paper follows the method proposed by Hidalgo & Hausman (2009) and further developed by Balland et al. (2019). The method connects the regions to technologies in which they have RTA. The complexity is determined by the range and ubiquity of the technologies that the regions use. The variable that measures complexity of knowledge in regions is knowledge complexity index (KCI).

KCI has two components. Diversity is the number of technology classes in which the region (r) has relative technological advantage. Ubiquity is the number of regions that exhibit revealed technological advantage in a given technology (Balland & Rigby, 2017).

$$\text{Diversity} = K_{r,0} = \sum_i M_{r,i}$$

Where $M_{r,i}$ is a binary variable that represents whether the region r has RTA in the production of technology i.

$$\text{Ubiquity} = K_{i,0} = \sum_r M_{r,i}$$

Where $M_{r,i}$ is a binary variable that represents the number of regions with RTA in the production of technology i.

The KCI combines the information obtained from the diversity and ubiquity variables following the iterations outlined in Hidalgo & Hausmann (2009). The method includes sequentially combining the diversity of regions and ubiquity of technological classes and simultaneously computes the following 2 equations over a series of n iterations:

$$\text{KCI(regions)} = K_{r,n} = \frac{1}{K_{r,0}} \sum_i M_{r,i} K_{i,n-1}$$

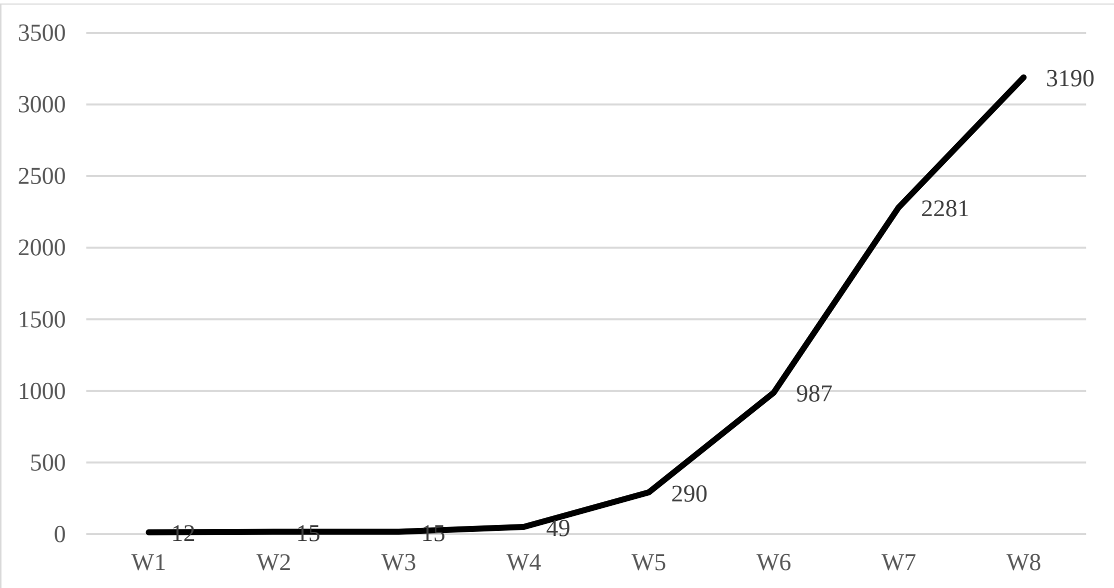
$$\text{KCI (technologies)} = K_{i,n} = \frac{1}{K_{i,0}} \sum_i M_{r,i} K_{r,n-1}$$

6. Findings

The findings section first demonstrates Turkey’s total number patent applications and distribution of patent applications according to WIPO classes.[2] We then present the distribution and growth of patent applications across Turkey’s NUTS2 regions. Third, the paper demonstrates distribution of regions according to their ability to produce and use tacit knowledge that is difficult to replicate outside the geography (knowledge complexity). The paper then continues to demonstrate the regions’ ability to show technological flexibility (average relatedness density) and observe whether the regions are able to attract new technologies that are not part of their regional portfolio and diversify into related economic activities.

The findings contain eight 5-year period intervals (windows: W) during the 1978-2017 period (W1 through W8).[3]

Figure 1: Total number of patent applications (1978-2017)



Note: W1: 1978-1982: W2: 1983-1987; W3: 1988-1992; W4: 1993-1997; W5: 1998-2002; W6: 2003-2007; W7: 2008-2012; W8: 2013-2017

[2] Note that the patent application data is from OECD, REGPAT database, January 2020.
[3] W1: 1978-1982: W2: 1983-1987; W3: 1988-1992; W4: 1993-1997; W5: 1998-2002; W6: 2003-2007; W7: 2008-2012; W8: 2013-2017

Source: Authors' own calculations from OECD, 2020.

6.1. Patent applications:

The number of patent applications indicates the size and strength of the technology market in the country (Uzun, 2001). Figure 1 demonstrates that over the 1978-2017 period, there has been an increase in total number of patent applications in Turkey. While the number of total patent applications was 12 during the 1978-1982 period (W1), the patent applications increased to over 3100 in 2013-2017 period (W8).

The increase in number of patent applications is particularly faster after W4 (1993-1997) period and onwards). This increase corresponds to the period during and after which State Planning Organization (SPO) and TUBITAK prepared the first published document on innovation policies "Science Policy of Turkey: 1983-2003" (Turkish Science Policy: 1983–2003 (in Turkish), T.C. Devlet Bakanligi, Ankara, 1983.). After the document, the Supreme Council for Science and Technology (SCST) evolved as a new institution with a mission to oversee the science and technology policies in Turkey. Mid-1990s is a turning point for the science and technology policies in Turkey with a shift from "building a national research & development infrastructure" to "innovation-oriented national policies" (Uzun, 2001). Furthermore, policy papers such as, 'Science and Technology Human Resource Strategy and Action Plan (2011-2016)'[4] developed by 'The Supreme Council for Science and Technology' (SCST) with the coordination of the Ministry of Science, Industry and Technology, the Scientific and Research Council of Turkey (TUBITAK) contributed to development of National innovation policies in Turkey. Among the top national priorities of the plan are: (a) promoting research and development careers and support human resource development; (b) increasing the mobility of researchers within the European Research Area; (c) encouraging the involvement of Turkish institutions in international consortiums under Horizon 2020 programs; (d) fostering a research and innovation culture in Turkey.

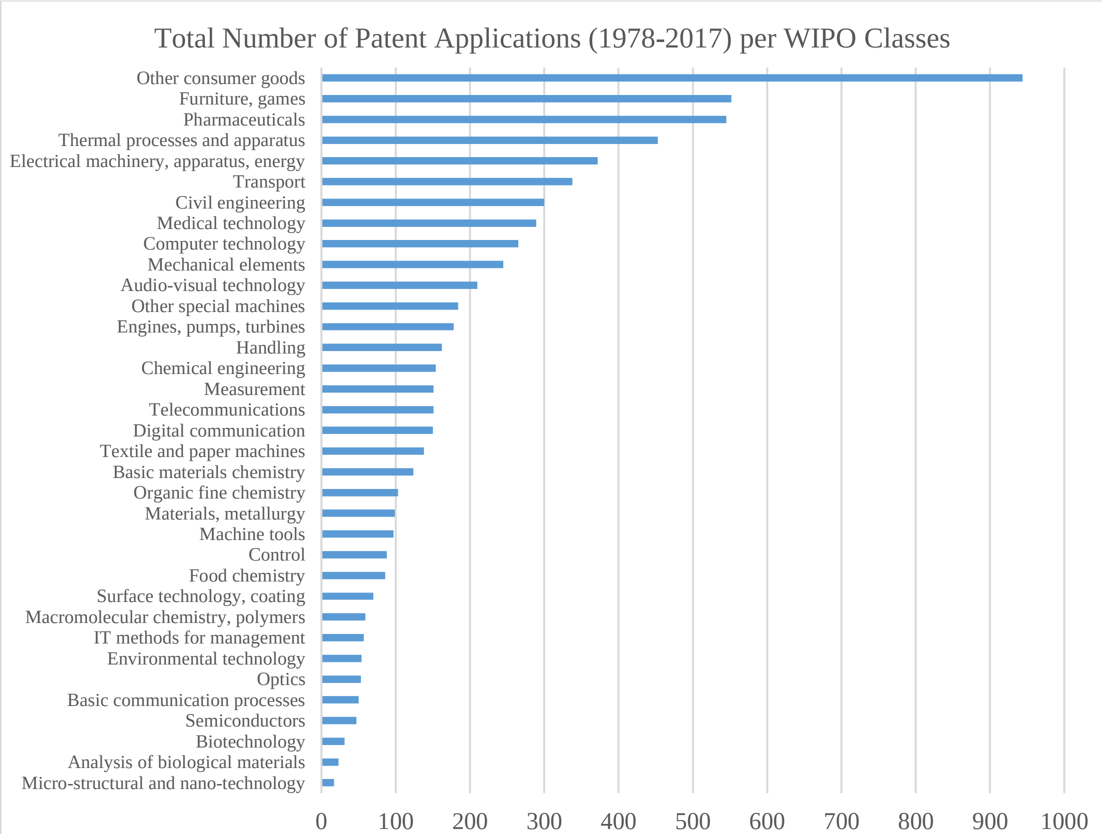
Other innovation plans include 'Vision 2023' project where the main theme is to create a welfare society that has a command of science and technology, uses technology consciously and can produce new technologies, and has the ability to transform technological developments into social and economic benefits. Priorities were determined to create a comprehensive innovation policy (TUBITAK, 2004). Turkey's preparation for integration to the EU with programs to increase research and development activities provided further stimulus for Turkey's innovation policies (Dereli & Durmus, 2009).

Another initiative to improve innovation activities in Turkey is the establishment of a platform to facilitate university-industry collaboration with an aim to produce

[4] Science and Technology Human Resource Strategy and Action Plan (2011-2016), TUBITAK, 2010.

innovative activities to increase international competitiveness of Turkey (Üniversite Sanayi İşbirliği Merkezleri Platformu, 2021). Moreover, university techno parks started to have an important place in the innovation system (Pekol & Erbaş, 2011). Additionally, signing a partnership agreement with the European Patent System at the end of 2000 can be another reason for the increase in number of patent applications where an integration across Turkish and European Patent System is reinforced thus providing a push for the development of the innovation capacity of the economy (Karaöz & Albeni, 2004).

Figure 2: Total number of patent applications (1978-2017) per WIPO classes



Source: Authors' own calculations from OECD, 2020.

Figure 2 presents the distribution of patent applications according to WIPO technological classification. The highest number of patent applications during the 1978-2017 period cover "other consumer goods", followed by "furniture, games" and "pharmaceuticals".[5]

[5] According to WIPO classification:
34: Other consumer goods include IPC classes A24#, A41B, A41C, A41D, A41F, A41G, A42#, A43B, A43C, A44#, A45#, A46B, A62B, B42#, B43#, D04D, D07#, G10B, G10C, G10D, G10F, G10G, G10H, G10K, B44#, B68#, D06F, D06N, F25D, A99Z;
33: Furniture, games include IPC classes A47#, A63#

Overall, “Other consumer goods”, according to WIPO classification, includes products such as tobacco, wearing apparel, jewelry, textiles, treatment of textiles, refrigeration and cooling all of which are low technology products. These products in this field primarily represents less research-intensive sub-fields. “Furniture, games” includes furniture; domestic articles or appliances; coffee mills; spice mills; suction cleaners in general and sports; games; amusements all of which correspond to low-tech products. Pharmaceuticals include devices and methods for medical, dental, or toilet purposes.

Pharmaceuticals correspond to high-tech sectors as defined by EUROSTAT while other consumer goods and furniture, games correspond to low-tech sectors (EUROSTAT, 2020).[6] Other high-tech sectors such as “micro-structural and Nano-technology, “analysis of biological materials” and “biotechnology” are low in number of overall patent applications. WIPO Codes and technology classification of the economic activities are in the appendices (Appendix 1 and Appendix 2).

Moreover, the type and number of patents changed during the 1978-2017 period. As demonstrated in Table 1, 25.0% of the patent applications in W1 (1978-1982) is WIPO class 31 (Mechanical elements) and 20.0% of the patent applications in W2 (1983-1987) is WIPO class 30 (Thermal processes and apparatus). In W3 (1988-1992), 46.7% of the patent applications is WIPO class 16 (Pharmaceuticals). After a high share of patent applications in pharmaceuticals during the 1988-1992 (W3), the patent applications in pharmaceuticals decreased and its share ranged between as low as 2.1% to a maximum of 13.2%.

In W4 through W8 (during the 1993-2017 period), the highest share of patent applications is on WIPO classification 34 (other consumer goods) with percentage shares of 12.2%, 15.5%, 19.5% and 16.3% and 10.3%. Overall, the patent applications in Turkey during the period of investigation covers mainly low-tech products.

16: Pharmaceuticals include IPC classes A61K not A61K-008:
“PREPARATIONS FOR MEDICAL, DENTAL, OR TOILET PURPOSES (devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms A61J 3/00; chemical aspects of, or use of materials for deodorisation of air, for disinfection or sterilisation, or for bandages, dressings, absorbent pads or surgical articles A61L; soap compositions C11D” not “Cosmetics or similar toilet preparations”.

[6] https://ec.europa.eu/eurostat/cache/metadata/FR/htec_esms.htm (access 21.04.2021) and Eurostat indicators on High-tech industry and Knowledge – intensive services

Table 1: Percentage Distribution of Patent Applications According to WIPO Codes

WIPO codes	Periods							
	W1	W2	W3	W4	W5	W6	W7	W8
1	16,7	6,7	0,0	6,1	4,1	6,1	4,9	5,7
2	0,0	0,0	0,0	0,0	0,7	4,6	3,2	2,8
3	0,0	0,0	0,0	4,1	1,4	2,0	1,6	2,8
4	0,0	0,0	0,0	0,0	0,7	0,9	1,5	3,3
5	0,0	0,0	0,0	0,0	0,3	1,5	0,7	0,6
6	0,0	0,0	0,0	2,0	1,0	2,9	2,6	5,4
7	0,0	0,0	0,0	0,0	0,7	1,1	0,4	1,1
8	0,0	0,0	0,0	0,0	0,0	0,4	0,8	0,8
9	0,0	0,0	0,0	0,0	0,3	0,0	0,3	1,4
10	0,0	0,0	0,0	2,0	0,0	1,9	1,3	3,2
11	0,0	6,7	0,0	0,0	0,0	0,2	0,3	0,4
12	0,0	0,0	0,0	4,1	0,7	1,9	0,8	1,4
13	8,3	0,0	0,0	4,1	4,8	1,7	4,5	4,8
14	0,0	0,0	0,0	0,0	4,1	1,2	1,4	1,5
15	0,0	0,0	0,0	0,0	1,0	0,2	0,3	0,6
16	0,0	6,7	46,7	4,1	2,8	2,1	13,2	6,4
17	0,0	0,0	13,3	0,0	1,0	0,4	0,8	1,0
18	0,0	0,0	6,7	2,0	1,0	0,9	1,6	1,1
19	8,3	0,0	6,7	0,0	3,1	0,9	1,0	2,6
20	0,0	0,0	0,0	2,0	3,4	1,4	1,1	1,5
21	0,0	0,0	0,0	6,1	1,4	1,1	1,1	0,9
22	0,0	0,0	0,0	0,0	0,0	0,0	0,2	0,4
23	8,3	0,0	0,0	0,0	3,4	1,8	2,0	2,5
24	8,3	6,7	0,0	0,0	2,1	0,7	0,6	0,8
25	0,0	13,3	6,7	8,2	4,5	1,7	2,1	2,4
26	0,0	6,7	6,7	2,0	1,4	1,2	1,7	1,2
27	8,3	0,0	0,0	6,1	4,1	3,0	2,5	2,4
28	0,0	0,0	0,0	0,0	2,8	1,6	1,4	2,6
29	8,3	6,7	0,0	10,2	4,1	1,8	2,6	2,7
30	25,0	0,0	0,0	2,0	5,2	8,9	7,7	5,4
31	0,0	20,0	6,7	4,1	3,1	3,3	3,5	3,7
32	0,0	20,0	0,0	4,1	2,1	4,3	3,1	6,7
33	0,0	0,0	6,7	8,2	14,5	12,4	8,7	5,8
34	0,0	6,7	0,0	12,2	15,5	19,5	16,3	10,3
35	8,3	0,0	0,0	6,1	4,5	6,1	4,4	3,9
	100	100	100	100	100	100	100	100

Note: W1: 1978-1982: W2: 1983-1987; W3: 1988-1992; W4: 1993-1997; W5: 1998-2002; W6: 2003-2007; W7: 2008-2012; W8: 2013-2017

For WIPO codes, see, Appendix 1

Figure 3: Distribution of patents according to NUTS3 regions

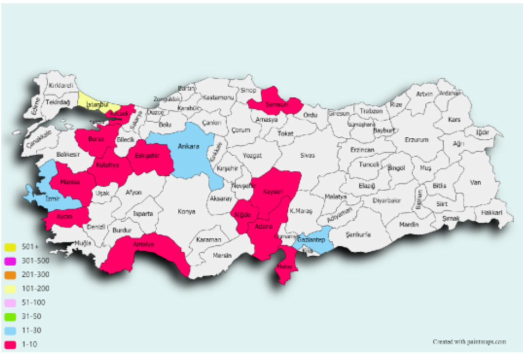
1978-1982

1983-1987

1988-1992

1993-1997

1998-2002



2003-2007

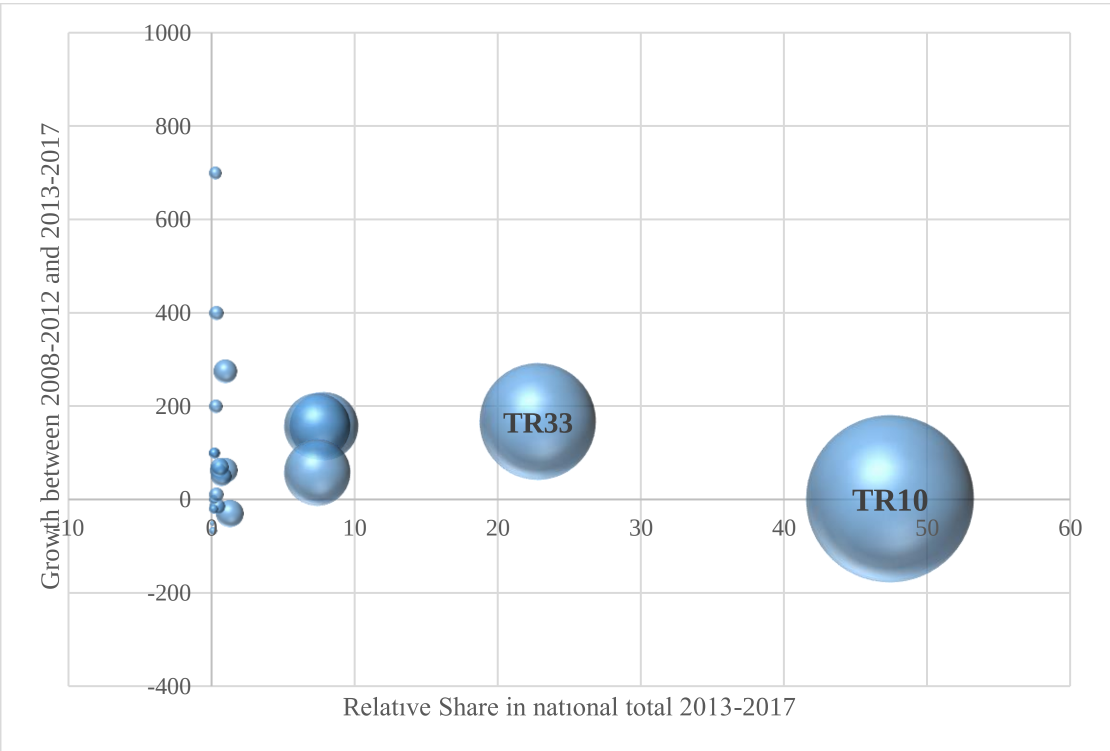
Figure 3 (Cont.):

2008-2012

2013-2017

The regions with no color denote no patent applications.
Source: Authors' own calculations from OECD, 2020.

Figure 4: Growth rate and share of patents (percentage) (NUTS2 regions) (2013-2017)



Source: Authors' own calculations from OECD, 2020.

6.2. Regional distribution of patents:

As demonstrated in Figure 3, a notable number of patent applications are in Turkey's three largest metropolitan cities, Istanbul, Ankara and Izmir, showing that large metropolitan areas create patents. The figure further points out that distribution of patent applications is generally higher in the western part of Turkey, most of which are in Istanbul and Manisa, while eastern provinces start to show increase in patent applications.

Figure 4 presents the relative shares and growth rates of patent applications during the 2013-2017 period.[7] TR10 (Istanbul) and TR33 (Manisa) together constitute more than half of Turkey's patent applications, with shares 47.4% and 22.8%, respectively. The rest of the patents are distributed across Turkey's other regions, where TR41 (Bursa), TR42 (Kocaeli) and TR51 (Ankara) are the next highest in share of patents (7.8%, 7.4% and 7.3, respectively) with a total growth rate of less than 10% over 5 years. Growth rates of patent applications for the regions with already low share of patents are low. Conversely, growth rates of patent applications for the regions with already high share of patents are high; indicating that the gap across regional distribution of patent applications is likely to increase in favor of regions with already high number of patent applications.

6.3. Knowledge Complexity of the Regions

The number of patents is only one indication of the innovativeness of the region. In order to be innovative and at the same time sustain competitiveness, the quality of the knowledge created in the region should be among key concerns. Knowledge is valuable if it is difficult to replicate outside the geography. Knowledge that is tacit and sticky in the field is a source for competitive advantage for the regions. As explained in the methods section, the variable that measures complexity of knowledge in regions is knowledge complexity index of the region (KCI regional). Figure 5 shows the knowledge complexity indices of Turkey's NUTS3 regions.

It is possible to follow the knowledge complexity of regions from maps in periods of five years during the 1978-2017 period. The maps demonstrate that there is no variability in the first four maps; therefore, it is not possible to make sound comments.

As the number of patent applications and geographic variability increases as of 1998-2002 period, we observe that the provinces on the western part of Istanbul-Ankara-Niğde-Hatay axis have higher complexity. Complexity decreases as we move to the Eastern provinces.

[7] To make the graph visually simpler, we aggregated the data to NUTS2 regions in Figure 4.

Figure 5: Knowledge Complexity of the Regions (NUTS3 Regions)

1978-1982

1983-1987

1988-1992

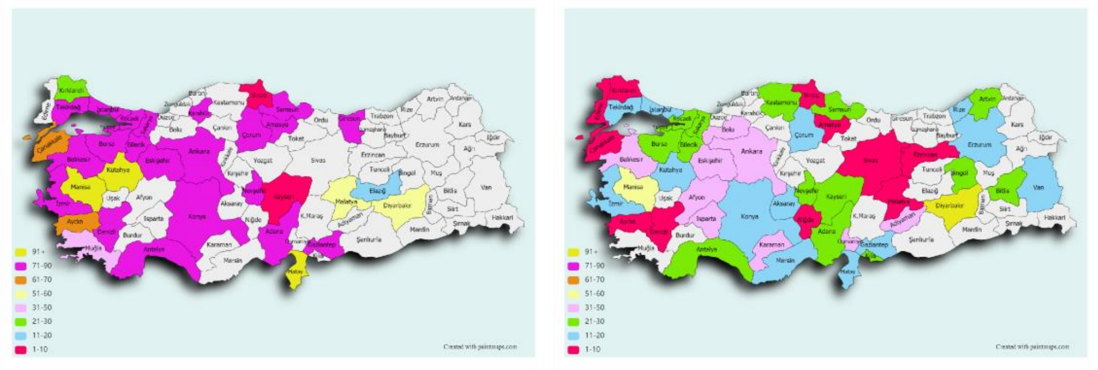
1993-1997

1998-2002

2003-2007

Figure 5 (Cont.):

2008-2012 2013-2017



The regions with no color denote no patent applications.
Source: Authors' own calculations from OECD, 2020

Complexity of Istanbul decreased after 2003 and we see that Konya and Malatya started to increase in complexity, followed by Erzurum. Eastern provinces surpassed western part of the country during the 2003-2007 period with Kars and Van joining as highly complex regions.

After 2008, the pattern changes again in favor of western provinces where Manisa, Kütahya and Hatay increased in complexity. During the 2008-2012 period, western regions in terms of complexity became more homogeneous while in the East, the complexity declined. During 2013-2017, it is possible to say that complexity became homogenous across the country, with Diyarbakır having the highest index for knowledge complexity.

Overall, during the 1978-2017 period, the regional complexity was mostly higher in western provinces until 2012. During the 2013-2017 period, the regional knowledge complexity index became uniform across the regions, indicating that ability to keep unique and hard-to-imitate knowledge in the region became harder. Consequently, the possibility of limiting imitations/replications outside the geographies became lower.

6.4. Average Relatedness Density of the Regions

The emergence of new technologies in the regions is not random and innovations and new technologies depend on existing set of capabilities (Boschma, 2017). Frenken & Boschma (2007) propose that diversification of the economic activities is a branching process and the emergence of new technologies is reliant on past knowledge.

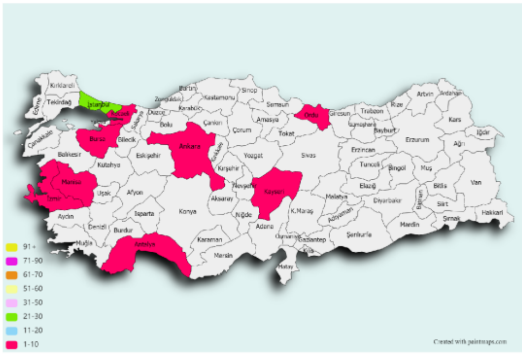
Figure 6: Average Relatedness Density of the Regions (NUTS3 Regions)

1978-1982

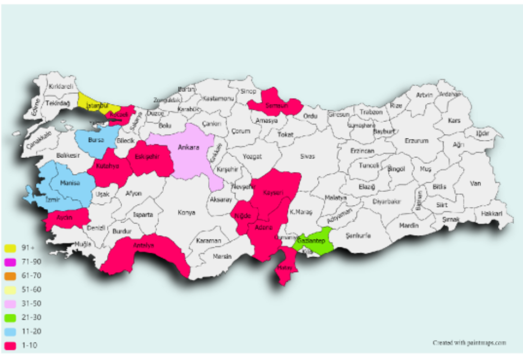
1983-1987

1988-1992

1993-1997



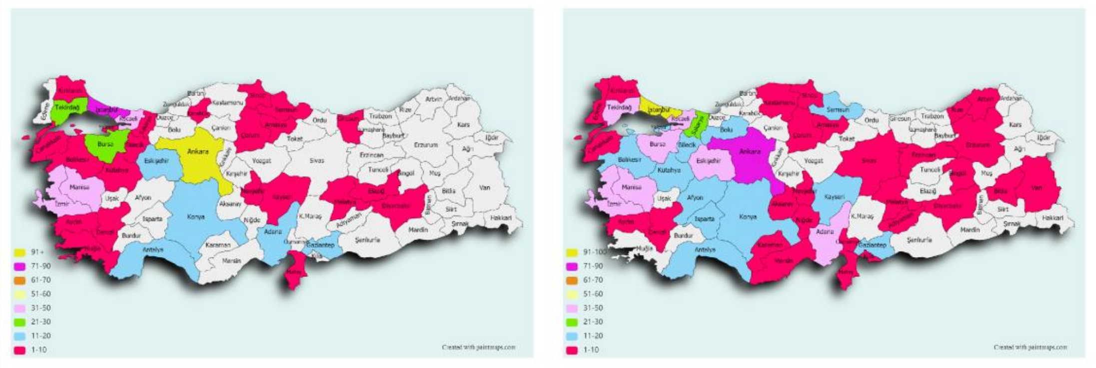
1998-2002



2003-2007

Figure 6 (Cont.):

2008-2012 **2013-2017**



The regions with no color denote no patent applications.
Source: Authors’ own calculations from OECD, 2020.

In order to show the regional branching opportunities in Turkey, we present changes in average relatedness density of the regions during the 1978-2017 period. Average relatedness density shows the potential of new and related technologies to enter the region.

Figure 6 shows regional branching opportunities in Turkey. We observe that relatedness density increases in the western provinces, particularly in Istanbul and Ankara, then in Bursa, Kocaeli, İzmir, Manisa while Tekirdağ and Muğla start to follow. Overall, we see that the average relatedness density is higher in the western provinces particularly on the western side of the Istanbul-Bursa-Ankara-Adana axis.

7. Conclusion

The paper reveals developments in innovative activities in Turkey with presenting patent applications and regional distribution of patents during the 1978-2017 period. The paper further explores how Turkey’s regions have evolved concerning knowledge complexity and relatedness density, where complexity corresponds to the ability of regions’ uniqueness and possess tacit and valuable knowledge. The complexity of the region shows that the regional knowledge is difficult to access and region is able to keep and sustain competitiveness. Relatedness density reveals the regions’ ability to attract new and related technologies with a potential to evolve into innovative (related) new products and processes.

Overall, the results show four major outcomes:

First, we see that patent applications in Turkey during the 1978-2017 period are mostly low-tech products where highest patent applications are for “other consumer goods”, and “furniture and games”. Although “Pharmaceuticals” is the third highest share of technology group in total patent applications, the high share is due to the five-year period, 1988-1992 where the pharmaceutical share was 46.2%. After 1992, the share of pharmaceuticals decreases to levels between 2.8% to 13.2%. During the last five 5-year periods, “other consumer goods”, a group consisting of low technology products, continue to have the highest share in total patent applications.

Second, the distribution of patent applications, knowledge complexity and relatedness density are uneven across space in Turkey. In general, we see that the western regions are better in innovativeness.

Third, until 2012, the knowledge complexity of the western regions increased indicating presence of tacit technologies that are difficult to access. However, the distribution of complexity index became uniform after 2012. During the 2013-2017 period, the difference between western and eastern provinces became less visible. Diyarbakır became the highest technologically complex region in the country.

Fourth, for all five-year periods, the ability of the regions to attract related technologies is higher for the western provinces. This means that the western provinces (west of Istanbul-Bursa-Ankara-Adana axis) have potentially higher ability to create innovative products and processes that are compatible to their existing knowledge bases. The results show that smart specialization policies would work better for the provinces that are on the western part of Turkey, where patent applications and relatedness density are higher. It would then be possible to create regions that are more technologically complex and difficult to imitate for sustainable competitiveness.

The next step is to investigate and verify the connection between innovativeness with relatedness density and technological complexity in Turkey. Although the paper is a preliminary attempt to show long run patterns of innovative activities, the paper reveals uneven regional distribution of smart specialization patterns and conditions to attract potential new technologies to the regions are diverse across Turkey. The paper supports the idea that smart specialization policy based on the relatedness framework is not a one-size fits all policy and all regions ought to focus on their existing portfolios to draw new economic activities.

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Appendix 1: WIPO codes

Area, field		IPC code
I	**Electrical engineering**	
1	Electrical machinery, apparatus, energy	F21#, H01B, H01C, H01F, H01G, H01H, H01J, H01K, H01M, H01R, H01T, H02#, H05B, H05C, H05F, H99Z
2	Audio-visual technology	G09F, G09G, G11B, H04N-003, H04N-005, H04N-009, H04N-013, H04N-015, H04N-017, H04R, H04S, H05K
3	Telecommunications	G08C, H01P, H01Q, H04B, H04H, H04J, H04K, H04M, H04N-001, H04N-007, H04N-011, H04Q
4	Digital communication	H04L
5	Basic communication processes	H03#
6	Computer technology	(G06# not G06Q), G11C, G10L
7	IT methods for management	G06Q
8	Semiconductors	H01L
II	**Instruments**	
9	Optics	G02#, G03B, G03C, G03D, G03F, G03G, G03H, H01S
10	Measurement	G01B, G01C, G01D, G01F, G01G, G01H, G01J, G01K, G01L, G01M, (G01N not G01N-033), G01P, G01R, G01S; G01V, G01W, G04#, G12B, G99Z
11	Analysis of biological materials	G01N-033
12	Control	G05B, G05D, G05F, G07#, G08B, G08G, G09B, G09C, G09D
13	Medical technology	A61B, A61C, A61D, A61F, A61G, A61H, A61J, A61L, A61M, A61N, H05G
III	**Chemistry**	
14	Organic fine chemistry	(C07B, C07C, C07D, C07F, C07H, C07J, C40B) not A61K, A61K-008, A61Q
15	Biotechnology	(C07G, C07K, C12M, C12N, C12P, C12Q, C12R, C12S) not A61K
16	Pharmaceuticals	A61K not A61K-008
17	Macromolecular chemistry, polymers	C08B, C08C, C08F, C08G, C08H, C08K, C08L
18	Food chemistry	A01H, A21D, A23B, A23C, A23D, A23F, A23G, A23J, A23K, A23L, C12C, C12F, C12G, C12H, C12J, C13D, C13F, C13J, C13K
19	Basic materials chemistry	A01N, A01P, C05#, C06#, C09B, C09C, C09F, C09G, C09H, C09K, C09D, C09J, C10B, C10C, C10F, C10G, C10H, C10J, C10K, C10L, C10M, C10N, C11B, C11C, C11D, C99Z

20	Materials, metallurgy	C01#, C03C, C04#, C21#, C22#, B22#
21	Surface technology, coating	B05C, B05D, B32#, C23#, C25#, C30#
22	Micro-structure and nano-technology	B81#, B82#
23	Chemical engineering	B01B, B01D-000#, B01D-01##, B01D-02##, B01D-03##, B01D-041, B01D-043, B01D-057, B01D-059, B01D-06##, B01D-07##, B01F, B01J, B01L, B02C, B03#, B04#, B05B, B06B, B07#, B08#, D06B, D06C, D06L, F25J, F26#, C14C, H05H
24	Environmental technology	A62D, B01D-045, B01D-046, B01D-047, B01D-049, B01D-050, B01D-051, B01D-052, B01D-053, B09#, B65F, C02#, F01N, F23G, F23J, G01T, E01F-008, A62C
IV	**Mechanical engineering**	
25	Handling	B25J, B65B, B65C, B65D, B65G, B65H, B66#, B67#
26	Machine tools	B21#, B23#, B24#, B26D, B26F, B27#, B30#, B25B, B25C, B25D, B25F, B25G, B25H, B26B
27	Engines, pumps, turbines	F01B, F01C, F01D, F01K, F01L, F01M, F01P, F02#, F03#, F04#, F23R, G21#, F99Z
28	Textile and paper machines	A41H, A43D, A46D, C14B, D01#, D02#, D03#, D04B, D04C, D04G, D04H, D05#, D06G, D06H, D06J, D06M, D06P, D06Q, D99Z, B31#, D21#, B41#
29	Other special machines	A01B, A01C, A01D, A01F, A01G, A01J, A01K, A01L, A01M, A21B, A21C, A22#, A23N, A23P, B02B, C12L, C13C, C13G, C13H, B28#, B29#, C03B, C08J, B99Z, F41#, F42#
30	Thermal processes and apparatus	F22#, F23B, F23C, F23D, F23H, F23K, F23L, F23M, F23N, F23Q, F24#, F25B, F25C, F27#, F28#
31	Mechanical elements	F15#, F16#, F17#, G05G
32	Transport	B60#, B61#, B62#, B63B, B63C, B63G, B63H, B63J, B64#
V	**Other fields**	
33	Furniture, games	A47#, A63#
34	Other consumer goods	A24#, A41B, A41C, A41D, A41F, A41G, A42#, A43B, A43C, A44#, A45#, A46B, A62B, B42#, B43#, D04D, D07#, G10B, G10C, G10D, G10F, G10G, G10H, G10K, B44#, B68#, D06F, D06N, F25D, A99Z
35	Civil engineering	E02#, E01B, E01C, E01D, E01F-001, E01F-003, E01F-005, E01F-007, E01F-009, E01F-01#, E01H, E03#, E04#, E05#, E06#, E21#, E99Z

Note: This table is available in Excel format on: *www.wipo.int/ipstats/en/statistics/patents*

Source: WIPO IPC-Technology Concordance Table.

Appendix 2: Technology and Knowledge Classification[8]

Technology Classification

High technology
Manufacture of basic pharmaceutical products and pharmaceutical preparations. Manufacture of computer, electronic and optical products.
Medium-high technology
Manufacture of chemicals and chemical products. Manufacture of electrical equipment. Manufacture of machinery and equipment n.e.c. Manufacture of motor vehicles, trailers and semi-trailers. Manufacture of other transport equipment.
Medium-low technology
Manufacture of coke and refined petroleum products. Manufacture of rubber and plastic products. Manufacture of other non-metallic mineral products. Manufacture of basic metals. Manufacture of fabricated metals machinery and equipment; products, except machinery and equipment Repair and installation of machinery and equipment.
Low technology
Manufacture of food products, beverages, tobacco products, textile, wearing apparel, leather and related products, wood and of products of wood, paper and paper reproduction of recorded media. Manufacture of furniture. Other manufacturing

Knowledge Classification

Knowledge intensive services
Water transport. Air transport. Publishing activities. Motion picture, video and television programme production, sound recording and music publish activities. Programming and broadcasting activities. Telecommunications; computer programming, consultancy and related activities; Information service activities (section J). Financial and insurance activities (section K).

[8] Source: https://ec.europa.eu/eurostat/cache/metadata/FR/htec_esms.htm (access 21.04.2021) and Eurostat indicators on High-tech industry and Knowledge – intensive services (Annex 3 – High-tech aggregation by NACE Rev.2).

Legal and accounting activities; Activities of head offices, management consultancy activities. Architectural and engineering activities, technical testing and analysis; Scientific research and development. Advertising and market research; Other professional, scientific and technical activities; Veterinary activities (section M). Employment activities. Security and investigation activities. Public administration and defence, compulsory social security (section O). Education (section P). Human health and social work activities (section Q). Arts, entertainment and recreation (section R).
Knowledge intensive market eservices (excluding high-tech and financial services)
Water transport. Air transport. Legal and accounting activities. Activities of head offices, management consultancy activities. Architectural and engineering activities, technical testing and analysis. Advertising and market research. Other professional, scientific and technical activities. Employment activities. Security and investigation activities.
High-tech knowledge intensive services
Motion picture, video and television programme production, sound recording and music publish activities. Programming and broadcasting activities. Telecommunications; computer programming, consultancy and related activities. Information service activities. Scientific research and development.
Knowledge intensive financial services
Financial and insurance activities (section K).
Other knowledge intensive services
Publishing activities. Veterinary activities. Public administration and defense, compulsory social security (section O). Education (section P). Human health and social work activities (section Q). Arts, entertainment and recreation (section R).
Less knowledge intensive services (LKIS)
Wholesale and retail trade; Repair of motor vehicles and motorcycles (section G). Land transport and transport via pipelines. Warehousing and support activities for transportation; Postal and courier activities. Accommodation and food service activities (section I). Real estate activities (section L). Rental and leasing activities. Travel agency, tour operator reservation service and related activities. Services to buildings and landscape activities. Office administrative, office support and other business support activities. Activities of membership organization. Repair of computers and personal and household goods. Other personal service activities (section S). Activities of households as employers of domestic personnel.

Undifferentiated goods- and services-producing activities of private households for own use (section T). Activities of extraterritorial organisations and bodies (section U).
Less knowledge intensive market services
Wholesale and retail trade. Repair of motor vehicles and motorcycles (section G). Land transport and transport via pipelines. Warehousing and support activities for transportation. Accommodation and food service activities (section I). Real estate activities (section L). Rental and leasing activities. Travel agency, tour operator reservation service and related activities. Services to buildings and landscape activities. Office administrative, office support and other business support activities. Repair of computers and personal and household goods.
Other less knowledge intensive services
Postal and courier activities. Activities of membership organization. Other personal service activities. Activities of households as employers of domestic personnel. Undifferentiated goods- and services-producing activities of private households for own use (section T). Activities of extraterritorial organisations and bodies (section U).