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THE INNOVATION INDEX OF CITIES OF TURKEY: AN EMPIRICAL ANALYSIS FOR DETERMINING FACTORS OF INNOVATION

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Abstract
In this study, the level of 81 city in Turkey, will be presented the results of innovation index. The index was created by 25 different variables. Following the announcement of the innovation index, an empirical analysis of the determinants of innovation will be made. In this study, correlation analysis is applied and found correlations between innovation and 276 different variables for cities. The main variables that affect the competition will be determined. Thus, to put forth the factors affecting innovation at the level of provinces, a framework will be established for the discussion of the advantages and disadvantages of provinces in terms of innovation.

Keywords: Innovation Index, Competitiveness Index, Factor Analysis
Jel Classification: O31,O35

1. INTRODUCTION

When looking at early historical periods, it is possible to note that advanced countries/communities were generally established around rivers and streams, where they would have easy access to water. The most important reason for this was these countries'/communities' need to increase the amount of irrigation water available for their mainly agriculture-based economies, and to thereby enhance their productivity that depended heavily on labor and population. In the following historical periods up to the 15th century – a century of extensive geographical exploration – the prevalent economic structure across the world gradually became trade-based. During this period, trade routes such as the Silk Road and the Spice Road provided many advantages to the countries they crossed, both in terms of increased commerce and taxation.

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Following the age of exploration, increasing emphasis on seafaring and colonialism enabled countries such as Great Britain and France to gain a more dominant position in the world economy. The industrial revolution which began in the late 18th century increased the importance of production-based economies, while colonialism became even more prominent during this period. One of the most important consequences of the industrial revolution was the rapid and significant increase in the amount of energy required for production. This new requirement allowed the United States, a country with greater access to energy sources such as petroleum, to become the leading world economy. In the present-day world, the main locomotive – or driving force – for economies across the globe is innovation. The most important indication of this is the fact that many new companies established only 10-20 years ago have today reached market values expressed in the billions of dollars. In the present-day world, effective economic transformation further enhances the effects and benefits of information and innovation.

2. CONCEPT OF INNOVATION

The word innovation is etymologically derived from the Latin word "innovatus" (Güngör, 2013). "Innovatus" is, in turn, the past tense of the verb "innovare", formed by combining the words "in" (meaning "into …") and "novus" (meaning "new"). The Turkish Language Society (TDK) uses the Turkish word "yenileşim" for innovation (although the similar-sounding word "inovasyon" is also used in everyday Turkish), and defines it as "the utilization of new methods in social, cultural and managerial contexts in order to adapt to changing conditions." (TDK, 2015)

A review of the literature indicates that the concept of innovation is used in many different ways and contexts. The Oslo Manual, which is the "Guidelines for Collecting and Interpreting Technological Innovation Data", broadly defines the concept of innovation as "the introduction of goods or services that are new or significantly improved; the implementation of a new or significantly improved production or delivery methods; the implementation of new marketing methods; or the implementation of new organizational methods in business practices, workplace organization or external relations" (OECD, 2005)

Innovation was first defined by Joseph Schumpeter, who described it as the "driving force of development." In his book written in 1911, and translated to English in 1934, Schumpeter defines innovation as the "launch of a new product or a new species of a known product; the application of a new method of production; the opening of a new market; the acquisition of a new source of supply for raw materials or semi-finished goods; or the development of a new industry structure" (Elçi, 2006). "In its broadest sense, innovation can be defined as the conversion of knowledge into economic or social gain/benefit. For this reason, it involves a combination of technical, economic and social processes. It is the product of a desire for change, of the hunger for novelty, and of a culture of entrepreneurship" (Elçi, 2006).

The Oslo Manual evaluates the different types of innovation under 4 headings, or groups. These are:

- Product innovation: The introduction into the market of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics.
- Process innovation: The implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software.
- Marketing innovation: The implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing
- Organizational innovation: The implementation of a new organizational method in the firm's business practices, workplace organization or external relations.(OECD,2005)

3. METHODOLOGY

3.1. Research Goal

Under the scope of this research, 276 variables have been used for the fifteen sub-dimensions which constitutes the competitiveness index. Innovation index is one of them. The data about said variables are reached through secondary data sources. That is, statistics by

institutions and organizations have been used. Therefore, this study is categorized under research using quantitative data.

In this study, the research concept is competitiveness. Therefore, we need to measure the concept of competitiveness. However, the concept of competitiveness cannot be observed (directly). Therefore, in order to measure the concept of competitiveness, some variables which can be observed have been used. For example, in order to measure demographic structure which is one of the sub-dimensions of the concept of competitiveness; observable variables such as population, area, age dependency ratio have been used. This way, competitiveness index scores for 81 cities have been calculated. In this purpose, weighted average method has been used. Because, there are many sub-dimensions that constitutes the concept of competitiveness. In addition, the said sub-dimensions cover different variables in their field. For this reason, the need to represent the said data set with only one value has emerged.

In order to represent the value, to summarize it and to demonstrate its general character and to compare different data sets with each other, the measures called measures of central tendency are being used. Arithmetic mean is the most common used measure of central tendency. Arithmetic mean is calculated by dividing the sum of all the values in data set to the unit number in that data. However, in the weighted average calculations related variables are weighed according to their level of importance.

In this study, in index calculation, 276 variables out of 300 data which is obtained from the secondary data sources have been used. The measurement units of most of these variables are different from others. While one variable is measured in square kilometers, the other one may have been measured in tons. Therefore, since different measurement units like tons, kilograms, kilometers, acres are used in raw data set, the findings resulted from analysis may be misleading. For this reason, in order to point out the meaningful relationships among data mining and mass data, the data has become independent from the measurement unit. For this reason, data has been converted to z score because the observations about the variables in the data matrix have different means and different variances. Thereby, a scaled data set independent from the measurement unit was obtained.

For standardization

$$z = (X - \mu)/\sigma \qquad (1)$$

transformation has been applied.

μ:arithmetic mean

σ:standard deviation

With the converted data, it has been possible to identify a single dimension which comprises of number of common and basic information set in different sizes. As a result of standardizing all the data, index are calculated with fixed weights for each variable.

Index calculation process has been completed by this formula

$$Index = \sum_i A_{ii} X_{ii} / \sum_i A_{ii} \qquad (2)$$

A_{ji}: The weight of the i lower variable of the j main variable

X_{ji}: The standardized value of the i lower variable of the j main variable

3.2. Sample and Data Collection

25 variables have been compiled under the field of innovation. The variables have been compiled by taking into consideration of the titles of patent, trademark, model number, innovation infrastructure and the number of projects. All the examined variables have positive directions. The variables and their impact on the index in innovation field are shown in the table below.

Table 1. Innovation Indicators (Patent, Trademark, etc.)

	Variable	**Direction**
Patent, Trademark, Number of Models	Average Patent Registration	Positive
	Average Trademark Registration	Positive
	Average Utility Model Registration	Positive
	Average of Industrial Design Registration	Positive
	Number of Patent Applications / Total	Positive
	Number of Patent Application / Population	Positive
	Number of Brand Applications / Total	Positive
	Number of Brand Applications / Population	Positive
	Number of Utility Model Applications / Total	Positive
	Number of Utility Model Applications / Population	Positive
	Number of Industrial Design Applications / Total	Positive
	Number of Industrial Design Applications / Population	Positive

Table 2. Innovation Indicators (High-Tech Exports)

	Variable	Direction
High-Tech Exports	Diversity in the Export Rate	Positive
	High-Tech Exports / TR Total	Positive
	High-Tech Exports / Total Exports of the Province	Positive
	Medium-High Technology Exports / TR Total	
	Medium-High Technology Exports / Total Exports of the Province	Positive
	Export Mediocrity Index	Positive

Table 3. Innovation Indicators (Innovation Infrastructure)

	Variable	Direction
Innovation Infrastructure	R & D Centers	Positive
	Number of Techno polis	Positive
	Number of Companies with R & D Unit / Total	Positive
	Number of R & D Unit Employees / Total	Positive
	Number of Engineers / Total	Positive

Table 4. Innovation Indicators (Number of Projects)

	Variable	Direction
Number of Projects	Turkey Scientific and Technological Research Council (TUBITAK) Project-University / Total	Positive
	Turkey Scientific and Technological Research Council (TUBITAK) Registered Researchers / Total	Positive

3.3. Analyses and Results

3.3.1. Results of Innovation Index

Innovation index is one of the sub-components of the competitiveness index and falls under entrepreneurship and innovation indicators title. In this index, number of patents, brands and models, the innovation infrastructure and the number of projects in the province take place. Indicators such as the ratio of the number of patent applications in the city to the number of patent applications in the country, the number of industrial design applications per a hundred thousand people, the number of research and development (R&D) centers in the province, the number of techno polis in the province, the ratio of the number of Turkey Scientific and Technological Research Council (TUBITAK) projects to the number of Turkey Scientific and Technological Research Council projects in the country and etc. have been taken into consideration. Twenty five indicators have been used in this index. Most of the data

about these indicators have been taken from The Turkish Patent Institute (TPE), Ministry of Science, Industry and Technology and Turkey Scientific and Technological Research Council statistics. These data cover the years of 2013 and 2014. Innovation index has a weight of 10% in the competitiveness index.

When the city rank is examined according to index, it can be seen that İstanbul ranks first with the score of 79,73. Ankara with a score of 48,28 follow İstanbul. Bursa is in the third place with a score of 29,31. It can be said that the variability between these three cities is high. İzmir, Kocaeli, Eskişehir, Konya, Antalya, Sakarya and Kayseri follow these three cities in this order. When these cities are looked at geographically, it can be seen that most of them are located in Central Anatolian and Marmara Regions. When the innovation index is examined, it can be seen that Yozgat, Ardahan, Uşak, Erzincan, Siirt, Tunceli, Kastamonu, Sinop, Muş and Bayburt are in the bottom rows. Index score average of these cities is 4,74. When the scores of these cities are examined, it can be seen that most of these cities are located in Central Anatolian and Marmara Regions.

Table 5. Turkey Innovation Index (81 Cities)

Rank	City	Index score	Rank	City	Index score	Rank	City	Index score
1	İstanbul	79,73	**28**	Çankırı	10,98	**55**	Batman	7,84
2	Ankara	48,28	**29**	Sivas	10,96	**56**	Elazığ	7,72
3	Bursa	29,31	**30**	Trabzon	10,78	**57**	Afyon	7,60
4	İzmir	28,30	**31**	Ağrı	10,70	**58**	Kırıkkale	7,55
5	Kocaeli	27,10	**32**	Aksaray	10,36	**59**	Kilis	7,33
6	Eskişehir	22,61	**33**	Bilecik	10,25	**60**	Hakkari	7,02
7	Konya	21,23	**34**	Çanakkale	9,97	**61**	Karabük	6,74
8	Antalya	18,91	**35**	Yalova	9,84	**62**	Giresun	6,60
9	Sakarya	18,74	**36**	Erzurum	9,43	**63**	Iğdır	6,51
10	Kayseri	17,18	**37**	Niğde	9,40	**64**	Ordu	6,36
11	Aydın	16,71	**38**	Şanlıurfa	9,21	**65**	Adıyaman	5,97
12	Balıkesir	16,32	**39**	Muğla	9,01	**66**	Zonguldak	5,94
13	Manisa	14,88	**40**	Mardin	8,90	**67**	Gümüşhane	5,82
14	Diyarbakır	14,75	**41**	Kütahya	8,87	**68**	Osmaniye	5,81
15	Adana	14,37	**42**	Nevşehir	8,83	**69**	Bartın	5,80
16	Gaziantep	14,09	**43**	Van	8,81	**70**	Tokat	5,75
17	Denizli	13,58	**44**	Bingöl	8,65	**71**	Kırşehir	5,74
18	Çorum	13,05	**45**	Artvin	8,56	**72**	Yozgat	5,67
19	Samsun	12,56	**46**	Maraş	8,54	**73**	Ardahan	5,50
20	Düzce	12,19	**47**	Bolu	8,46	**74**	Uşak	5,42
21	Tekirdağ	12,13	**48**	Malatya	8,32	**75**	Erzincan	5,41
22	Mersin	11,99	**49**	Amasya	8,08	**76**	Siirt	5,34
23	Burdur	11,73	**50**	Edirne	8,07	**77**	Tunceli	4,92
24	Hatay	11,39	**51**	Kırklareli	8,05	**78**	Kastamonu	4,84
25	Rize	11,24	**52**	Karaman	8,01	**79**	Sinop	3,98
26	Isparta	11,22	**53**	Şırnak	7,94	**80**	Muş	3,83
27	Bitlis	11,15	**54**	Kars	7,86	**81**	Bayburt	2,46

When the innovation index is examined, it can be seen that Yozgat, Ardahan, Uşak, Erzincan, Siirt, Tunceli, Kastamonu, Sinop, Muş and Bayburt are in the bottom rows. Index score average of these cities is 4,74. When the scores of these cities are examined, it can be seen that most of these cities are located in Central Anatolian and Marmara Regions.

Innovation index scoring is ranged between 0 and 100. However, there are no cities with the score of 100. The highest score in innovation index is 79,73 and the lowest score is 2,46. The average of the cities in innovation index is 11,62 and 23 cities are above this average. The remaining 58 cities, however, are below the average. However, it is important to mention that this index has extreme values in both ends. (Şeker, vd.; 2015:74)

3.3.2. An Empirical Analysis for Determining Factors of Innovation

This study was performed using the correlation analysis method – a statistical method used for testing and determining the extent of a linear relationship between two variables, or of a single variable with two or more variables. In this context; we determined the correlation of the "number of patents obtained in a province" with the other study variables, and identified 10 variables showing high correlation with the number of patents.

Table 6. Turkey Innovation Index (81 Cities)

Pearson Correlation	Variables
0,985	The number of industrial firms
0,970	Export ratio
0,966	The number of RD Centers
0,966	The number of RD department in firm
0,953	The number of expo
0,947	Tax income
0,938	Population
0,897	Trade flight traffic
0,848	Number of academics
0,805	Number of scientific projects (TUBITAK)

4. CONCLUSION

Within the frame of this study, inter-provincial innovation index results were determined for the 81 provinces in Turkey by using 25 different variables. According to the index results, the three highest-ranking provinces in terms of innovation were Istanbul, Ankara and Bursa. Although 276 different variables were used for calculating the index, some of these variables were determined to have a more significant and pronounced effect on innovation. These important variables included: the number of industrial businesses in the province; the level of exports; the number of R&D centers; the number of companies with R&D centers; the number of fairs being organized; the level of tax revenues; total population;

commercial aircraft traffic; the number of academicians in the province; and the number of ongoing Turkey Scientific and Technological Research Council projects.

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