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The Similarity Analysis of Industrial Development in EU Countries and Turkey Using the Hierarchical Cluster Technique

Abstract: Industrial activities have a notable percentage in whole national economies. Thus, it is necessary to follow the development of the industrial activities to be able to review economic development. Identification of similarities or differences among countries provides the ability to notice more clearly the level of regional development and its problems. However, it makes complex subject with a large number of data and with different national data methodology for each country and year. Statistical analysis is a proven tool to make it easier. The goal was to follow the developments since it has the ability to summarize complex data. In this study, we found out similar characteristics among EU Countries (except Croatia which joined EU in 2013) and Turkey by using export and import rates, industrial production index, recent prices, percent of GDP of industry parameters in industrial sector variables. Squared Euclid distance, Pearson proximity matrix and Ward's method were used to calculate distances between different countries variables and to find out country groups which have similar development characteristics. The analyses were supported with dendogram and maps.

Key words: Hierarchical cluster technique, Turkey, EU countries, development, industry

Introduction

Similarity and closeness of countries to each other have affected density of trade among them throughout history. Huge economies acted as a center of gravity for their periphery. In addition to this, similarity of language, rule of law and culture increased the attractiveness of trade (Persson 2010: 14). Sometimes, communities fought to expand their economy and their area of interest. Nonetheless, they noticed that war results in irreparable damages and, following this progress, setting up an economic union instead of making war is seen as more logical by communities. European Union (EU) is an example of this approach. EU has been setup to be an economic power. However, nowadays there is a huge gap regarding economic

situations and development rate among EU member countries. It can be said that this stems from different natural resources, labor force each country has and politics each country follows.

The development of technology and transportation has been transforming the world into a global village throughout the history of mankind. Today, economic developments or problems especially in developed countries create a global impact. The crisis related to the mortgage market in the USA is a good example to that end. From the last quarter of 2008, the world has faced a great crisis influencing firstly the finance market and thereafter national economies. Quickly growing crisis affected state economies devastatingly at a global scale. Along with the deterioration in finance environment and reduced global demand, the global trade slowed down sharply. This situation clearly affects production sectors.

When one looks over the financial stress index for years in between 2000 and 2011, it is noted that stress level clearly rises for 2007–2011 time frame and picks in 2009 (Chang 2011: 26). Due to this fact, in the present study data belonging in between 2007 and 2011 is preferred.

In the final years, the reflection of crisis in EU countries can be seen in the industrial sector as well as other sectors. This state affects also Turkey, which is one of the candidate members of EU (Gençtürk 2012: 10), as the economic crisis caused some negative ideas arise for this country (Zenginoğlu 2012: 11).

Because developments on industrial sector reflect economic crisis or recessions, analyzing periodic differentiation and changes among countries is an area of interest for economic geography. However, many parameters related to industrial sector make the subject complex (Wilczyński 2012: 124). Today, statistical analysis even with huge data can be implemented within seconds thanks to statistics software such as SPSS program. One of the most convenient analysis methods is the hierarchical cluster analysis to detect similarity or differences in different populations. Similarity among many parameters belonging to different populations can be detected clearly via the hierarchical cluster analysis. The purpose of this article is to detect similarity and differences in industrial development and countries in 5-year time frame (2007–2011) by using miscellaneous parameters in industry of EU countries and Turkey. Addition of Turkey to EU countries was given because Turkey has the longest period of political pressure on EU to join it. Comparison with Turkey is carried out in order to check if it really matches European industrial development and, if so, in which group of countries the Turkish economy would be. Squared Euclid distance, Pearson proximity matrix and Ward's method were used to calculate distances between different countries variables and to find out country groups which have similar development characteristics. The analyses were supported with dendograms.

Material and Method

Objects or events having similar characteristics can be reviewed by using a method named the hierarchical cluster analysis. Because each event to analyze has a tendency to be

alike to each other or otherwise, similar homogenous groups with clustering analysis method can be determined mathematically. As in other statistical methods, the following decisions should be taken firstly in the chosen method: which data types are applied, which mathematical methods are used to measure the distance and which criteria are used to determine group numbers (Mc Grew, Monroe 1993: 65). Since variables selected inappropriately cause false results to be produced, it is important to determine which variables will be applied in the cluster analysis. Furthermore, if a relevant variable is excluded from the analysis, incomplete and incorrect results will be produced (Karabulut, Gürbüz, Sandal 2004: 68). Thus, it should be decided reasonably which variables should be applied in clustering. The list of applied variables is presented below (Tab. 1). In the cluster analysis, the distance between variables should be taken into consideration while making groups. Other than that, distance determines similarity and closeness of objects or events while determining how far they are to each others. For the similar objects, measure of the distance is subtle, but the similarity measure is obvious (Yılmaz, Patır 2011). In the study, as measure of the distance squared Euclid distance and Pearson proximity matrix were applied. Choosen variables listed in Table 1 were taken after considering all the above-mentioned criteria.

Because the scale levels of the variables (units of measure) influence the result directly, raw data has been converted into a standardized form. Because of this fact, in our study, the values are standardized in between '0' and '1'.

The standardized values to determine similarity levels among countries have been grouped applying agglomerative hierarchical method. While making combinations of clusters or groups, simple connection and the nearest neighbor technique have been preferred. Moreover, applying Pearson proximity matrix, proximity among countries has been determined. To show hierarchical cluster results, the dendogram method has been applied. The dendogram has been scaled as 0–25 units from left to right. The distance between units is equal.

The horizontal lines represent the distance and the vertical lines represent unified clusters on the dendogram. The unified points of clusters on the scale show both which groups have been formed and the distance between the groups. In that study, the countries have been grouped in accordance with the distances scaled among 0–25 units and, SPSS 19 has been applied. Analysis has been carried out separately for every year and the results are depicted on maps by using ArcGIS 9.3 program. Table 1 shows the parameters related to industry. Because of the insufficient data of Luxembourg and Malta, these countries are excluded from the study. To convert the currency of the countries, which are out of the Euro Zone, data taken from www.forex.pl for 2007–2011 time frame is used.

Tab. 1. The detailed list of parameters used in cluster analysis

Parameters
Industrial Production Index*
Current Prices*
Production of Textiles, ISIC Classification 17*
Production of Wearing Apparel, Dressing and Dyeing of Fur, ISIC Classification 18*
Production of Tanned and Dressed Leather, Luggage, Handbags, Saddlery, Harness and Footwear, ISIC Classification 19*
Production of Wood and Products of Wood, Cork and Straw, ISIC Classification 20*
Production of Paper and Paper Products, ISIC Classification 21*
Publishing, Printing and Reproduction of Recorded Media, ISIC Classification 22*
Production of Coke, Refined Petroleum Products and Nuclear Fuel, ISIC Classification 23*
Production of Chemicals and Chemical Products, ISIC Classification 24*
Production of Rubber and Plastics Products, ISIC Classification 25*
Production of Other Non-Metallic Mineral Products, ISIC Classification 26*
Production of Basic Metals, ISIC Classification 27*
Production of Fabricated Metal Products, Except Machinery and Equipment, ISIC Classification 28*
Production of Machinery and Equipment, ISIC Classification 29*
Production of Office, Accounting and Computing Machinery, ISIC Classification 30*
Production of Electrical Machinery and Apparatus N.E.C., ISIC Classification 31*
Production of Radio, Television and Communication Equipment and Apparatus, ISIC Classification 32*
Production of Medical, Precision and Optical Instruments, Watches and Clocks, ISIC Classification 33*
Production of Motor Vehicles, Trailers and Semi-Trailers, ISIC Classification 34*
Production of Other Transport Equipment, ISIC Classification 35*
Production of Furniture and Other Products, ISIC Classification 36*
Production of Recycling, ISIC Classification 37*
Import & Export of Goods (% of GDP)**,***
Value added of Industrial Production (% of GDP)**

Sources:

* http://www.euromonitor.com/medialibrary/PDF/Book_Imdas_2013.pdf (2007–2011 versions)

** http://data.worldbank.org (The World Development Indicators Data Bank)

*** https://www.cia.gov/library/publications/the-world-factbook/rankorder/rankorderguide.html

The compared amounts of different types of industrial production which were supported by comparison to other economic variables mentioned above reflect not only the structure of different economies (these are usually dependent on resources and other regional factors), but also the level of industrial development, as it was explained earlier in previous similar analytical works (Rachwał, Wiedermann, Kilar 2008; Rachwał, Wiedermann, Kilar 2009). In this article, industrial production index, current prices levels of comparable industrial products in euros, production quantities in metric tonnes, percentage of import and export in GDP, and percentage of industry in GDP (all variables defined as in cited sources) are used as parameters. Prices reflect costs of production (which depend on the development level, especially its technological and innovative advances), and production quantities show industrial development of production abilities of compared countries. Variables' standardized values which where compared are supported by the percentage of import and export value in GDP. It

was chosen because it reflects competition of goods produced by industries of the compared states on the global market. As a secondary factor, it could reflect the quality of industrial goods as well as innovations in management in industry, but the consideration would be too far-going, as it would imply oversimplification of complex economical processes present in the global economy. Thus, the variable should be considered as a picture of global competition only. The percentage of industry in GDP is chosen because it mainly shows industrial value added to economies of the specified countries. Finally, the industrial production index deals with production in industry and consumed energy during production as a whole. These variables are quite different from recently published choice of data focused on the employed population (Rachwał 2010; Rachwał 2011a; Rachwał 2011b; Gierańczyk, Rachwał 2012), so there was a need for supplementary analysis in this field of geographical research.

Findings

In order to determine the resemblance of Turkey to EU countries and their industrial development, the hierarchical cluster analysis has been applied and analysis has been performed, separately for each year. To detect level of similarity of countries, proximity matrix is used. In this matrix, the distance changes in between +1 and -1. To variables related to the industry end, when countries show a similarity, closeness matrix converges to +1, but if there is no similarity, it converges to -1 instead of +1 . Cluster is adjusted to 5 for the minimum and to 10 for the maximum. The distance changes in between 0 and 25 on the dendogram. The most reasonable similarity takes place on clusters occurring at a one-unit distance (Sandal, Karabulut, Gürbüz 2005: 5).

When one looks at analysis results of 2007 (Figure 1), it is seen that Greece, Portugal, Denmark, Latvia, Cyprus and Estonia hold a place in the first cluster being at a one-unit distance. Also, Finland, Sweden, Lithuania, Poland, Romania and Austria hold a place in the second cluster. On the other hand, Turkey holds a place in the third cluster alone so that it does not resemble any country at a one-unit distance. Other than that, Belgium, Netherlands, Bulgaria, Slovenia, Slovakia, Czech Republic and Hungary are seen in the fourth cluster. In addition to this, Ireland, Italy and Germany hold a place in the fifth, seventh and eighth cluster alone. Finally, France, UK and Spain hold a place in the sixth cluster. Simultaneously, main cities of these countries have strong international links (Raźniak, Winiarczyk-Raźniak 2013). This may be some explanation for the first analyzed period, which matches the beginning of European financial crisis. Most of new EU countries which have recently joined the organization are in clusters with countries considered to be playing strong socialist economic policy (e.g. Sweden, Greece, Portugal).

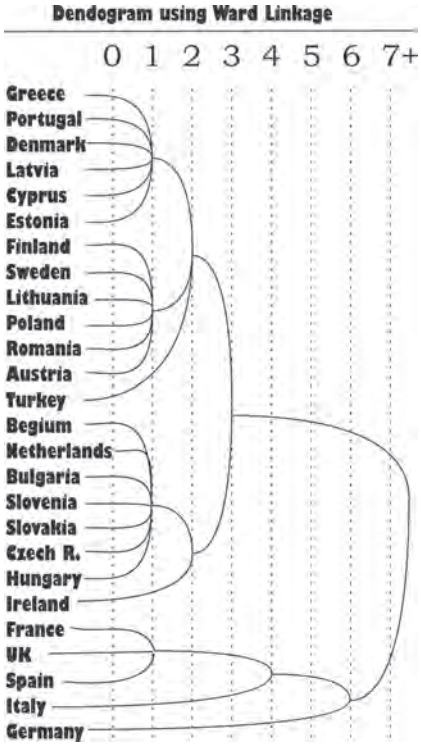

Fig. 1. 2007 Cluster Groups Dendogram
Source: authors' evaluation

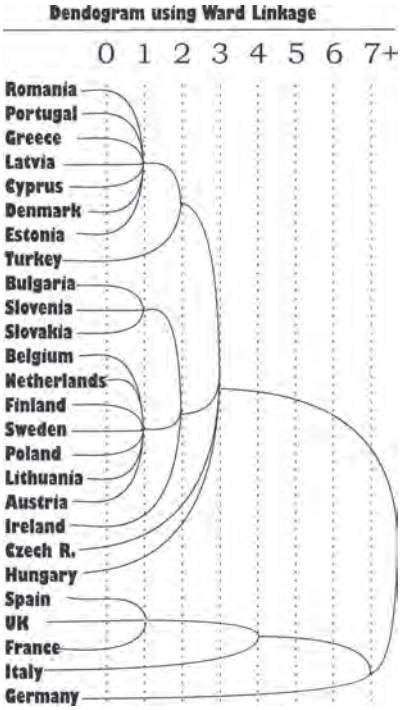

Fig. 2. 2008 Cluster Groups Dendogram
Source: authors' evaluation

In 2008, Romania, Portugal, Greece, Latvia, Cyprus, Denmark and Estonia comprise the first cluster at a one-unit distance while Turkey holds a place in the second cluster. Bulgaria, Slovenia and Slovakia are in third cluster. Fourth cluster is comprised of Belgium, Netherlands, Finland, Sweden, Poland, Lithuania and Austria. Ireland, Czech Rep. and Hungary are alone in the fifth, sixth and seventh cluster, respectively. The eighth cluster is comprised of Spain, UK and France. Italy and Germany are alone in the ninth and tenth cluster respectively (Figure 2). The financial crisis which began in 2007 gave a lot of changes in industry of the compared countries. Bigger, more resistant economies moved to last clusters. Most of the rest were still untouched by its consequences, but first countries which might be considered as drained by recession (e.g. Latvia, Cyprus, Portugal, Greece) were grouped in the first cluster.

In 2009, Latvia, Cyprus, Denmark, Estonia, Romania, Portugal and Greece comprise the first cluster at a one-unit distance while Turkey holds a place in the second cluster. Slovakia, Slovenia, Czech Republic and Hungary are in the third cluster. The fourth cluster makes up the most crowded cluster in 2009 (Figure 3). In this cluster, Netherlands, Lithuania, Finland, Sweden, Poland and Austria hold a place. Ireland and Bulgaria are alone in the fifth and the sixth cluster respectively whereas France and UK are in the seventh cluster. Finally, Spain, Italy and Germany hold a place alone in the eighth, ninth and tenth cluster respectively. That shows the increasing number of clusters. It may be caused by the financial crisis as well. Industrial development differentiates due to difficulties on the global market.

In 2010, Bulgaria, Slovenia, Hungary, Slovakia, Czech Rep. comprise the first cluster at a one-unit distance while Belgium, Netherlands and Lithuania hold a place in the second cluster. Ireland is in the third cluster alone. Romania, Greece, Portugal, Latvia, Cyprus, Denmark and Estonia are in the fourth cluster. Finland, Sweden, Poland, Austria and Turkey comprise of the fifth cluster. For the first time, Turkey is not alone in this cluster. France and UK are in the sixth cluster. Finally, Spain, Italy and Germany hold a place alone in the seventh, eighth and ninth cluster respectively (Figure 4). After three years of economic difficulties, clusters compared to those from 2007 are totally rearranged. New EU countries, which still did not have so many economic ties with the rest, are in the first cluster. Specific destination of Ireland, which is close with the cluster of economic crisis most troubled countries, reflects a huge impact of this economic condition on industrial development.

Finally in 2011, Bulgaria, Slovenia, Hungary, Slovakia, Czech Rep. comprise the first cluster at a one-unit distance again, while Belgium, Netherlands and Lithuania hold a place in the second cluster. Ireland is in the third cluster alone. The fourth cluster is the most crowded cluster for this year. Romania, Portugal, Greece, Latvia, Cyprus, Denmark and Estonia are in this cluster, while Poland, Austria, Finland and Sweden hold a place in the fifth cluster. Again, Turkey comprises of the sixth cluster alone, while France and UK are in the seventh cluster (Figure 5). Subsequently, Spain, Italy and Germany hold a place alone in the eighth, ninth and tenth cluster respectively. There seem to be no important changes in industrial development between 2010 and 2011.

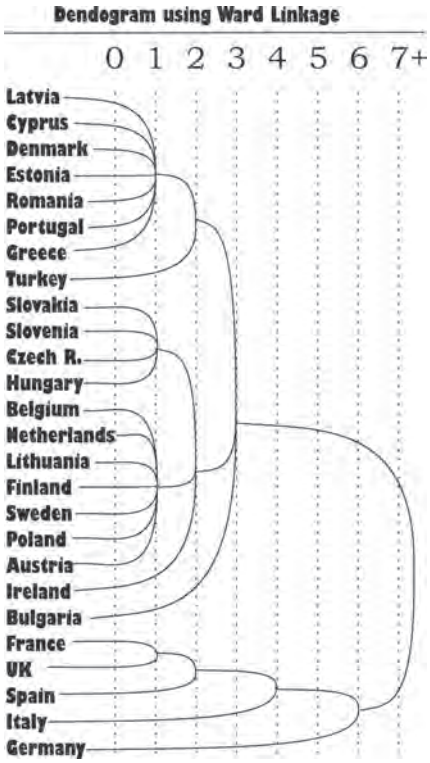

Fig. 3. 2009 Cluster Groups Dendogram
Source: authors' evaluation

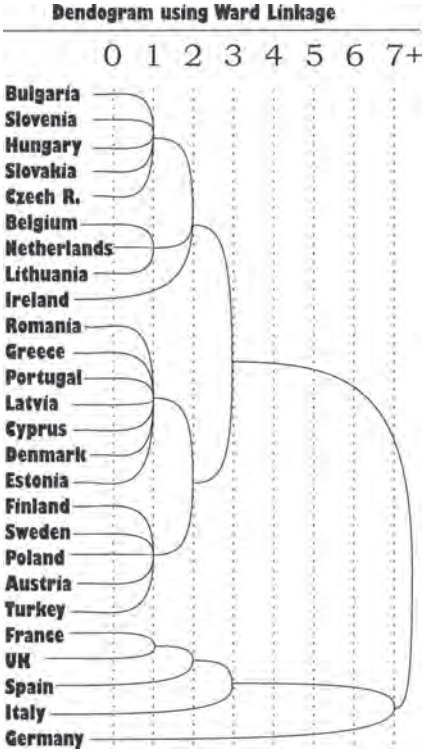

Fig. 4. 2010 Cluster Groups Dendogram
Source: authors' evaluation.

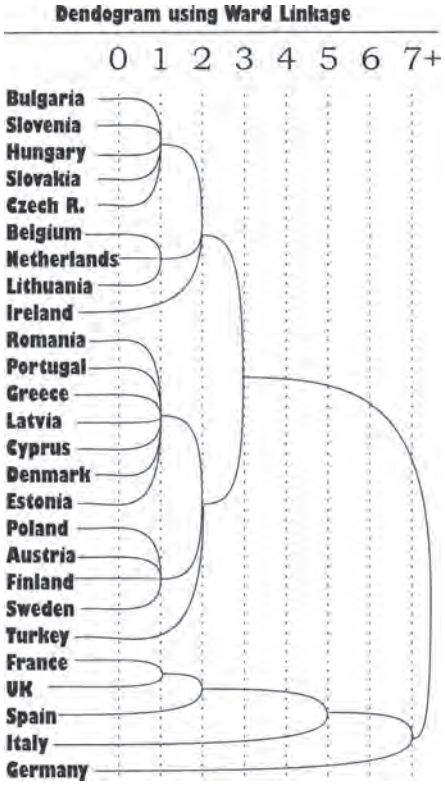

Fig. 5. 2011 Cluster Groups Dendogram
Source: authors' evaluation

CONCLUSION

The most meaningful clustering occurred at a one-unit distance. In this study covering the 2007–2011 time frame, even if countries show different clustering in every year, the general composition does not change dramatically. This means that there is no huge difference among cluster units, or in other words, similarity groups. It seems that, except policy and long-lasting economic factors like regional resource availability, composition of clusters were the most influenced by the economic recession. Changes occurred in most countries which were in the biggest recession during the analyzed period, which reflects previous findings made with the use of other analyzing methods (Rachwał 2011a; Rachwał 2011b).

Ireland always comprises a cluster alone, and thus it does not resemble any country at a one-unit distance. Also, Turkey comprises a cluster alone except for 2010. This shows that the situation and growth of Turkey in terms of industry does not relate to the EU countries. Germany and Italy always make up a cluster together throughout these years, while France and UK are in same cluster except the year 2008. This means that industrial characteristics of these countries do not correlate with any other European country. Although Spain shows similarity to France and UK in 2007 and 2008, it holds a place in an independent cluster between 2009 and 2011. It is noted that Austria, Sweden, Poland and Finland are in same cluster persistently. These countries' industrial characteristics and growth have developed

similarly. Greece, Portugal, Latvia, Cyprus and Romania fall into the same cluster with an exception in 2007 when Romania forms a cluster with other countries. Denmark falls into the same cluster with Latvia, Greece, Portugal, Cyprus and Romania except the year 2010. Bulgaria, Slovenia, Slovakia, Hungary and Czech Rep. form a five-country cluster except the years 2008 and 2009. Lithuania, Netherlands and Belgium take part in the same cluster except the year 2007. As for Estonia, it falls into the same cluster with Cyprus, Denmark, Greece, Latvia, and Portugal for 5 years and Romania joins that cluster during all these years except the year 2007.

Upon looking over industry developments in the 5-year time frame, huge differences between the countries are not noticed. From Turkey's perspective, it can be seen easily that it does not resemble EU countries with regard to industry. It seems to stems from production differences and prices. Also, the collocation of France and UK is noted. Apparently its main reason stems from income similarity in the industry sector. On the other hand, Ireland, Germany and Italy comprise independent clusters in every year. It appears to originate from the fact that production income and prices does not resemble any other EU country.

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