Industrial Clustering Approach in Regional Development: The Case of Turkey

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In this paper, a "3-Star Analysis," commonly used in cluster mapping studies in the European Union (E.U.), was conducted, and manufacturing sectors with clustering potential in Turkey were determined across the 26 regions (NUTS 2). This study first introduces a novel concept of "cluster density index" for the manufacturing sectors in Turkey and then analyzes the relationship between the cluster density index and openness, economic development level and public incentives for investment. In this analysis, we used the non-parametric spearman's rank correlation to test the relationships between the variables of interest.

INTRODUCTION

In 2006, the Public Law 5449 laid out the foundation for establishing 26 Economic Development Agencies across Turkey. The primary goal of this initiative was to promote a competitive economic environment across the regions through public-private partnerships under the leadership of a regional administrator appointed by the central government. Since then, these agencies have initiated a notable number of economic development projects and commissioned studies to uncover the regional economic dynamics.[1]

What was the underlying approach to economic development behind all these efforts? Around the same time that Public Law 5449 was enacted, "(White Book)-Beyaz Kitap" with a subtitle of "The Project on Developing a Clustering Policy in Turkey" was published with the support of both government research institutes and major chambers of commerce, calling for cluster-based regional economic development policies in Turkey (Beyaz Kitap, 2007). Of course, these concepts of regional economic development and industrial clustering are not new in economic development literature. Gaining wide-recognition with Porter (1990) and his subsequent efforts through the Harvard-based "Institute for Strategy and Competitiveness," the cluster-based regional economic development policies have become primary tools across many countries including the European Union. Given the increasing emphasis on the cluster-based policies by the European Union leaders, these regional initiatives in Turkey may be considered as a targeted attempt to harmonize regional economic development policies with the European Union policies.

The goal of this study is to assess (a) how these Turkish regional economic development policies contributed to cluster development in the 24 manufacturing sectors across 26 newly-established regions, and (b) whether the extent of cluster formation is related to economic openness, economic development level, and public incentives for investment in these 26 economic development districts.

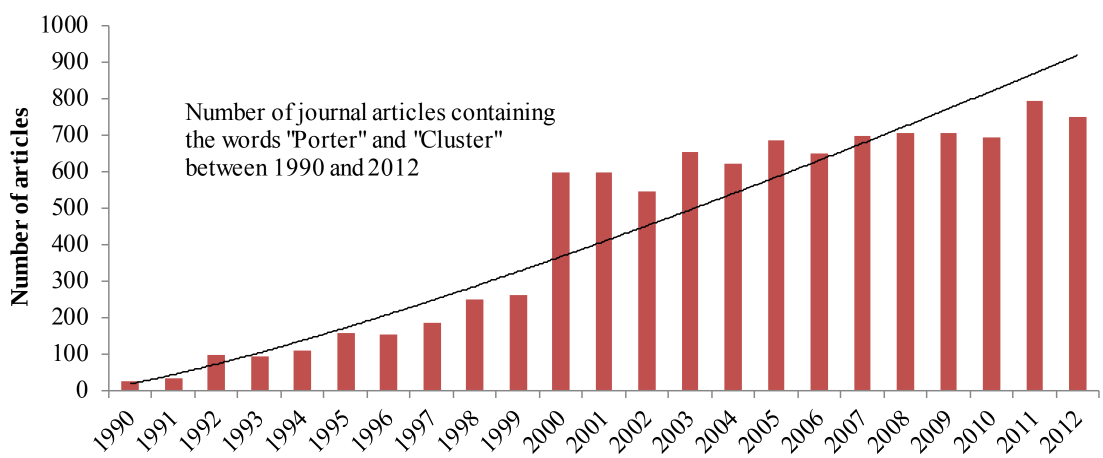
The rest of this paper is organized as follows: First, we provide a background on the clustering approach in regional economic development policies. Second, we offer a detailed discussion about the current practices and issues in literature regarding the industrial cluster policies, as well as the Porter's (1990) diamond approach. Third, we present the method of inquiry with a conceptual framework, hypotheses, data, and measurement issues. A final discussion and conclusion will follow.

BACKGROUND ON INDUSTRIAL CLUSTERING APPROACH

Although it emerged as a discipline after World War II, regional economy or spatial economics had its roots in the early 19th century with the work of German economist Johann Heinrich von Thuehen (Nijkamp & Mills, 1986, p.1). The Great Depression in the 1930s however, had a profound impact on the macroeconomic dynamics around the world. J. M. Keynes (1936) argued that government intervention, not the free market mechanism, is the way to get out of this depression, ushering a period that has influenced regional economics literature. The real life embodiment of this line of thinking was a success story in the Tennessee Valley region, initiated by the Federal Government in the United States between 1930 and 1940.[2] Adapted and expanded by the neoclassical growth models in the 1950s and 1960s, the Keynesian models of regional growth eventually gave way to such concepts as "industrial zones" and "industrial clusters" through the extensive works of F. Perroux, G. Mrydal, and A. Hirschman (Tuyluoglu & Karakas, 2006, pp.197-198)

In 1990, Michael Porter advanced the concept of cluster-based regional economic development by investigating the elements of regional competitiveness at the international level. Porter's study concludes that competitive sectors of countries tend to have cluster formations. Porter's work has added a new vision to economic development and competitiveness approaches by underlining the fact that sustainable competitive advantage depends on a unique mix of internal and external resources in the general business environment. Considered as a new approach or a new way of thinking, clustering has brought a new dimension to industrial policy, regional development policies, innovation, and small and medium enterprises (SME) policies (Quandt & Pacheco, 2000). Since the Porter's diamond model, elaborated in his 1990 study, the literature that has at least cited this model has grown unabated over the years (Figure 1).

FIGURE 1
NUMBER OF JOURNAL ARTICLES INCLUDING WORDS "PORTER" AND CLUSTER



Source: ABI/INFORM Complete Database

A review of some recent works suggests why the clustering approach to regional development has not lost its appeal over the years. For example, giant clusters, which make a major contribution in terms of regional development, are widely observed in the United States. The notable example is the California's Silicon Valley. Klepper (2010) provides a good history of how Silicon Valley and Detroit have transformed their respective cities in the last 30 years through the semiconductor and automotive industries, respectively (Klepper, 2010, p.15).

In addition to broader regional development tool, the clustering approach is often seen as, first, an effective mechanism to promote the emergence of new business opportunities for the small and medium enterprises in the cluster (Quandt & Pacheco, 2000, p.1). Second, the firms in industrial clusters benefit from knowledge and technology transfer. Third, the firms located within a cluster may have access to qualified and/or trained personnel through educational institutions and institutions associated with the labor market in the cluster. Finally, cluster network provides the firms with the opportunity to access specialized suppliers (Isbasoiu, 2007). Businesses located within an industrial cluster will reduce their transaction costs by using local suppliers instead of procuring intermediate goods from a remote supplier.

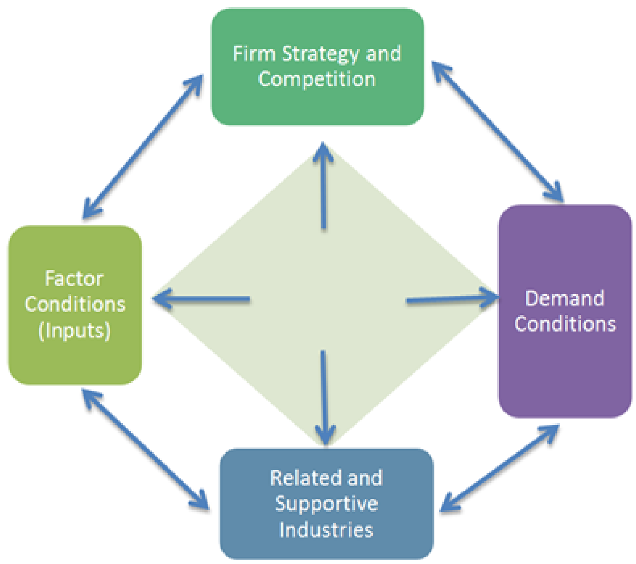
From a marketing perspective, the clustering has two major benefits: on one hand, the enterprises in an industrial cluster will have recognition and prestige, an efficient distribution network, and the opportunity to penetrate deeply into the market. This will in turn increase the number of customers and revenues for the firms not only in the local markets but also in the international markets. On the other hand, the cluster itself is also an important internal market. The clustering approach provides significant opportunities to access facilities and services offered by public institutions to the enterprises which are located within the cluster network. Physical infrastructure provided by the public sector, institutions such as research institutes and testing laboratories, and services such as education are offered to enterprises located within the cluster. All of these facilities increase the success and the competitiveness of enterprises located in industrial clusters. Because of these potential benefits, industrial clustering approach has still been one of the favorite tools used by scholars, professionals and political leaders for regional development and the economic competitiveness.

LITERATURE REVIEW

The industrial clustering approach is mainly based on the brief references related to "industrial districts" proposed by Alfred Marshall in his book "The Principles of Economy" which was published for the first time in 1890. Marshall (1890) refers to three conditions for the formation of industrial clusters. These are the existence of a pool of adequate labor, the presence of specialized suppliers and the possibility of external spill-overs (the rapid transfer of know-how and ideas inside the cluster). Walter Isard (1960) developed the concept of industrial clusters by adding export-oriented industries and links of these industries to other industries in the region. According to Isard, these strong industrial links are a proof of the existence of industrial clusters (Isbasoiu, 2007, p.3). Industrial clusters are defined by many academics as industrial groups concentrated in a particular geographic area, connected to each other both vertically (having relationships with suppliers and customers) and horizontally (sharing common resources such as technology and human resources) (Porter, 1990; Feser & Bergman, 2000; Feser, 2005). Today, many articles on clustering approach are published in scientific journals related to the economy, growth, and regional development (Maskell, P. & Kebir, L., 2006, p.30; see Figure 1 for the general trend).

In recent years, there has been a surge in the number of the clustering studies that deals with regional and international competitiveness created by the clusters. For example, ABI/INFORM Complete Search using the “cluster” and “competitiveness” keyword combinations produces 2,454 articles between 1990 and 1999; 8,641 articles between 2000 and 2009; and 4,195 records between 2010 and 2014. As highlighted previously, the pioneering work of Michael Porter (1990) has contributed to this surge. Because of its significance, this section further elaborates Porter’s approach to industrial clustering and economic competitiveness. According to Porter (1990), a cluster as a whole is greater than the sum of its constituent parts. The Porter’s diamond model proposed in this study explains why some societies have a comparative advantage in certain industries. The diamond model highlights the conditions necessary for a region to achieve an international competitive advantage using four inter-related elements (Porter, 1990, pp.72-74). These are (1) factor conditions, (2) demand conditions, (3) firm strategy and competition, and (4) related and supportive industries (Figure 2).

FIGURE 2
PORTER'S DIAMOND MODEL (1990)



Source: Recreated by Authors from Porter (1990)

According to Porter (1990), favorable factor conditions (Figure 2) are necessary to achieve an international competitive advantage. These factor conditions fall under two main categories: simple and advanced. While natural resources, climate, physical infrastructure, unskilled and semi-skilled labor, and financial capital are grouped under the simple category, modern digital data communications infrastructure, highly trained administrative staff such as engineers and computer scientists, and research institutions are cited under the advanced factor conditions. Nowadays, especially advanced factor conditions are very important in achieving international competitive advantage for the firms.

To briefly highlight other elements, Porter considers the structure of the household demand for products and services of industries, demand conditions, as an important element for a competitive regional economy. The third element in his model includes related and supporting industries, representing the presence or absence of industries producing internationally competitive products and the first-tier suppliers of these industries in a nation or region. The last element is firm strategy, structure, and rivalry, which are related to how businesses are set up, how they are organized, the structure of local competition, and the level of competition in a given geographical area (Porter, 1990, pp.74-77).

An important part of the cluster model developed by Porter is that governments play an important but indirect role in creating internationally competitive sectors. According to Porter, the government should not try to create a competitive advantage on its own, but should indirectly contribute to the creation of a competitive environment by supporting the four main elements in the model. Porter suggests that governments may positively or negatively affect (or may be affected by) the four main elements in the diamond model. In addition to government, there are also the chance factors in the Diamond Model, described as events beyond anyone's control but whose occurrence may adversely affect sectors and change their relative positions in the competitive environment (Porter, 1990, p.127).

A major research question in the cluster-related papers is about the differential growth rates across the regions (Porter, 1990, 1998a; Saxenian, 1996; Barro & Sala-i-Martin, 1995). Within this context, some studies emphasize the relationship between cluster formation and entrepreneurship. For example, Delgado, Porter & Stern (2010) investigated the impact of industrial clustering or agglomeration at regional industry level on entrepreneurship. Using a novel panel dataset from the Longitudinal Business Database of the Census Bureau and the U.S. Cluster Mapping Project, this study focused on the distinct influences of convergence and agglomeration on the number of start-up firms as well as employment growth in these new firms in a given region The major findings of this study are that (1) clusters have positive impact on entrepreneurship; (2) strong clusters mean more start-ups and employment growth; (3) the strong industrial clusters lead to the expansion of existing companies; and (4) the strong clusters mean a high survival rate for the start-up firms (Delgado, Porter & Stern, 2010, p.2).

A somewhat related study looks at the relationship of how clustering is connected with entrepreneurship and economic growth. Wennberg and Lindqvist (2008), for example, compared the performance and chances of survival of newly established enterprises located in industrial clusters with those that are not located in industrial clusters. Using a rigorous methodology, the study concludes that (1) companies located within the cluster were more fortunate in terms of survival; and (2) enterprises located within the cluster created more employment, paid higher wages to their employees, and paid higher taxes as well (Wennberg & Lindqvist 2008, p.2).

Today, the clustering approach is regarded as an important program in regional development, sustainable growth, and increasing competitiveness. Because of its significance, it is not hard to find many studies commissioned by developed countries on industrial clustering. For example, European Cluster Policy Group (ECPG) was established in 2008 by a decision of the European Commission aiming to carry out studies to increase coordination and quality. The European Cluster Policy Group (ECPG) is composed of 20 independent experts. ECPG is assigned the task of "producing suggestions on how to better design the clustering policies within the EU."[3] The studies conducted by this group demonstrate that companies located within a cluster reach higher levels of productivity and innovation, and clusters provide higher chances of survival and higher growth rates for newly established firms suggesting the continuation of clustering programs across the region.

In addition to academic and country specific clustering analyses, it is worth mentioning several institutions and programs that have emerged as a major force in cluster research. Among these programs and institutions, the U.S. Cluster Mapping Project[4] carried out by Institute for Strategy and Competitiveness, [5] Harvard University, under the leadership of Michael E. Porter is a major project funded by the U.S. Department of Commerce and the Economic Development Administration. The U.S. Cluster Mapping website created within the scope of the project offers data for researchers and policy-makers across the United States allowing them to analyze regional clusters. The European equivalent of this institution is the Center for Strategy and Competitiveness[6] located within Stockholm School of Economics and funded by DG Enterprise and Industry of the European Commission. This Center is also the coordinator of the European Cluster Observatory[7] and Europe INNOVA Cluster Mapping Project.[8]

In Turkey, a major source on clustering studies is the so-called "White Book." The White Book of "The Project on Developing a Clustering Policy in Turkey" is prepared with a participatory approach by the direct and active participation of sixteen stakeholders including the Undersecretariat of the Treasury, the Ministry of Industry and Commerce, the State Planning Organization, TUBITAK (the Scientific and Technological Research Council of Turkey), Middle East Technical University, the Ministry of Agriculture and Rural Affairs, the Ministry of Culture and Tourism, the Ministry of Labor and Social Security, the Ministry of Education, the Undersecretariat of Foreign Trade, TUSIAD (Turkish Industry and Business Association), MUSIAD (Association of Independent Industrialists and Businessmen), TOBB (The Union of Chambers and Commodity Exchanges of Turkey), and Exporters Association of Turkey. The White Book (Beyaz Kitap) includes the principles and the goals of clustering policies, as well as the levels and stages of policy process, policy tools and success factors (Beyaz Kitap, 2007, p.11).

In addition to this general framework, in recent years academic interest on clustering approach is on the rise in Turkey as well (Eraslan, Bulu, & Bakan, 2008, p.5; Alsac, 2010). In the sections that follow, we introduce a cluster density index using a standard cluster identification method in Europe, and then test whether this index is associated with certain elements identified directly or indirectly in the Porter's Diamond Model.

METHODS

The goal of this study is twofold: (1) developing a clustering map of Turkish manufacturing industry, and (2) assessing the relationship between clustering density and certain variables of interest. For this purpose, available data allows us to map out the industrial clusters for 2008 and 2011. What are the methods used for industrial clustering? These methods range from using qualitative information to sophisticated statistical methods. Some examples of these methods include face-to-face interviews, focus groups, 3-Star Analysis, Input-Output Analysis, and Shift Share Analysis. One of the common methods used in Europe to compare cluster formations across the member countries is the 3-Star Analysis.[9] This study utilizes the 3-Star Approach in identifying industrial clusters in Turkey. As the name suggests, three different analyses are performed in the 3-Star Analysis. These are the Location Quotient (LQ) analysis, local dominance (sector's share in local economy), and size (local sector's share in national sector).

Commonly used in "cluster mapping" studies in the European Union (EU), the 3-Star Analysis for the manufacturing sectors at NACE Rev. 2 at the two-digit level (see Appendix 1) is conducted across 26 regions (NUTS-II) in Turkey. These 26 regions (Table 1) overlap with the 26 Economic Development Districts introduced in Turkey in 2006. Because of the data availability issues at the sectoral level across the regions, we used employment by industry data, which was Distribution of Insured Persons and Work Place by Activity Groups and Provinces (Under Article 4-1/a of Act 5510), retrieved from the Social Security Institution of Turkey.

There are three important criteria used in the 3-Star Analysis:

Size: This measure is defined as the ratio of region's employment to the national employment in a given industry, specified as

$$Size = \frac{e_{ij}}{E_i} \tag{1}$$

$where\ e_{ij} =\ i^{th} industry's\ employment\ in\ j^{th}\ region$

$E_i =\ i^{th}\ industry'semployment\ in\ the\ nation$

Dominance: This measure is related to a sector's relative strength in a region's economy, defined as

$$Dominance = \frac{e_{ij}}{e_j} \tag{2}$$

$where\ e_{ij} =\ i^{th} industry's\ employment\ in\ j^{th}\ region$

$e_j =\ j^{th}\ region's\ total\ employment$

Specialization: This measure is the ratio of the share of employment in the sector in the region to the share of employment in the sector in the total employment in the country. Here;

$$Specialization\ (LQ) = \left[{}^{e_{ij}}/_{e_j}\right] / \left[{}^{E_i}/_{E_n}\right] \tag{3}$$

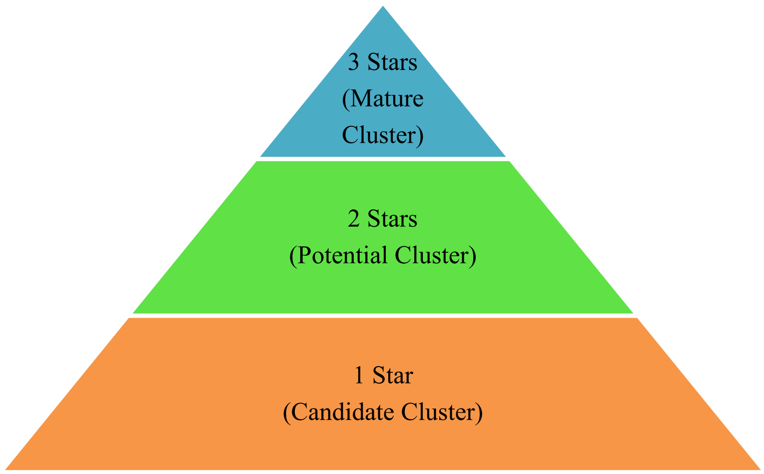
$where\ e_{ij} =\ i^{th}\ industry'semployment\ in\ j^{th}\ region$

$e_j =\ j^{th}\ region's\ total\ employment$

$E_i = i^{th}\ industry' s employment\ in\ the\ nation$
$E_n = total\ employment\ in\ the\ nation$

What are some common thresholds used to assign a star to an industry? There is no standard measure in the literature. For example, some studies determine a threshold value for each criterion (size, dominance, and specialization). A sector exceeding the threshold value in any one of the ‘size,’ ‘dominance,’ or ‘specialization’ criteria is given one star. Figure 3 establishes the relationship between star levels and maturity of clusters.

FIGURE 3
3-STAR CLUSTER MAPPING APPROACH AND CLUSTER MATURITY



What thresholds are used in this study? Threshold values differ by studies. For example, in the Ketels & Solvell's 3-Star Clustering Analysis study including 10 new EU member countries, the threshold value for ‘size’ and ‘dominance’ criteria was 0.7 and the threshold for ‘specialization’ coefficient was higher than (LQ>) 1.75 (Ketels and Sölvell, 2006, p.24). Cluster Observatory uses a different approach in its study covering all EU countries. Cluster Observatory first calculates the 'size' and 'focus' [‘dominance’ in this paper] values. Then, according to the calculated 'size' value, it allocates a star to the best 10% of the clusters that are located in a region. Similarly, according to the calculated 'focus' value, it allocates a star to the best 10% of the clusters that are located in a region. When evaluating the specialization criterion, Cluster Observatory assumes a Location Quotient value higher than (LQ>) 2. [10]

The cluster analysis in this paper is based on the methodology used by Cluster Observatory. However, the assumptions regarding the threshold values were relaxed. We used the NUTS-II regions (26 regions) and NACE Rev. 2 two-digit sector codes (24 manufacturing sectors). First, ‘size’, ‘focus’[dominance], and ‘specialization’ values were calculated. Then, according to the calculated 'size' or ‘focus’[dominance] values, a star was allocated to the best 20% of the clusters located in a region. The threshold value for specialization was set as higher than (LQ >) 1.

Conceptual Framework and Hypothesis

Figure 4 below lays out the conceptual framework and hypothesized relationships in this study. The method for the cluster identification phase is already outlined above.

FIGURE 4
CONCEPTUAL FRAMEWORK:
3-STAR CLUSTER MAPPING AND REGIONAL ECONOMY

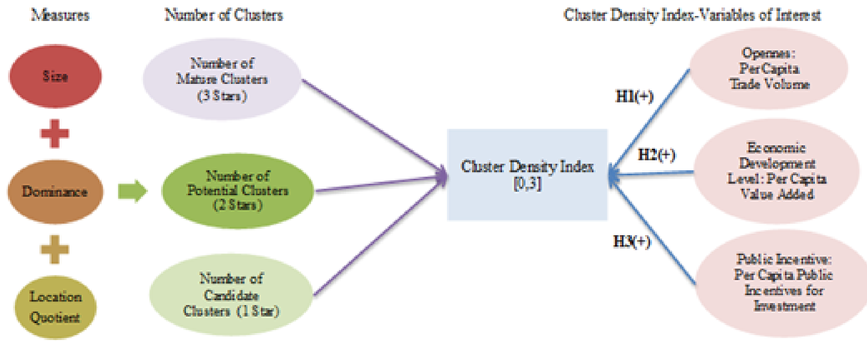


Figure 4 highlights the relationship between cluster development and macroeconomic dynamics in a region. The study proposes a summary measure of cluster dynamics at the regional level and then explores the relationship between this summary measure and macroeconomic indicators. Based on literature review, we have three hypotheses:

> *Hypothesis 1: Economic openness level is positively related to the high level of cluster density in a region.*

We assume that openness in a regional economy promotes a competitive business environment.

> *Hypothesis 2: Economic development level is positively related to the high level of cluster density in a region.*

We assume that economic growth and cluster development are positively associated.

> *Hypothesis 3: Government incentives are positively related to the high level of cluster density in a region.*

We assume that government incentives promote regional cluster development.

Data

Manufacturing employment data is obtained from the Social Security Institution of Turkey. The regional level data that includes export, import, population, public incentives, and value-added is from the Ministry of Development (www.dpt.gov.tr).

Measurement and Definitions

Cluster Density Index (CDI) is defined as

$$CDI = [(1 \times CC_n) + (2 \times PC_n) + (3 \times MC_n)]/24 \quad (4)$$

$where\ CC_n = Number\ of\ Candidate\ Clusters$
$PC_n = Number\ of\ Potential\ Clusters$
$MC_n = Number\ of\ Mature\ Clusters$
$24 = Number\ of\ Manufacturing\ Sectors\ Included\ in\ the\ Analysis$

Openness is defined as per capita trade volume (exports + imports).
Economic Development Level is defined as per capita value added in 2008.
Public Incentives for Investment is defined as per capita public incentives for investment projects across the region.

Spearman's Rank-Order Correlations

Spearman's rank-order correlation is the nonparametric version of the Pearson product-moment correlation. Because of the sample size (26 regions) and large outliers across the variables and regions (Table 4 below), we opted for the rank-order correlation rather than a regression analysis. We rank regions by cluster density index (CDI), openness, economic development level, and public incentives per capita from 1 (the highest score value) to 26 (the lowest score value in a given category). The formula for the Spearman's rank-order correlation is given below

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \tag{5}$$

$Where\ d_i = difference\ in\ paired\ ranks\ and\ n = number\ of\ cases$

The Spearman's rank-order correlation ($\rho\ or\ r_s$) takes a value between +1 and -1; +1 indicating a perfect association; 0 indicating "no-association"; and -1 indicating a perfect negative association. We used SPSS to analyze the association between the cluster density and variables of interest.

CLUSTERS BY REGIONS

The results of the 3-Star analysis are summarized below in Table 1 for 2008 and in Table 2 for 2011. The analyses were conducted for all NACE Rev. 2 sectors. In this paper, only manufacturing sectors are provided (Appendix 1). The results for all NACE Rev. 2 sectors can be provided by the authors upon request.

Tables 1 and 2 present the results of the 3-Star Cluster analysis for 2008 and 2011. By looking at these tables, we would like to offer a few general conclusions about the methodology and findings. First, the many industries in the large regions such as TR10 (Istanbul) tend to get 1 star cluster designation. Second, there has been a dramatic shift across the regions and within the manufacturing industry between 2008 and 2011. For example, the number of industries receiving candidate cluster status through 'size' and 'focus' increased dramatically while the industries getting the same designation through the 'specialization' (LQ) declined by 57 percent. Finally, the number of 3-Star Clusters (mature clusters) increased from 25 to 27 across the regions. A notable shift occurred in Istanbul (TR10) as the region had its three mature clusters in 2011. These were (1) manufacture of wearing apparel, (2) manufacture of rubber and plastic products, and (3) manufacture of fabricated metal products, except machinery and equipment.

TABLE 1
REGIONS WITH TYPE OF CLUSTERS: 2008

Region	A=Size (1Star) B=Dominance (1Star) C=LQ (1Star) AB=Size and Dominance (2Stars) AC=Size and LQ (2Stars) BC=Dominance and LQ (2Stars) and ABC=Size, Dominance and LQ (3Stars)						
	A	B	C	AB	AC	BC	ABC
TR10 (İstanbul)	10, 11, 15, 16, 17, 18, 19, 20, 23, 24, 26, 27, 28, 29, 30, 31, 33			13, 14, 22, 25	21, 32		
TR21 (Tekirdağ, Edirne, Kırklareli)		25	22, 23, 24, 26, 27		11, 15, 17, 20, 21	10	13,14
TR22 (Balıkesir, Çanakkale)		14	11, 15, 16, 20, 28, 29, 30, 31, 33			10, 23, 24	
TR31 (İzmir)	13, 32		23, 31		11, 12, 15, 16, 17, 18, 19, 20, 22, 24, 26, 27, 29, 33		10, 14, 25, 28
TR32 (Aydın, Denizli, Muğla)			11, 17, 25, 26, 27, 30, 33		16, 32	10	13, 14, 23
TR33 (Kütahya, Manisa, Afyon, Uşak)			11, 16, 20, 22, 24, 29		12, 15, 18, 26, 27	10, 13, 25	23
TR41 (Bilecik, Bursa, Eskişehir)	18, 33			14	10, 11, 16, 17, 20, 22, 23,		13, 25, 28
TR42 (Bolu, Düzce, Kocaeli, Sakarya, Yalova)	14		27		11, 16, 17, 19, 20, 21, 23, 24, 26, 29, 30, 31, 33		10, 22, 25, 28
TR51 (Ankara)			16, 20, 23, 24		11, 15, 18, 21, 26, 27, 30	10	25, 28, 33
TR52 (Konya, Karaman)			11, 15, 16, 17, 18, 22, 24, 27, 31		10, 29	23, 25, 28	
TR61 (Antalya, Burdur, Isparta)			11, 16, 18, 19, 20, 27, 30, 31, 33		32	10, 13, 23, 25	
TR62 (Adana, Mersin)			11, 12, 16, 18, 20, 22, 23, 24, 27, 28, 32, 33		17, 19	10, 13, 14, 25	
TR63 (Hatay, Kahramanmaraş, Osmaniye)			16, 19, 23, 29		12	10, 13, 25	24
TR71 (Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir)			11, 13, 16, 18, 22, 24, 28, 29, 31, 33		19	10, 14, 23, 25	
TR72 (Kayseri, Sivas, Yozgat)			17, 20, 22, 24, 26, 27, 28, 33		30, 31	10,13,23,25	
TR81(Bartın, Karabük, Zonguldak)			10, 15, 16, 23, 30, 31			14, 25, 33	24
TR82 (Çankırı, Kastamonu, Sinop)			20, 24, 26, 30			10, 14, 16, 23	
TR83 (Amasya, Çorum, Samsun, Tokat)			11, 16, 17, 18, 22, 24, 26, 28, 31, 32, 33		12, 21	10, 14, 23, 25	
TR90 (Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon)		14	11, 12, 16, 18, 27, 30, 31, 32			23, 33	10
TRA1 (Bayburt, Erzincan, Erzurum)			16, 18, 19, 24, 26, 31, 32			10, 23, 25, 33	
TRA2 (Ağrı, Ardahan, Iğdır, Kars)			11, 16, 33			10, 15, 18, 23	
TRB1 (Bingöl, Elazığ, Malatya, Tunceli)			11, 12, 16, 17, 18, 22, 27, 30, 33			10, 13, 14, 23	
TRB2 (Bitlis, Hakkari, Muş, Van)			12, 16, 18, 19, 24, 30, 32			10, 14, 23, 33	
TRC1 (Adıyaman, Gaziantep, Kilis)		14	17, 19		12, 15	10	13, 22
TRC2 (Şanlıurfa, Diyarbakır)			11, 16, 18, 19, 20, 27, 28, 32		12	10, 13, 23, 33	
TRC3 (Batman, Mardin, Şırnak, Siirt)			11, 12, 16, 18, 20, 27, 28, 32, 33			10, 14, 19, 23	

TABLE 2
REGIONS WITH TYPE OF CLUSTERS: 2011

A=Size (1Star) B=Dominance (1Star) C=LQ (1Star)
AB=Size and Dominance (2Stars) AC=Size and LQ (2Stars)
BC=Dominance and LQ (2Stars) and ABC=Size, Dominance and LQ (3Stars)

Region	A	B	C	AB	AC	BC	ABC
TR10 (İstanbul)	10, 11, 12, 16, 23, 24, 29, 30, 31			13	15, 17, 18, 20, 21, 26, 27, 28, 32, 33		14, 22, 25
TR21 (Tekirdağ, Edirne, Kırklareli)	21	10, 25	26		11, 15, 17, 20, 27		13, 14
TR22 (Balıkesir, Çanakkale)		25	11, 16, 20, 31			10, 23, 24	
TR31 (İzmir)	16, 18, 22, 29		24	10, 25	11, 12, 15, 17, 19, 20, 26, 31, 32, 33		14, 28
TR32 (Aydın, Denizli, Muğla)			11, 16, 33	14		10	13, 23
TR33 (Kütahya, Manisa, Afyon, Uşak)	12, 18	13, 25	11, 16		15, 26, 27	10	23
TR41 (Bilecik, Bursa, Eskişehir)	14, 16, 17, 20, 22, 30, 33			10	11, 23, 27, 28, 31		13, 25, 29
TR42 (Bolu, Düzce, Kocaeli, Sakarya, Yalova)	14, 18, 23, 26, 32, 33			10	11, 16, 17, 19, 20, 21, 27, 28, 29, 30		22, 24, 25
TR51 (Ankara)	15, 21	10	27		18, 24, 26, 30, 31, 32		25, 28, 33
TR52 (Konya, Karaman)			15, 16		29	24, 25, 28	10
TR61 (Antalya, Burdur, Isparta)		13, 25	11, 18, 20, 30, 31		16, 32	10, 23	
TR62 (Adana, Mersin)		13, 14, 25	16, 20, 22, 23, 24, 28, 33		11, 12, 17, 19	10	
TR63 (Hatay, Kahramanmaraş, Osmaniye)		10, 25	19			13	24
TR71 (Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir)			11, 22, 24, 31		19	10,23, 25, 28	
TR72 (Kayseri, Sivas, Yozgat)		13	24, 27		30	10, 25	31
TR81(Bartın, Karabük, Zonguldak)		10	15, 16, 30			14, 23	24
TR82 (Çankırı, Kastamonu, Sinop)			20, 27, 30			10, 14 23	16
TR83 (Amasya, Çorum, Samsun, Tokat)	21	14, 25	16, 17, 24, 31, 32, 33			10, 23	
TR90 (Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon)	12	14, 25	11, 16, 31			23	10
TRA1 (Bayburt, Erzincan, Erzurum)		25	11, 16, 18, 24, 32			10, 23, 33	
TRA2 (Ağrı, Ardahan, Iğdır, Kars)		33	11, 16			10, 18, 23	
TRB1 (Bingöl, Elazığ, Malatya, Tunceli)			11, 30, 31, 33			10, 13, 14, 23	
TRB2 (Bitlis, Hakkari, Muş, Van)		13, 14	18, 19, 33			10, 23	
TRC1 (Adıyaman, Gaziantep, Kilis)		14	17		15	10	13, 22
TRC2 (Şanlıurfa, Diyarbakır)			27, 28		12, 13	10, 23, 33	
TRC3 (Batman, Mardin, Şırnak, Siirt)		13	11, 18, 31, 32		19	10, 23, 33	

Table 3 below highlights regional distribution of mature clusters in 2008 and 2011. The TR31 (İzmir) region experienced a dramatic shift between 2008 and 2011 as its two sectors lost its mature cluster designation in this period. Mature clusters in TR31 (Izmir) Region in 2008 were (1) manufacture of food products, (2) manufacture of wearing apparel, (3) manufacture of fabricated metal products, except machinery and equipment, and (4) manufacture of machinery and equipment n.e.c. In 2011, fabricated metals and food products were no longer part of the mature industrial clusters in this region.

A similar trend is visible across the western regions such as TR32 (Aydın, Denizli, Muğla) region, which lost its competitive advantage in wearing apparel manufacturing industry, and TR42 (Bolu, Düzce, Kocaeli, Sakarya, Yalova) region, which lost its competitive advantage in food products manufacturing industry.

On the positive side, there were several regions that made significant progress: TR52 (Konya, Karaman) has gained competitive advantage in food manufacturing industry; TR72 (Kayseri, Sivas, Yozgat) region has gained competitive advantages in furniture manufacturing industry; and TR82 (Çankırı, Kastamonu, Sinop) region has gained competitive advantage in woods, wooden products and cork products manufacturing (excluding furniture) industry.

TABLE 3
MATURE INDUSTRIAL CLUSTERS: 2008-2011

	Sectors with three stars in 2008 (Mature Clusters)	Sectors with three stars in 2011 (Mature Clusters)
TR10 (İstanbul)		14, 22, 25
TR21 (Tekirdağ, Edirne, Kırklareli)	13,14	13, 14
TR22 (Balıkesir, Çanakkale)		
TR31 (İzmir)	10, 14, 25, 28	14, 28
TR32 (Aydın, Denizli, Muğla)	13, 14, 23	13, 23
TR33 (Kütahya, Manisa, Afyon, Uşak)	23	23
TR41 (Bilecik, Bursa, Eskişehir)	13, 25, 28	13, 25, 29
TR42 (Bolu, Düzce, Kocaeli, Sakarya, Yalova)	10, 22, 25, 28	22, 24, 25
TR51 (Ankara)	25, 28, 33	25, 28, 33
TR52 (Konya, Karaman)		10
TR61 (Antalya, Burdur, Isparta)		
TR62 (Adana, Mersin)		
TR63 (Hatay, Kahramanmaraş, Osmaniye)	24	24
TR71 (Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir)		
TR72 (Kayseri, Sivas, Yozgat)		31
TR81(Bartın, Karabük, Zonguldak)	24	24
TR82 (Çankırı, Kastamonu, Sinop)		16
TR83 (Amasya, Çorum, Samsun, Tokat)		
TR90 (Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon)	10	10
TRA1 (Bayburt, Erzincan, Erzurum)		
TRA2 (Ağrı, Ardahan, Iğdır, Kars)		
TRB1 (Bingöl, Elazığ, Malatya, Tunceli)		
TRB2 (Bitlis, Hakkari, Muş, Van)		
TRC1 (Adıyaman, Gaziantep, Kilis)	13, 22	13, 22
TRC2 (Şanlıurfa, Diyarbakır)		
TRC3 (Batman, Mardin, Şırnak, Siirt)		

As highlighted in Tables 1-3, there have been changes in the fortunes of the regions. What might be some of the factors that are related to the cluster density across the regions? Does relatively high trade volume promote a competitive business environment? How about the role of government? How does initial development level contribute to clustering in future periods? These are some of the critical questions that should be explored in Turkey. Because of data limitations, in the next section, we will look at the nonparametric relationship between the cluster density index and these variables without implying any causal relationships.

STUDY RESULTS

Summary Data

Table 4 below summarizes major variables used in this paper. For each variable, the five best performing regions (green) and the five worst performing regions (red) are highlighted. There are significant variations across the regions in terms of economic development, openness, cluster density, and public investment incentives. The coefficient of variations are higher than 0.4 across all variables suggesting regional uneven economic development. One notable observation is that the coefficient of variation for per capita trade volume is 1.24 suggesting that a few regions account for a large portion of the trade volume in the nation. Indeed, a review of data shows the extreme concentration of trade activities in a few regions, with Istanbul topping the list as an extreme outlier.

Spearman's Rank-Order Correlations

As Table 4 clearly shows, data is highly skewed to conduct regression analysis. Spearman's rho seems to be the best approach to look at the association between the Cluster Density Index and regional macroeconomic indicators. Table 5 reports the strength of association between the Cluster Density Index and per capita trade volume. Spearman rho correlation coefficient suggests a statistically significant relationship between the cluster density and openness in the region (*$r_s(26)=.575$, $p<0.002$*). If we square the correlation coefficient, we can argue that 33.1 percent of the variance in cluster density is accounted for by per capita trade volume, and likewise, 33.1 percent of the variance in per capita trade volume is accounted for by the cluster density. Test result confirms our first hypothesis.

TABLE 4
SUMMARY DATA: CLUSTER DENSITY INDEX, VALUE ADDED, PUBLIC INVESTMENT INCENTIVES AND TRADE VOLUME

Region	Per Capita Value Added in 2008 (TL)	Cluster Density Index 2011	Per Capita Public Incentives for Investment 2011 (TL)	Per Capita Trade Volume in 2011 (US$)
TR10 (İstanbul)	**14,591**	**1.67**	3,586	**13,379**
TR21 (Tekirdağ, Edirne, Kırklareli)	**12,243**	0.83	**6,892**	1,227
TR22 (Balıkesir, Çanakkale)	9,000	**0.46**	4,682	698
TR31 (İzmir)	11,568	**1.46**	4,636	**4,667**
TR32 (Aydın, Denizli, Muğla)	9,076	0.54	3,753	2,232
TR33 (Kütahya, Manisa, Afyon, Uşak)	8,256	0.71	3,731	2,972
TR41 (Bilecik, Bursa, Eskişehir)	**12,983**	**1.17**	3,971	**6,850**
TR42 (Bolu, Düzce, Kocaeli, Sakarya, Yalova)	**13,265**	**1.54**	**6,668**	**8,570**
TR51 (Ankara)	**12,598**	**1.04**	3,078	3,729
TR52 (Konya, Karaman)	7,213	0.54	3,259	1,177
TR61 (Antalya, Burdur, Isparta)	10,334	0.63	**5,388**	761
TR62 (Adana, Mersin)	7,363	0.83	**7,680**	1,919
TR63 (Hatay, Kahramanmaraş, Osmaniye)	5,937	**0.33**	4,543	3,131
TR71 (Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir)	6,789	0.58	4,359	535
TR72 (Kayseri, Sivas, Yozgat)	6,813	0.50	2,620	1,438
TR81(Bartın, Karabük, Zonguldak)	8,734	**0.46**	3,640	2,599
TR82 (Çankırı, Kastamonu, Sinop)	6,676	0.50	4,114	**218**
TR83 (Amasya, Çorum, Samsun, Tokat)	6,914	0.54	**2,084**	689
TR90 (Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon)	7,059	**0.46**	3,078	921
TRA1 (Bayburt, Erzincan, Erzurum)	5,520	0.50	3,184	**100**
TRA2 (Ağrı, Ardahan, Iğdır, Kars)	**3,601**	**0.38**	**1,748**	**225**
TRB1 (Bingöl, Elazığ, Malatya, Tunceli)	5,517	0.50	2,516	295
TRB2 (Bitlis, Hakkari, Muş, Van)	**3,419**	**0.38**	**1,577**	**217**
TRC1 (Adıyaman, Gaziantep, Kilis)	**4,597**	0.50	**4,698**	**3,853**
TRC2 (Şanlıurfa, Diyarbakır)	**3,724**	0.50	**1,336**	**200**
TRC3 (Batman, Mardin, Şırnak, Siirt)	**3,812**	0.54	**2,326**	955
Average	7,985	0.70	3,813	2,444
Standard Deviation	3,211	0.37	1,567	3,022
Coefficient of Variation (CV)	0.40	0.53	0.41	1.24

Source: Authors' calculations from official government statistics, Ministry of Development, www.dpt.gov.tr

TABLE 5
CORRELATIONS \ SPEARMAN'S RHO:
CLUSTER DENSITY INDEX VS. OPENNES (PER CAPITA TRADE VOLUME)

			Cluster Density Index	Per Capita Trade Volume (Opennes)
Spearman's rho	Cluster Density Index	Correlation Coefficient	1.000	.575**
		Sig. (2-tailed)		.002
		N	26	26
	Per Capita Trade Volume (Openness)	Correlation Coefficient	.575**	1.000
		Sig. (2-tailed)	.002	
		N	26	26

** Correlation is significant at the 0.01 level (2-tailed).

Our second hypothesis was about the positive association between economic development level and cluster density index. Table 6 presents correlation coefficients for this relationship. In this analysis, we used per capita value added in 2008 as a proxy for economic development level of regions. The correlation coefficient is statistically significant and has the expected positive sign (*rs(26)=.74, p<0.000).* The squaring the correlation coefficient suggests that 54.8 percent of the variance in the cluster density is accounted for by economic development level, and similarly, 54.8 percent of the variance in the economic development is accounted for by the cluster density in a region.

TABLE 6
CORRELATIONS \ SPEARMAN'S RHO:
CLUSTER DENSITY INDEX VS. PER CAPITA VALUE ADDED

			Cluster Density Index	Per Capita Value Added
Spearman's rho	Cluster Density Index	Correlation Coefficient	1.000	.740**
		Sig. (2-tailed)		.000
		N	26	26
	Per Capita Value Added	Correlation Coefficient	.740**	1.000
		Sig. (2-tailed)	.000	
		N	26	26

** Correlation is significant at the 0.01 level (2-tailed).

Our last hypothesis was about the role of government in cluster development. We hypothesized that government incentives for investment are positively associated with the cluster density index. Table 7 below suggests that there is a statistically significant relationship between the per capita government incentives for investment and the cluster density index, and the correlation coefficient has the expected sign. However, the relationship is not as robust as we reported in the previous tables (*rs(26)=.401, p<.042).* The squaring of the coefficients in this case suggests that only 16.1 percent of the variance in the cluster density is accounted for by the per capita government incentives for investment, and similarly, only 16.1 percent of the variance in the per capita government incentives for investment is accounted for by the cluster density in a region. This finding suggests that the government incentives for investment have different macroeconomic dynamics.

TABLE 7
CORRELATIONS \ SPEARMAN'S RHO:
CLUSTER DENSITY INDEX VS. PER CAPITA GOVERNMENT INCENTIVES

			Cluster Density Index	Per Capita Government Incentives
Spearman's rho	Cluster Density Index	Correlation Coefficient	1.000	.401*
		Sig. (2-tailed)		.042
		N	26	26
	Per Capita Government incentives	Correlation Coefficient	.401*	1.000
		Sig. (2-tailed)	.042	
		N	26	26

* Correlation is significant at the 0.05 level (2-tailed).

CONCLUSION AND RECOMMENDATIONS

In this study, we attempted to achieve several goals. First, we provided a brief review of the importance of clustering in regional economic development. Second, we highlighted critical literature and institutions in clustering efforts. Third, adopting a commonly used clustering methodology, we performed a 3-Star Cluster Mapping for the manufacturing industry across the 26 Economic Development Districts in Turkey. Finally, we tested several relationships between the regional cluster density and macroeconomic indicators. Our findings about the relationship among macroeconomic indicators are in line with the findings in literature. In other words, regional economic clustering has a close relationship with (a) international openness of the region, and (b) economic growth in a region.

Although targeted government incentives for investment should promote cluster type industrial concentration in the regions, the findings show a weak relationship between the cluster density and government incentives. This may be because (a) the government efforts alone to create industrial clusters are not enough, or (b) the government efforts are directed towards the less developed areas in which case it may take some time to assess the impact of those efforts on mature cluster formation.

For future studies, we recommend the further refinement of the cluster density index developed here as a broader regional cluster summary measure. We also recommend that businesses should strategically position themselves in areas of international trade as the per capita trade volume seems to promote competitive economic dynamics and cluster formation.

ENDNOTES

1. For a review of activities of each agency, see the Ministry of Development at http://www.mod.gov.tr/en/SitePages/mod_aboutus.aspx
2. The Tennessee Valley Authority, Access Date 05.05.2013, http://www.tva.com/abouttva/history.htm
3. European Cluster Policy Group Portal, Access Date 05.05.2013, http://www.proinno-europe.eu/ecpg
4. U.S. Cluster Mapping Portal, Access Date 05.05.2013, http://mvp.clustermapping.us/
5. Harvard University, Institute for Strategy and Competitiveness , Access Date 05.05.2013, http://www.isc.hbs.edu/econ-clusters.htm
6. The Center for Strategy and Competitiveness (CSC), Access Date 05.05.2013, http://www.hhs.se/csc/Pages/default.aspx
7. The Cluster Observatory Portal, Access Date 05.05.2013, http://www.clusterobservatory.eu/index.html
8. The new Europe INNOVA Portal, Access Date 05.05.2013, http://archive.europe-innova.eu/index.jsp
9. Access Date 05.05.2013, http://www.clusterobservatory.eu/index.html#!view=aboutobservatory;url=/about-observatory/methodology/indicators/

10. Access Date 05.05.2013, http://www.clusterobservatory.eu/index.html#!view=aboutobservatory;url=/about-observatory/methodology/indicators/

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APPENDIX

APPENDIX 1
NACE REV.2 STATISTICAL CLASSIFICATION OF ECONOMIC ACTIVITIES IN THE EUROPEAN COMMUNITY (2-DIGIT LEVEL MANUFACTURING SECTORS)

10	Manufacture of food products
11	Manufacture of beverages
12	Manufacture of tobacco products
13	Manufacture of textiles
14	Manufacture of wearing apparel
15	Manufacture of leather and related products
16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
17	Manufacture of paper and paper products
18	Printing and reproduction of recorded media
19	Manufacture of coke and refined petroleum products
20	Manufacture of chemicals and chemical products
21	Manufacture of basic pharmaceutical products and pharmaceutical preparations
22	Manufacture of rubber and plastic products
23	Manufacture of other non-metallic mineral products
24	Manufacture of basic metals
25	Manufacture of fabricated metal products, except machinery and equipment
26	Manufacture of computer, electronic and optical products
27	Manufacture of electrical equipment
28	Manufacture of machinery and equipment n.e.c
29	Manufacture of motor vehicles, trailers and semi-trailers
30	Manufacture of other transport equipment
31	Manufacture of furniture
32	Other manufacturing
33	Repair and installation of machinery and equipment