Regional Disparity and Clusters in Turkey:
A Lisa (Local Indicators of Spatial Association) Analysis

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ABSTRACT: In recent years, regional disparity problem across provinces and regions of Turkey and solving suggestions have been debated by many scientist and politicians. East and West dualism is very clear that Western part of the country is significantly more developed than the East. This situation can be shown the tools of spatial statistics reveal the presence of spatial dependence across provinces and regions. The presence of heterogeneity is reflected in the distribution of Local Indicators of Spatial Association (LISA) statistics. The aim of this study is to present a LISA analysis by using GeoDa (Geographic Data Analysis Program) in order to show regional disparity and clusters in Turkey. This paper present important result on the distribution of growth in provinces of Turkey and its relation with other important indicators of development. Findings shows that powerfulness (or weakness) of per capita GDP levels of provinces parallel to patent applications, automobile numbers, electricity consumption, entrepreneurship, net migration rates, unemployment rates, per capita export and import, literacy rates, university degrees, and bed numbers of per hundred thousand patients in Turkey. Despite East and South Eastern Anatolia provinces obtain high level public investment values; these cities have less level per capita income.

Keywords: Regional Disparities, Regional Cluster, Local Indicators of Spatial Association (LISA), East-West Dualism

ÖZET: Son yıllarda, Türkiye'nin bölgeleri ve illeri arasındaki bölgesel eşitsizlik problemi ve çözüm önerileri pek çok bilim insanı ve politikacı tarafından tartışılmaktadır. Doğu ve Batı dualizmi çok açıktır ki, ülkenin batı bölgeleri belirgin bir şekilde doğusundan daha fazla gelişmiştir. Bu durum iller ve bölgeler arasındaki mekansal bağımlılığın ortaya çıkarılması için kullanılan mekansal istatistiğin araçları ile gösterilebilir. Heterojenitenin varlığı LISA istatistiklerinin dağılımında yansıtılmaktadır. Bu çalışmanın amacı, Türkiye'de bölgesel eşitsizlik ve yığışımlar göstermek için GeoDa programı kullanarak bir LISA analizi sunmaktır. Bu çalışma, Türkiye'nin illerinde büyümenin dağılımı ve kalkınmanın diğer önemli göstergelerle ilişkisi üzerine önemli sonuçlar sunmaktadır. Bulgular göstermektedir ki, Türkiye'de illerin kişi başına GSYİH düzeyinin yüksekliği (azlığı), patent başvuruları, otomobil sayıları, elektrik tüketimi, girişimcilik, net göç oranları, işsizlik oranları, kişi başına ithalat ve ihracat, okuryazarlık oranı, üniversite mezunlarının sayısı, bin hasta başına düşen yatak sayısına paraleldir. Doğu ve Güney Doğu Anadolu illeri yüksek düzeyde kamu yatırımı almasına rağmen, bu şehirler düşük seviyede kişi başına gelire sahiptir.

Anahtar Kelimeler: Bölgesel Eşitsizlik, Bölgesel Yığışım, LISA, Doğu-Batı Dualizmi

INTRODUCTION

In recent years, regional disparity problem across provinces and regions of Turkey and solving suggestions have been debated by many scientist and politicians. East and West dualism is very clear that Western part of the country is significantly more developed than the East. East regions are very weak in terms of development indicators, such as patent applications, automobile numbers, electricity consumption, entrepreneurship, net migration rates, unemployment rates, per capita export and import, literacy rates, university degrees, and bed numbers of per hundred thousand patients.

Turkish regional imbalances have been the subject of a large literature over the years. Atalik (1990) investigates regional income disparities over 1975-1985 and finds that inequalities have increased. Ates et al. (2000) try to assess the performance of the Southeastern Anatolia Project by measuring sigma and beta-convergence between the recipient regions and the rest of Turkey (excluding Marmara). They discover that convergence is taking place among these (Eastern) regions. Berber et al. (2000) also conclude to the absence of beta and sigma convergence over 1975-1997. As Ertugal (2005) indicates, previous contributions conclude that re-distribution policies did not necessarily

achieve the aim of increasing cohesion within the country. Çelebioglu and Dall'erba (2010) perform an exploratory spatial data analysis on the growth and development level of the 76 Turkish regions over 1995–2001. Their results shed new light on the distribution of growth across Turkish regions and its relation with public investments and human capital, two indicators of development.

A couple of reasons have been highlighted in the past to justify the East-West divide that has marked the Turkish regional economies for a couple of decades (Ates et al. 2000; Balkir 1995; Gezici and Hewings 2004). They are, among others, inequalities in salaries (Elveren and Galbright, 2008), the dependence on agriculture and weakness of industrial sector (Ozaslan et al. 2006; Akgungor 2003), the divide in the education level (Ozturk 2002; Tansel and Gungor 2000), the migratory flows from the east to the west (Keles 1985; Kirdar and Saracoglu 2007), ethnic terrorism (PKK terrorist organization, especially after the 1970s) (Feridun and Sezgin 2008), populist and misguided policies applied by governments (TUGIK Report 2008) and the lack of private investment in the east (Deliktas et al. 2008). Balkir (1995) proposed to classify the Turkish regional disparities in three categories: demographic disparities, including migration and urbanization, economic disparities, that include several of the components mentioned above, and the disparities in infrastructures, including the provision of public services.

This situation can be shown the tools of spatial statistics reveal the presence of spatial dependence across provinces and regions.

DATA

Our dataset comes from the Turkish Statistical Institute[1] and the State Planning Organization[2]. They represent for each region the level of per capita income in 2001 because of data limitation. There is no province level per capita GDP data after 2001. Besides we use per capita public investment in 2007, per capita patent applications in 2009, per thousand number of automobile in 2009, per capita electricity consumption in 2008, per capita entrepreneurship in 2008, net migration rates (per thousand) in 2009, unemployment rates (%) in 2008, per capita export (dollar) in 2008, per capita import values (dollar) in 2008, literacy rates in 2009, university degrees (%) in 2009 and numbers of bed (per hundred thousand patients) in 2007. At the same time, these indicators are generally used by World Bank in World Development Indicators Databases. Our dataset has been composed for 81 provinces.

QUARTILE MAPS

The analysis starts with the quartile maps of the distribution of our variables for each province. Darker colors in the maps represent higher values and lighter colors characterize lower levels.

Figure 1 displays the distribution of province level per capita GDP in 2001. This figure shows obviously east-west duality in Turkey. Especially Eastern and South Eastern Anatolia provinces have low level per capita GDP.

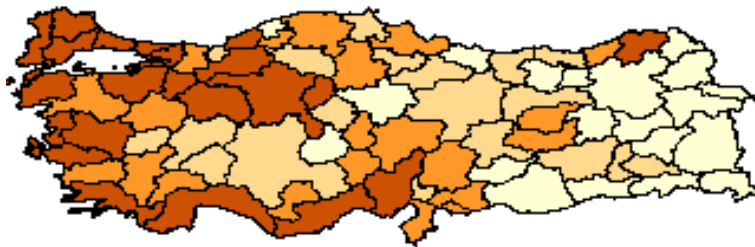Figure 1: Distribution of province level per capita GDP in 2001

Figure 2 shows per capita public investment in 2007. Per capita public investment values randomly distribute. Around of Istanbul, Ankara, Sivas and Erzurum have taken high level per capita public investment in 2007.

Figure 2: Province level per capita public investment in 2007.

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[1] www.turkstat.gov.tr, Turkish Statistical Institute
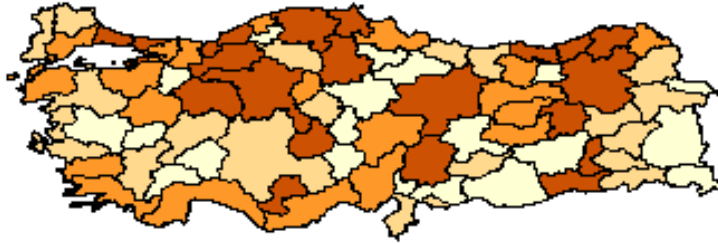[2] www.spo.gov.tr, State Planning Organization

Figure 3 displays distribution of per capita patent applications in 2009. Applications of patent concentrate especially in Marmara, Aegean and Central Anatolia Regions. East provinces haven't got enough application. Beside there is no application in some provinces of East and South East Anatolia Regions.

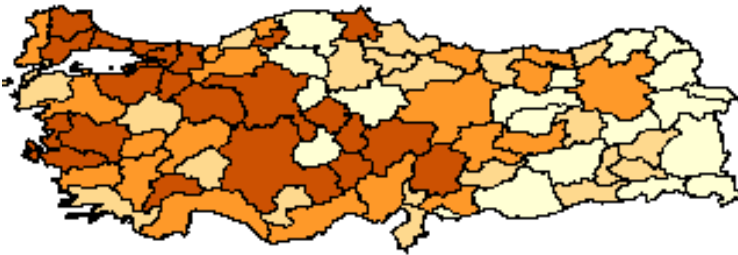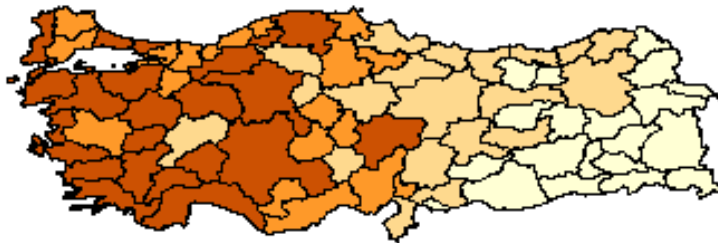Figure 3: Distribution of per capita patent applications in 2009

Figure 4 demonstrates per thousand number of automobile in 2009. In this figure clearly appear that there is big east and west duality in Turkey. Particularly South Eastern Anatolia region is very poor in terms of automobile figures.

Figure 4: Per thousand number of automobile in 2009

Electricity consumption is accepted as important indicator of development process. Many provinces of East Anatolia and some provinces of middle Anatolia have less level per capita consumption of electricity in 2008. Figure 5 denotes per capita electricity consumption in 2008 (MWh). This quartile map is another evidence of disparity in Turkey.

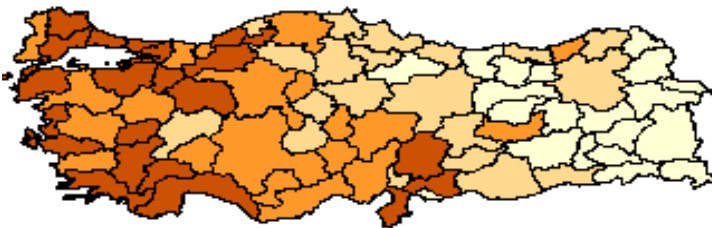Figure 5: Per capita electricity consumption in 2008

Figure 6 shows per capita entrepreneurship in 2008. Especially industrial cities (such as Istanbul, Bursa, Izmir, Denizli), coastal areas and Ankara (capital city of Turkey) have big figures about per capita entrepreneurship.

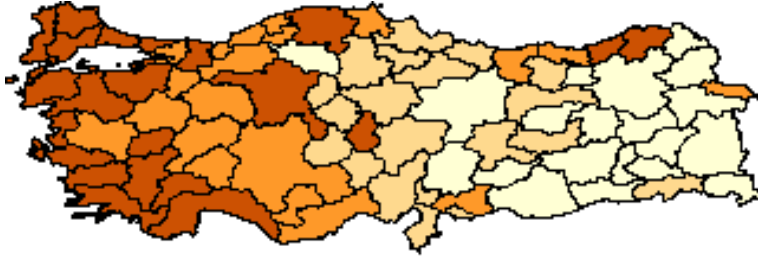Figure 6: Per capita entrepreneurship in 2008

Figure 7 indicates province level net migration rates (per thousand) in 2009. While big cities in western regions have positive migration rates (it means that this cities have taken migration), East and South Eastern Anatolia provinces have mostly negative migration rates in province level (it means that this cities have given migration).

Figure 7: Province level net migration rates in 2009
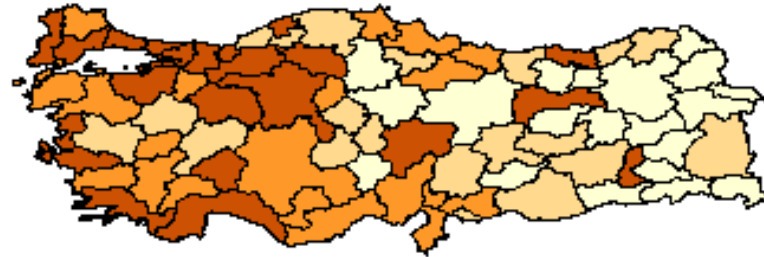
When we look at Figure 8, it can be observed that unemployment rates (%) in 2008. All South Eastern Anatolia, a part of Mediterranean Region (Mersin, Adana, Osmaniye, Hatay, K.Maraş) and Edirne have higher values of unemployment rates.

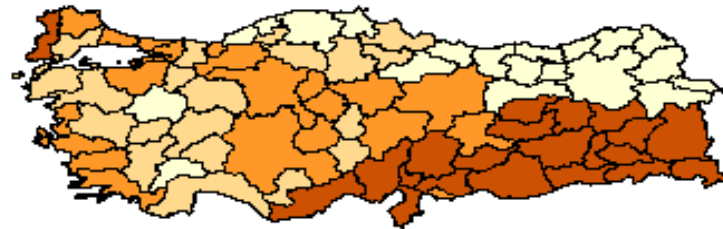Figure 8: Unemployment rates (%) in 2008

Figure 9 introduces per capita export (dollar) in 2008. Industrial centers of Turkey (İstanbul, İzmir, Kocaeli, Bursa, Manisa, Denizli, Ankara, Eskişehir, and Kayseri) and generally coastal areas have high values about per capita export. It is interest that Hakkari, Şırnak, Trabzon and Rize have also high values. We should explain special state here that Hakkari and Şırnak have high border trade levels. Besides Trabzon and Rize have Free Zone (free trade area).

Figure 9: Per capita export (dollar) in 2008
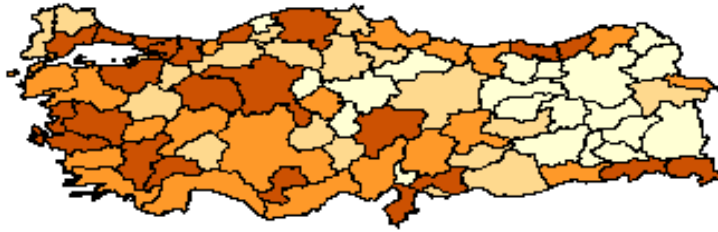
Industrial areas in Turkey have bigger import rates than East and South Eastern Anatolia regions. Mostly importation of Turkey comes from especially harbor cities such as Istanbul, Kocaeli, Izmir, Mersin, and Samsun. These provinces have common trait as free zone. Figure 10 shows this distribution in 2008.

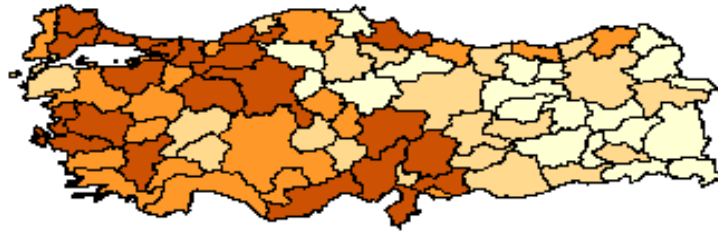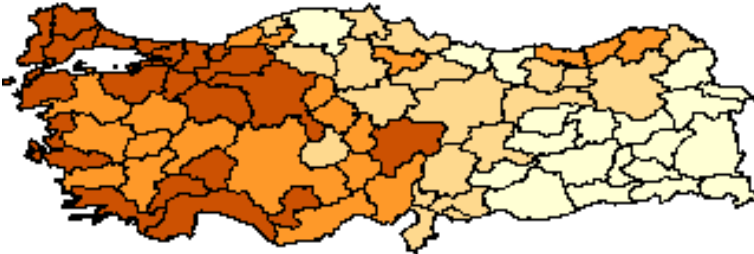Figure 10: Per capita import values in 2008

Figure 11 denotes literacy rates in provinces of Turkey in 2009. While west areas and coastal areas are relatively rich in terms of literacy rates, again East and South Eastern Anatolia regions are generally poor. This is also another pointer of disparity in Turkey.

Figure 11: Literacy rates in provinces of Turkey in 2009

The other important indicator of development related to education is the level of university degree. Figure 12 related to university degree (%) in 2009. The poorest areas are again East and South East Anatolia regions. The richest areas are big cities (Istanbul, Ankara, Izmir, Bursa, Antalya, and Mersin) and their hinterlands.
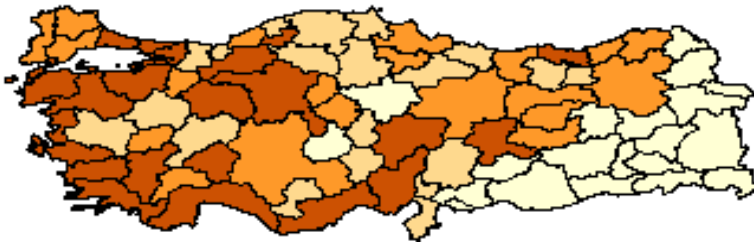
Figure 12: University degrees (%) in 2009

Figure 13 is about (per hundred thousand patients) numbers of bed in 2007. Particularly Ankara and its hinterland have excellence level towards other regions. Erzurum, Sivas and their some near neighbors have high level of bed for patients. Again the lowest values are belonging to East and South Eastern Anatolia provinces.

Figure 13: Numbers of bed (per hundred thousand patients) in 2007
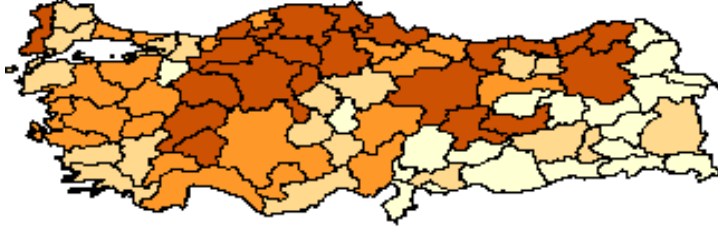
We are going to investigate regional clusters across regions of Turkey in the next section.

METHOD AND FINDINGS

Definition of Spatial Weight Matrix

A spatial weight matrix is the necessary tool to impose a neighborhood structure on a spatial dataset. As usual in the spatial statistics literature, neighbors are defined by a binary relationship (0 for non-neighbors, 1 for neighbors). This paper is performed under GeoDa. Two basic approaches have been used for defining neighborhood: contiguity (shared borders) and distance. Contiguity-based weights matrices include rook and queen. Areas are neighbors under the rook criterion if they share a common border, not vertices. Distance-based weights matrices include distance bands and k nearest neighbors. Based on these two concepts, k_8 nearest neighbor matrix has been created to investigate the distribution of variables of interest. The k_8 nearest neighbor matrix only below:

$$\begin{cases} w_{ij}(k) = 0 \; if \; i = j \\ w_{ij}(k) = 1 \; if \; d_{ij} \leq D_i(k) \; and \; \overset{*}{w}_{ij}(k) = w_{ij}(k) / \sum_j w_{ij}(k) \; for \; k = 8 \\ w_{ij}(k) = 0 \; if \; d_{ij} > D_i(k) \end{cases} \quad (1)$$

where d_{ij} is great circle distance between centroids of region i and j and $D_i(k)$ is the 8th order smallest distance between regions i and j such that each region i has exactly 8 neighbors. Now that the weight matrix has been defined, we estimate a couple of spatial statistics that will shed some light on the spatial distribution of our variables (Anselin, 1988).

LISA Analysis

LISA statistics measure, by definition, the presence of spatial autocorrelation for each of the location of our sample. It captures the presence or absence of significant spatial clusters or outliers for each location. Combined with the classification into four types defined in the Moran scatter plot above, LISA indicates significant local clusters (high–high or low–low) or local spatial outliers (high–low or low–high). The average of the Local Moran statistics is proportional to the Global Moran's I value (Anselin 1995; Anselin *et al.* 2007).

Anselin (1995) formulated the local Moran's statistics for each region i and year t as the follows:

$$I_i = \left(\frac{x_i}{m_0} \right) \sum_j w_{ij} x_j \quad with \ \ m_0 = \sum_i x_i^2 / n \qquad (2)$$

where w_{ij} is the elements of the row-standardized weights matrix W and $x_i (x_j)$ is the observation in region $i (j)$.

The significant results (at 5%) of the LISA statistics are presented. Their significance level is based on a randomization approach with 999 permutations of the neighboring provinces for each observation.

The randomization approach is used in the context of a numeric permutation approach to describe the computation of pseudo significance levels for local spatial autocorrelation statistics. In order to determine how likely it would be to observe the actual spatial distribution at hand, the actual values are randomly reshuffled over space 999 times. According to this calculation, some provinces have LL-type autocorrelation, but also some provinces have HH-type autocorrelation. We also provide the LISA maps (figures 14 to 26) as a visual representation of these results. Red areas show provinces in HH quadrants and blue areas are in LL quadrants the next figures.

Findings

Our first LISA Cluster Map (Figure 14) is about per capita GDP in 2001. It is clear that there is important duality between East and West Anatolia regions. Marmara region is completely replaced in High-High (HH) part of Scatter Plot. Conversely East and South Eastern Anatolia regions are in Low-Low (LL) part.

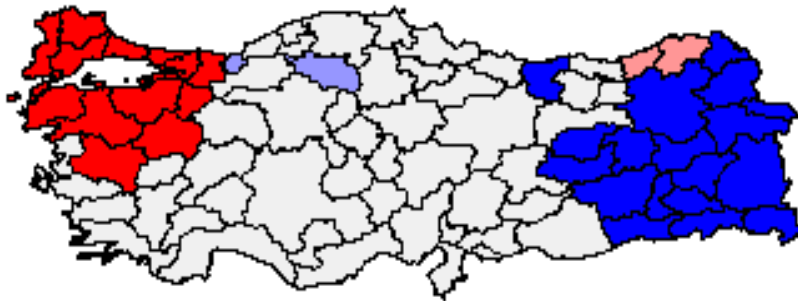Figure 14: LISA cluster map of per capita GDP in 2001

Figure 15 shows LISA cluster map of per capita public investment in Turkey. There is no cluster about public investment in Turkey. Public investments randomly distribute.

Figure 15: LISA cluster map of per capita public investment in 2007
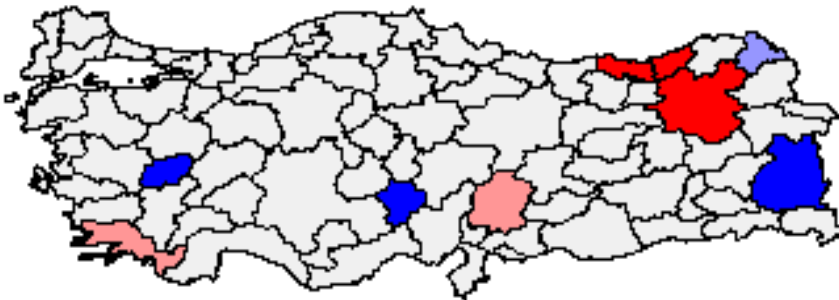

Figure 16 explains cluster map of patent applications in 2009. It can be mentioned about significantly cluster in this subject. Big cities in the west part of Turkey such as Istanbul, Kocaeli, Sakarya, and Bursa replace in High-High (HH) area of scatter plot. Many provinces in the east part of Turkey are in Low-Low (LL) area.

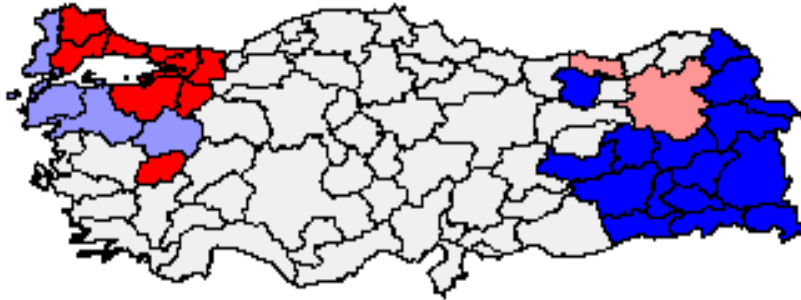Figure 16: LISA cluster map of per capita patent application in 2009

Figure 17 examines numbers of automobile (per thousand) in 2009. West and/or coastal areas (exclude Istanbul, Bursa and Kutahya) are mostly HH part of scatter plot. Almost all East and South eastern Anatolia provinces are in LL area.

Figure 17: LISA cluster map of number of automobile (per thousand) in 2009
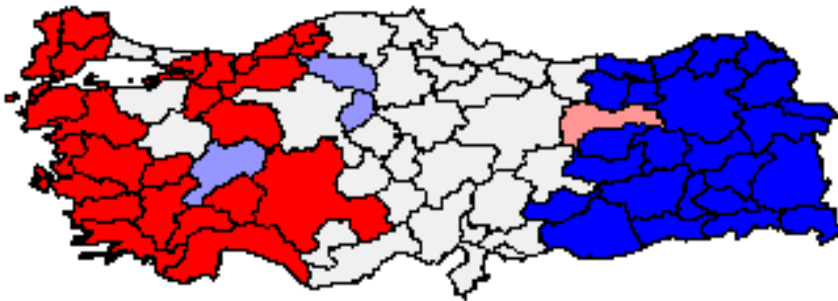
Figure 18 indicates LISA cluster map of per capita electricity consumption across of Turkey regions. Provinces that have high level electricity consumption in the Marmara Region attract to positive level each other. Conversely East and South Eastern Anatolia provinces attract to negative level each other.

Figure 18: LISA cluster map of per capita electricity consumption in 2008

Figure 19 demonstrates another cluster sample. This map shows an important duality about per capita entrepreneurship in 2008. East and west duality is very clear.

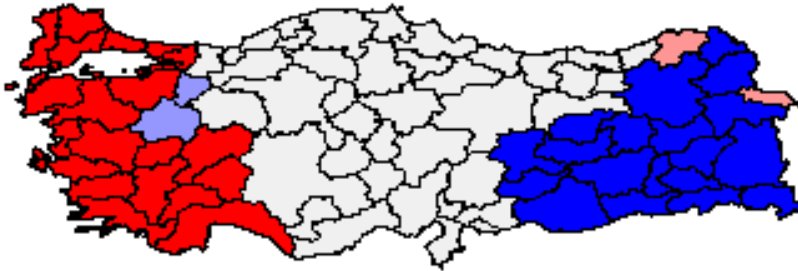Figure 19: LISA cluster map of per capita entrepreneurship in 2008

Figure 20 is related to net migration rates in 2009. Especially while Marmara Region and west part of Ankara (capital city of Turkey) are in positive cluster (HH) area, again almost East Anatolia provinces are in negative cluster (LL) area. The provinces in HH area take migration, but provinces in LL area give migration.

Figure 20: LISA cluster maps of province level net migration rates (per thousand) in 2009
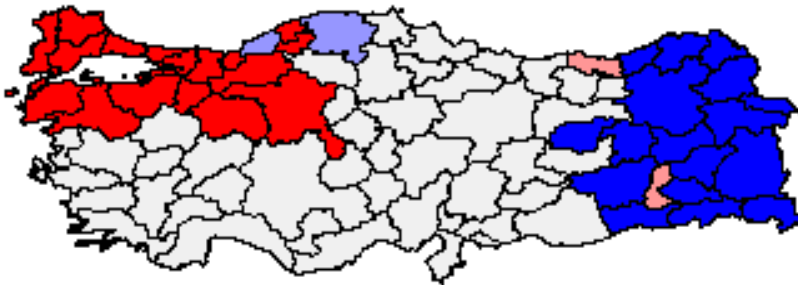

Figure 21 explains cluster map about unemployment rates in Turkey. Black Sea Area and north part of Erzurum are in negative attractive centers. But east part of Mediterranean Sea Area and all South Eastern Anatolia provinces are positive attractive centers. We should keep in the mind that, in this picture, negative attractive centers present low level unemployment values, conversely positive attractive centers present high level unemployment values.

Figure 21: LISA cluster map of unemployment rates (%) in 2008
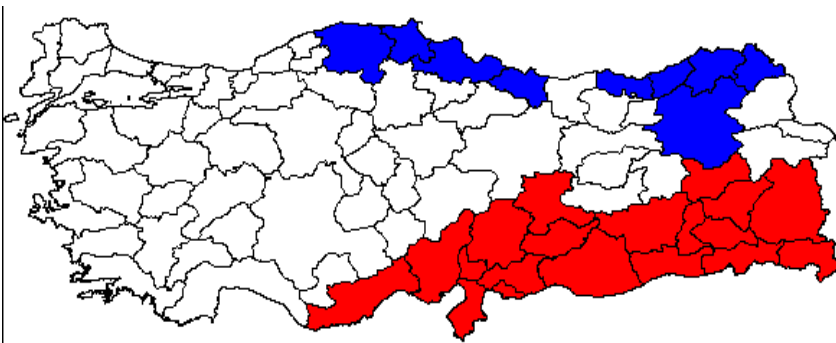
According to Figure 22, there is no big cluster about per capita export. But provinces such as Istanbul, Kocaeli, Bursa, and Sakarya are positively attractive centers.

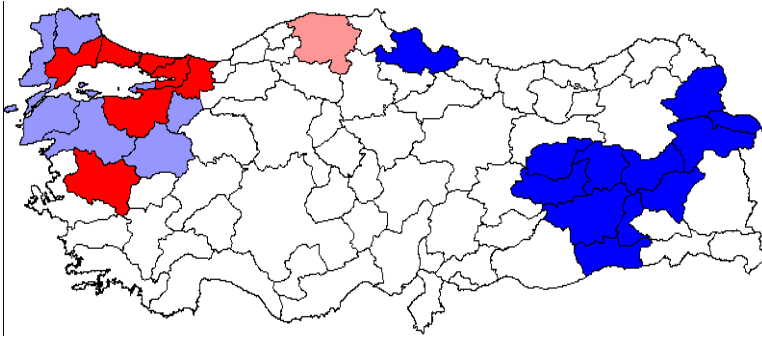Figure 22: LISA cluster map of per capita export (dollar) in 2008

Figure 23 also introduces more important cluster than Figure 22. There is big cluster especially in terms of per capita import values in East and South Eastern Anatolia provinces.

Figure 23: LISA Cluster Map of per capita import values in 2008
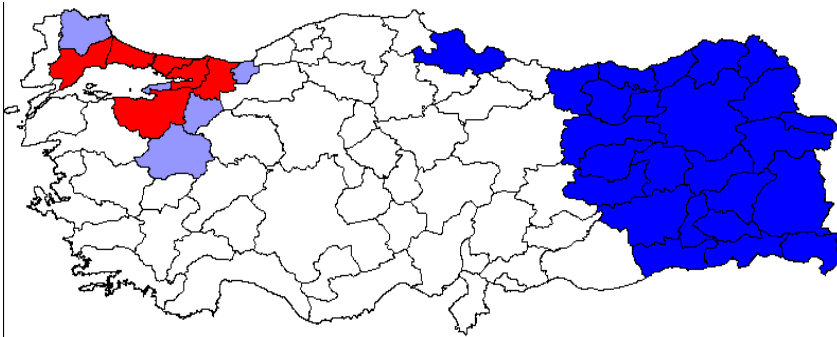

Figure 24 designates very significant cluster about literacy rates in Turkey. It is clear that west part of Turkey is completely in positive attractive (HH area) center. After all East Anatolia provinces are mostly in Low-Low area of scatter plot. Regional duality is very clear in this cluster map.

Figure 24: LISA Cluster Map of literacy rates in provinces of Turkey in 2009
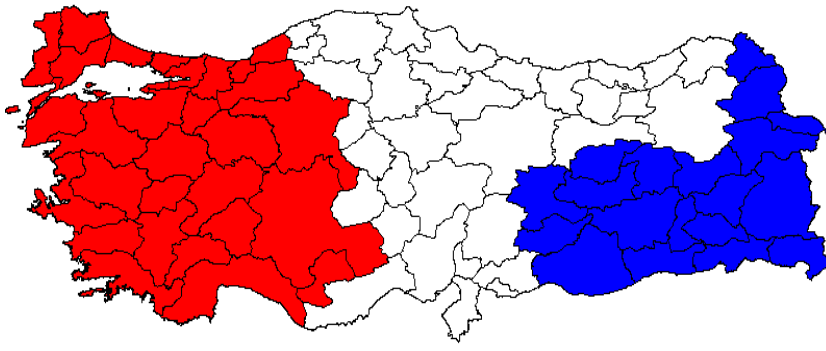
Figure 25 shows province level university degrees in Turkey. Again while west parts of Turkey have high level university degrees, east parts of Turkey have low university degrees figures in 2009. This situation is parallel to literacy rates figures.

Figure 25: LISA Cluster Map of university degrees (%) in 2009
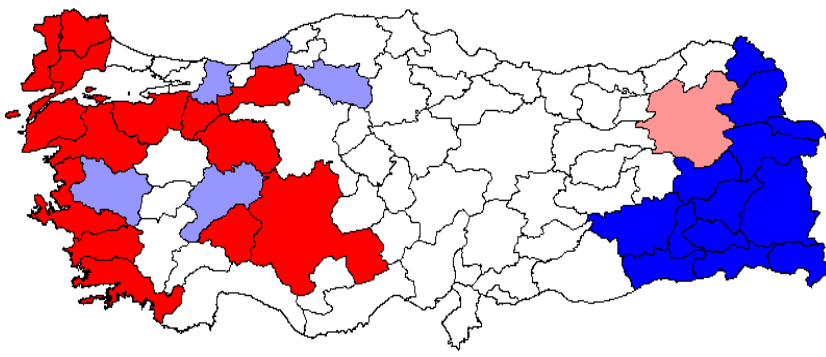
Figure 26 displays numbers of bed (per hundred thousand) in Turkey. Particularly around of Ankara (as Konya, Eskişehir, Afyon, Çankırı, Burdur, Zonguldak, Bartın, Kastamonu) is in High-High area. But blue areas (around of Antakya, G.Antep, Kilis, Osmaniye and around of Hakkari, Şırnak, Van, Bitlik, Siirt, Batman, Ağrı, Iğdır, Muş) are in Low-Low area in cluster map.

Figure 26: LISA Cluster Map of numbers of bed (per hundred thousand) in 2007
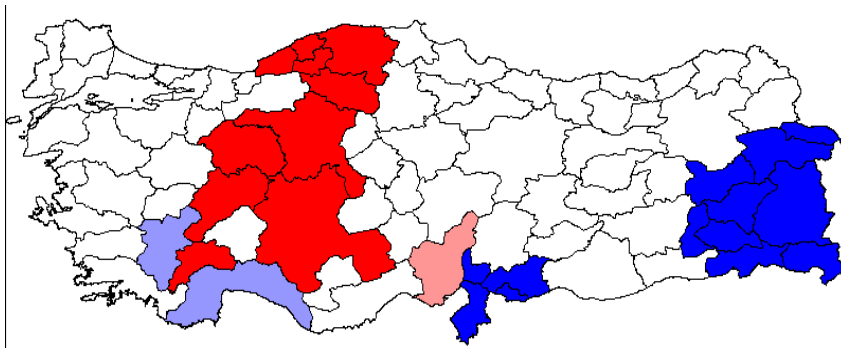
CONCLUSIONS

The purpose of this paper has been to perform an analysis of the economic disparities and dualities across 81 Turkish provinces. We have investigated the spatial distribution of our variables. Firstly, our quartile maps have revealed the gap between East and West of Turkey. Secondly our scatter plots display most of the eastern provinces in the Low-Low quadrant and the western ones in the High-High quadrant. Finally, LISA statistics confirm the significant presence of local spatial autocorrelation and highlight spatial heterogeneity in the form of two distinct spatial clusters of high and low values of variables.

This paper present important result on the distribution of growth in provinces of Turkey and its relation with other important indicators of development. Findings shows that powerfulness (or weakness) of per capita GDP levels of provinces parallel to patent applications, automobile numbers, electricity consumption, entrepreneurship, net migration rates, unemployment rates, per capita export and import, literacy rates, university degrees, and bed numbers of per hundred thousand patients in Turkey. Despite East and South Eastern Anatolia provinces obtain high level public investment values; these cities have less level per capita income.

These results confirm the dualistic structure of Turkey's economic geography, as many previous studies had showed. However, our results also show that this form of spatial heterogeneity goes along with the presence of spatial autocorrelation among provinces. Based on our results, we recommend fighting internal imbalances by promoting investments in education and the training of unemployed in the poorest areas. Besides private sector investment should be attracted to east part of Turkey. We also believe that developing the social and economic conditions in the East should be on the government's priority list so that migration to the West and eventually ethnic terrorism in the East will be reduced to a minimum.

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