# Spatial Distribution of Education and Regional Inequalities in Turkey

Burhan Can Karahasan and Emrah Uyar

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## Abstract

Education as a major human capital determinant of the modern growth models also enters the realm of spatial analysis. Yet, studies investigating the role of spatial distribution of education on income inequalities are rare. Originating from this central discussion, the study aims to understand the spatial dimensions of education in Turkey as a first step to link educational disparities with regional income inequalities. The regional disaggregated education data for Turkey is evaluated from two perspectives; inequality and spatial dependency. Results remark that education indicators witnessed diverse inequality paths for between and within regional inequalities. Moreover spatial dependency of education is detected for primary and secondary education. However the dependency is found to be strong in the educationally and economically lagging regions of Turkey.

**JEL Classification:** I21, R12, O18
**Keywords:** Human capital, inequality, regional development, LISA

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## 1. Introduction

The idea of human capital as a major contributing factor to the economic growth has been a popular theme in the growth literature since it first appeared in 1960s. Since Becker (1962) the idea of education, research and R&D as factors affecting economic growth has been analyzed through various methodologies (Barro and Sala-i-Martin 2004). As the literature has advanced from exogenous growth models to endogenous ones like New Economic Geography approach (Krugman 1991) recently spatial dimensions of economic growth began to attract attention.

Following this suit, the current study aims to analyze spatial distribution of educational inequalities in Turkey, with the expectation that these first endeavors in a, to the best of our knowledge, barren research area for Turkey, will constitute the building blocks of further studies that will link income inequalities with educational inequalities in the spatial dimension. Main premise of the paper is to show spatial inequalities between regions in Turkey at NUTS 1 level and existence of spatial clusters for educational attainment in 3 dimensions: Primary education, secondary education and university level. The data covers the period 1997-2006. Theil index will be used in order to demonstrate this. Later Moran's *I* statistic has been calculated using province level data in order to check out for spatial distribution of clusters.

The paper is organized as follows: The following part will investigate basic works of the growth literature that includes education (or human capital) as an intervening variable, like exogenous and endogenous growth models, and later surveys spatial studies analyzing education-income relationship in Europe and in Turkey. Third section presents the data and methodology used in this study, namely Theil index and Moran's *I* statistic. In Section 4 we present the findings of Theil index calculations, both for within and between regions in order to account for regional inequalities in education in Turkey. Section 5 investigates spatial distribution of education and searches clusters together with their movement along the period under investigation. Last section concludes.

## 2. Education and Economic Growth

The founding study that included education as a factor in economic growth is Becker's Human Capital (1964). "People's knowledge and skills are a form of capital that can yield income in just the same sense as a bank account, one hundred shares of IBM, assembly lines." (Wolf 2004, 315) This form of capital is called human capital and education is considered as the most important contributing factor to the human capital, although effects of related activities like on the job training and research is also recognized.

Denison (1962) who published approximately at the same time with Becker broke down factors in the classical growth theory (land, capital and labor) into its components but also stressed the importance of technological advancement (Wolf 2004, 317) According to Denison's analysis of the US economy US can sustain an additional 1% growth by "a 1% increase in average working week, doubling net immigration between 1962-1982 or adding "one and a half years to the average time that would otherwise be spent in school by everyone completing school between now and 1980 (Denison 1964, p.21 in Wolf 2004)."

When we look at neoclassical growth models like Solow (1956) and Swan (1956) production function is defined as an output of physical capital and labor (Pede et. al. 2006) and economic growth can be sustained with contribution of an exogenous factor, technological development. In their modified version of the Solow model Mankiw et. al. (1992) operationalized capital as physical and human capital and labor is decomposed as quality of the work force (human capital) and number of hours worked.

Although studies taking education as a contributing factor to the economic growth appeared in the 60s, some studies like Nelson and Phelps (1966) criticized new role attributed to human capital as a simple independent variable in the production function appeared as well (Pede et. al. 2006, 6). Recently endogenous growth theory focused on the importance of knowledge generation and spillover effects of education. Romer (1986, 1990), Lucas (1988) Krugman (1991) and Grossman and Helpman (1990) are among the prominent examples of endogenous growth theory.

However, these studies fail to include a spatial dimension to their models. One study to follow a spatial analysis is Benhabib and Spiegel (1994). Developing on Nelson and Phelps (1966) Benhabib and Spiegel first run a Cobb-Douglas production function with physical and human capital variables belonging to various countries and found out that human capital is insignificant in explaining per capita growth rate. Secondly, they specified "an alternative model in which the growth rate of total factor productivity depends on a nation's human capital stock level" (Benhabib and Spiegel 1994, 143).

In this model level of technology variable is defined by level of human capital plus "a catch up term that depends on the distance to the technology leader in terms of GDP per capita and the level of human capital that is available to adopt the ideas and technologies originating from the technology leader" (Pete et. al. 2006, 15). In the model human capital enters significantly in explaining increase in total factor productivity.

In a similar fashion with Nelson and Phelps (1966) Benhabib and Spiegel (1994) Pede et. al. (2006) looked at spatial distribution of economic growth in US counties and their analysis show that in neoclassical models human capital contributes to growth whereas in endogenous models geographical location (in this case distance from the technology leader) is more significant than human capital level itself.

On the relationship between educational inequalities and income distribution Tselios (2008) appears as a recent and valuable contribution. In this study Tselios analyzes income and educational inequalities in 94 European regions using a panel survey data covering years 1995-2000. Tselios (2008) is a methodologically very rich paper. He makes descriptive spatial analysis of income and educational inequalities with Theil index and Moran's *I* together with a series of non-spatial and spatial regressions like OLS, Fixed effects, Random effects, Dynamic panel, Spatial autoregressive (SAR) and Spatial error models (SEM). The main question Tselios is after is whether the effects of geographical location or institutional factors (especially welfare regime) are effective on inequalities. As a conclusion he finds that both geographical location and institutional factors are influential on creating inequalities in income and education. In our case since we are looking at regions within one country, institutional factors can be dropped.

In the literature studies analyzing the relationship between income and education is very scarce. Doğruel and Deniz (2008) documents Güngör (1997) which models effect of education attainment of industry workers on economic growth, Kasnakoğlu and Erdil (1994) which looks at real public expenditures on education in Turkey, and Çeçen et. al. (2003) which uses VAR model to analyze the relationship between growth and human capital formation in Turkey. Doğruel and Deniz (2008) also employs a similar VAR model and finds that all levels of education except for university level contributes economic development in Turkey. However, none of these studies endeavor to make a spatial analysis and all of them employ non-spatial models.

Limited number of spatial studies on Turkey, on the other hand, looks at spatial distribution of income. Gezici and Hewings (2002, 2007) looked at regional inequalities and found that regional disparities are persistent in Turkey throughout the period 1980-1997. Yıldırım and Öcal on the other hand, calculated Theil index for four different regions in Turkey and check for the beta convergence in income with SAR and SAM models. They found out that regions are homogenous within themselves and there is convergence at the national level.

## 3. Methodology

Within the core understanding of the ongoing research the empirical part of the study will be devoted to two separate analyses. While the social and economical impacts of education in Turkey will be highlightened throughout the study, as a preliminary observation regional educational inequalities will be illustrated by using Theil Index. Second in order to understand the possible spatial dependences of education, Moran's *I* will be computed and the spatial pattern of education distribution will be illustrated. Moreover as to widen the spatial interaction analysis, the local indicator of spatial association (LISA), local Moran's *I* analysis, will also be implemented.

While different measures such as, Gini coefficient, coefficient of variation or other convergence indicators are heavily used to account for inequalities; the current research prefers to use Theil Index to understand the educational inequalities in Turkey. The major power of the index is the decomposition of between and within regional inequalities. For different education levels (primary, secondary and university) Theil Indices will be computed. While equation one is the traditional Theil Index computation, equation two gives opportunity to decompose the overall educational inequalities. $y$ represents the relative share of education indicator in the overall country, while $x$ represents the relative share of population. $Y_k$ is the share of region $k$ in the economy, while $T_g$ represents Theil index accounting for the inequality within region $k$.

$$T = \sum_{i=1}^{n} y_i \log(\frac{y_i}{x_i}) \qquad \textbf{(1)}$$

$$T = \sum_{i=1}^{n} y_i \log(\frac{y_i}{x_i}) + \sum_{k=1}^{m} Y_k T_k \qquad \textbf{(2)}$$

As the second part of the study is devoted to the spatial interaction of educational levels of regions, the study will be directed to spatial autocorrelation analysis. The preferred measure to understand the spatial autocorrelation (global spatial autocorrelation) is the Moran's *I.* The statistic lies between -1 and +1 indicating positive and negative spatial autocorrelation. In case of detection of positive autocorrelation, there exits locational similarities and similar values of the variables are clustered together across space (Cliff, Ord, 1981). Within this understanding the global spatial autocorrelation measure of Moran's *I* can be defined as in equation 3. Here *n* represents the number of urban areas; *z*'s represents the deviation of the relevant education indicator from its own mean for each region. *W* is the weight matrix and finally *s* is the summation of all elements in the weight matrix. Weight matrix *(nxn)* is equal to 1 if *i* and *j* are neighbors and 0 otherwise. Major methods that can be preferred to construct a weight matrix are; contiguity matrix, distance weights and k-nearest neighbors. For the case of contiguity weight matrix three major types exist; rooks, bishop, Queens's (King's). While bishop is rarely used, rook computes common boundaries and queen's computes both the common boundaries and also nodes. For the distance weights, observer sets a threshold distance to determine the minimum distance between two points to be considered as neighbors. Finally observer can specify the number of neighbors that a unit or area should have.  Through out the ongoing study weights will be calculated by using rooks contiguity.

$$I_i = \frac{n}{s} \frac{\sum_i \sum_j w_{ij} z_i z_j}{\sum z_i^2} \qquad \textbf{(3)}$$

While the traditional Moran's *I* statistic is useful and commonly used to understand the spatial dimension of autocorrelation, as discussed by Anselin (1995) it fails to provide information regarding the local patterns of spatial association. Anselin (1995) offers different measures to account for the local spatial associations. In fact local indicator of spatial association (LISA) has two major issues (Anselin, 1995);

**i.** LISA provides some room to identify the possible significant spatial clusters

**ii.** Sum of all LISAs for all observations is just the global indicator of spatial association.

Anselin (1995) argues that locations with significant LISA measures are the local spatial clusters. Moreover Anselin (1995) adds that the LISA measure helps to decompose the global indicator of spatial autocorrelation.[1]

Within this framework local Moran's *I* is a major tool to account for LISA. Equation 4 is the transformed local Moran statistic. Note that summation of all local Moran's sum up to Moran's *I.*

$$I_i = z_i \sum_j w_{ij} z_j \qquad \textbf{(4)}$$

All data is collected from Turkish Statistics Office (TUKSTAT) and covers the 1997-2006 period. Three major education indicators used are: Pupils to teacher ratio in primary education, also secondary education and students to lecturer ratio in university education. While observation of regional inequalities and regional spatial patterns is at the center of the study, as to understand the economic development levels of urban areas regional per capital income levels will also be considered. Note that per capita income level at NUTS3 level is only available up to 2001.

## 4. Education Inequalities in Turkey

As discussed in the previous section, regional inequality measure used is the Theil index, which accounts for both between (inter-regional) and within (intra-regional) inequalities. As discussed by Gezici and Hewings (2002), regional unit of observation for Turkey can be defined under different classifications such as; geographical, functional and coastal regions. For the ongoing study to search for the

[1] For a detailed discussion regarding the two definitions of LISA measures see Anselin (1995, pp.3-8)

regional inequalities between regions of Turkey NUTS 1 level is preferred[2]. Second part of equation 2 will identify the regional disparities in each of the 12 regions and give profound information regarding the within inequalities.

Figure 1 and 2 indicate the between and within inequalities in Turkey. The major interesting finding here is related with the decomposition of the index. While for the inequalities between regions of Turkey, a more homogenous structure is observed, for the within inequality the pattern underlines the deviation of the university education inequalities from the other two education indicators. While the short time dimension of the study prevents one to comment on the path of the inequality, a more stable path for between regional inequalities can be observed. For the case of within educational inequalities, the path seems to turn down, however the short time dimension is still a constraint for generalized conclusion.

**Figure 1**
**Between Regional Inequalities in Turkey**

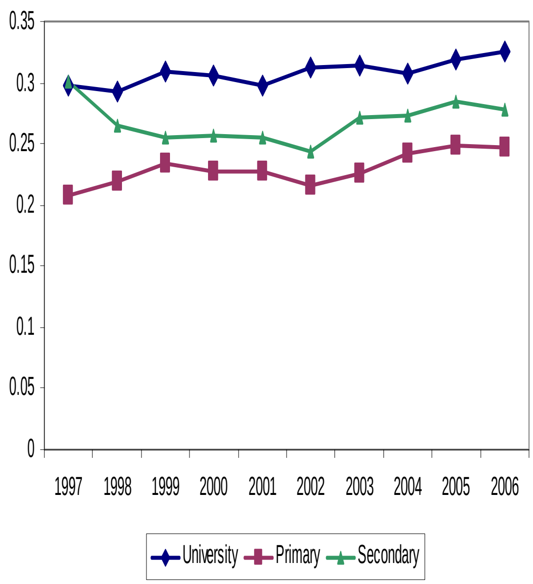
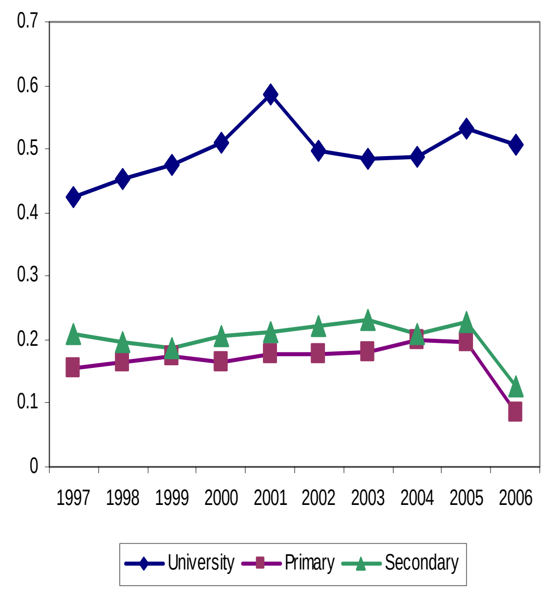



**Figure 2**
**Within Regional Inequalities in Turkey**




Source: TURKSTAT

[2] 12 geographic regions exists at NUTS 1 level in Turkey, www.tuik.gov.tr

While figures are informative in the sense that allows one to compare the regional inequalities at NUTS 1 and NUTS 3 levels, in order to compare the share of within and between educational inequalities, decomposition of Theil index is essential. Table 1 gives information regarding the share of between and within regional inequalities. Findings indicate that highest Theil index path is observed for the university education. Moreover the shares of intra regional education inequalities for primary and secondary education are 58% and 57% respectively and both higher than inter regional educational inequalities. However when the university education indicator is observed intra and inter regional educational inequalities are 38% and 62%. In short findings underline the structural distinction between higher and lower education inequalities for Turkey for the period under concern.

**Table 1. Decomposition of Regional Inequalities in Turkey**

| | **University Education** | | | **Primary Education** | | | **Secondary Education** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Theil** | **T(within)** | **T(Between)** | **Theil** | **T(within)** | **T(Between)** | **Theil** | **T(within)** | **T(Between)** |
| **1997** | 0.7208 | 41.20% | 58.80% | 0.3641 | 57.27% | 42.73% | 0.5099 | 59.02% | 40.98% |
| **1998** | 0.7444 | 39.36% | 60.64% | 0.3854 | 57.00% | 43.00% | 0.4622 | 57.46% | 42.54% |
| **1999** | 0.7849 | 39.47% | 60.53% | 0.4098 | 57.21% | 42.79% | 0.4412 | 57.99% | 42.01% |
| **2000** | 0.8165 | 37.44% | 62.56% | 0.3935 | 57.75% | 42.25% | 0.4623 | 55.42% | 44.58% |
| **2001** | 0.8851 | 33.64% | 66.36% | 0.4043 | 56.31% | 43.69% | 0.4672 | 54.59% | 45.41% |
| **2002** | 0.8108 | 38.62% | 61.38% | 0.392 | 55.06% | 44.94% | 0.4638 | 52.45% | 47.55% |
| **2003** | 0.7981 | 39.25% | 60.75% | 0.4068 | 55.64% | 44.36% | 0.5016 | 54.00% | 46.00% |
| **2004** | 0.7933 | 38.71% | 61.29% | 0.4403 | 54.88% | 45.12% | 0.4822 | 56.53% | 43.47% |
| **2005** | 0.8492 | 37.46% | 62.54% | 0.4446 | 55.87% | 44.13% | 0.5122 | 55.46% | 44.54% |
| **2006** | 0.8318 | 39.18% | 60.82% | 0.333 | 74.34% | 25.66% | 0.4053 | 68.40% | 31.60% |

## 5. Spatial Distribution of Education and Regional Impacts in Turkey

While the spatial interaction between regions of Turkey is an empirical matter of fact, it is also a reality. Even as Gezici and Hewings (2002) concentrates on the comparison between path of inequality and spatial dependency, Yıldırım and Öcal (2006) in a more recent study evaluates the convergence phenomenon of regional per capita income levels by using spatial dependent panel models. However observations regarding major social determinants of per capita income levels are rarely witnessed in the literature, especially for Turkey. The following interpretations aim to give a clear understanding regarding the spatial distribution of education indicators as well as formation of possible location clusters.

For a starting point to asses the path of global spatial autocorrelation, the Moran's *I,* is computed for three different education indicators. Results are reported in table 2. While there are significant positive global spatial autocorrelation signs for primary and secondary education measures, for university education indicator, no sign of significant spatial autocorrelation is detected. When primary and secondary education measures are compared a band between 0.40 and 0.69 is observed for the Moran's *I*. While the short time dimension of the study prevents one to comment on the spatial structure of distribution of education, still one can underline the importance of comparing these spatially dependent education indicators with the general economical environment of regions.

**Table 2. Global Autocorrelation of Education - Moran's *I* -**

| | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Prim.** | 0.4162** (0.0751) | 0.5737** (0.0715) | 0.6112** (0.0680) | 0.6234** (0.0808) | 0.5625** (0.0705) | 0.5268** (0.0781) | 0.5946** (0.0695) | 0.5547** (0.0735) | 0.6450** (0.0676) | 0.6270** (0.0641) |
| **Sec.** | 0.6504** (0.0795) | 0.5058** (0.07540 | 0.4325** (0.0698) | 0.5483** (0.0722) | 0.5626** (0.0734) | 0.4184** (0.0718) | 0.5594** (0.0773) | 0.6483** (0.0811) | 0.6225** (0.0686) | 0.6983** (0.0682) |
| **Uni.** | 0.0333 (0.0519) | 0.0435 (0.0585) | 0.0705 (0.0567) | 0.0322 (0.0601) | 0.0326 (0.0656) | 0.0349 (0.0457) | 0.0114 (0.0445) | -0.0134 (0.0590) | -0.0372 (0.0608) | -0.0203 (0.0538) |

*s.e. in parenthesis, ** represents significance at 5%*

To carry out the interest towards the interaction between education and regional economic conditions, it seems to be informative to concentrate on the possible spatial clusters in Turkey. In fact local indicator of spatial association (LISA) is a suitable measure to observe the location interactions. For two education measures instead of plotting the clusters for each year, two major illustrations are plotted; one for the sample beginning year of 1997 and one for the end of the sample, 2006.[3] Maps are illustrated in Appendix A.

While insignificant regions are not shaded (at 5% significance level), for the regions that significant LISA is indicated four possible groups are formed.[4] While HH and LL are the areas that show positive local spatial association, LH and HL are the outlier areas of the association. Note that quality indicators that are preferred is the ratio of pupils to teacher at different education levels, so increase in this rate represents a worsening in the quality of the education. In short for the clusters that one detects HH, emphasis should be given to the negative or lagging regions in terms of education and vice versa.

First of all for primary education, the cluster consisting of lagging regions in terms of primary education in the Southeast Anatolia and Eastern Anatolia is vital. While there seems to be two outliers, Iğdır and Hakkari in 1997, they also enter the cluster in 2006. Overall number of urban areas in the cluster increase from 12 to 13 within the time period observed. While Hatay and Gaziantep left the cluster, Iğdır, Hakkari and Şırnak entered the cluster. Overall share of HH urban areas in Turkey is 16% on average for the time period. Another important finding is related with the vanishing LL cluster in the Southwestern Mediterranean Region. In 1996 Afyon, Denizli and Muğla formed a LL cluster which disappears in 2006. A similar finding will also be observed for secondary education. The share of HH regions meaning lagging in terms of secondary education is 17%.

Overall the per capita income maps illustrated in Appendix B is informative. Both maps represent the 1987-2001 averages of the urban areas. The red bordered area represents the districts for the HH cluster that are computed by the LISA analysis. The figure indicates two major findings. First of all urban areas in the HH

[3] As the global spatial autocorrelation is only detected for primary and secondary education indicators, LISA maps are not plotted for university education indicator here. While university education LISA maps are weak and mostly insignificant, they can be obtained from the authors upon request.

[4] See appendix for details

clusters are the regions that exists in the lowest per capita quantile. Second of all, the reverse case, formation of LL clusters can not be observed for regions that are at higher quantiles in terms of per capita income. Such a finding underlines the rise in spatial interrelation in the lagging regions of the country. One may argue the absence of clusters in the urban areas of other regions, especially Blacksea Region, with low per capita income levels. As there are numerous factors behind regional prosperity and moreover as the central concern of the study is not to remark the causality between education and economic growth, the interest should be directed towards the regional prosperity of the regions that significant clusters are observed. Overall these findings also coincides with the remarks of Doğruel, Doğruel (2003) and Gezici, Hewings (2002) both remarking and underlining the locked in property of the east regions of Turkey.

## 6. Conclusion

Regional disparities, in the form of income inequalities, is a widely studied area in the literature. More recently the regional disparity question is also transformed into spatial analysis. While the mentioned discussion is also taken into account from a comparative perspective between inequalities and spatial relations, observation regarding the major social indicators of income growth is an emerging study area.

From this perspective, the study searches for educational inequalities and spatial distribution for the case of Turkey. While doing this education is decomposed between primary, secondary and university education. For the preliminary analysis to understand the regional inequalities in Turkey, a two fold observation is done. Both between and also within inequalities are evaluated at NUTS 1 level. Results indicate that between regional inequalities are slightly the same for primary and secondary education, however for the within inequalities university education deviates from the other two. Moreover when the decomposition of the Theil index is observed, within education inequalities` share in the overall Theil index is lowest for the university education.

Final remarks are related with the spatial autocorrelation. The initial findings regarding the global spatial autocorrelation are also clarified by the local indicator of spatial association (LISA) analysis. For university education no significant spatial relation is observed, whereas for primary and secondary education, there exist a spatial dependency. The LISA cluster maps indicate that the southwestern and southeastern regions of Turkey have asymmetric cluster structures. The social economically lagging regions on the South East and Eastern Anatolia constitute the worse clusters of Turkey. Interestingly very limited number of urban areas forms clusters that affect each other positively, and moreover these clusters seem to vanish or become smaller during the analysis period. Finally when the regional per capita income levels and education indicators are compared, the picture underlines the low per capita income level for the cluster in the eastern part of Turkey.

Overall results are vital in two senses. First of all decomposition of education is essential as to understand the regional impacts both from inequality perspective and also from spatial perspective. Second of all while the short time dimension of the study prevents one to comment on the long run relationships, one can compare the strength of inequality between different levels. Following this central argument, the study proposes some future areas of concentration. To clarify and deepen the spatial dependency and also to discuss the possible convergence phenomenon, spatial autoregressive models and also spatial error models can be preferred. Moreover to search for the place of education in the regional income disparities, one can asses some panel type spatial dependent and non dependent models.

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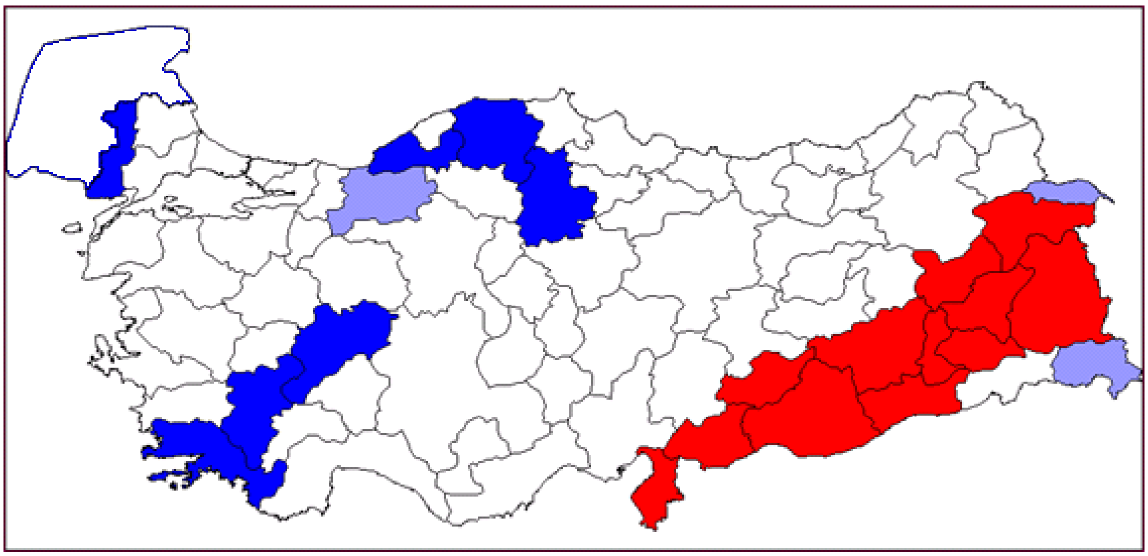
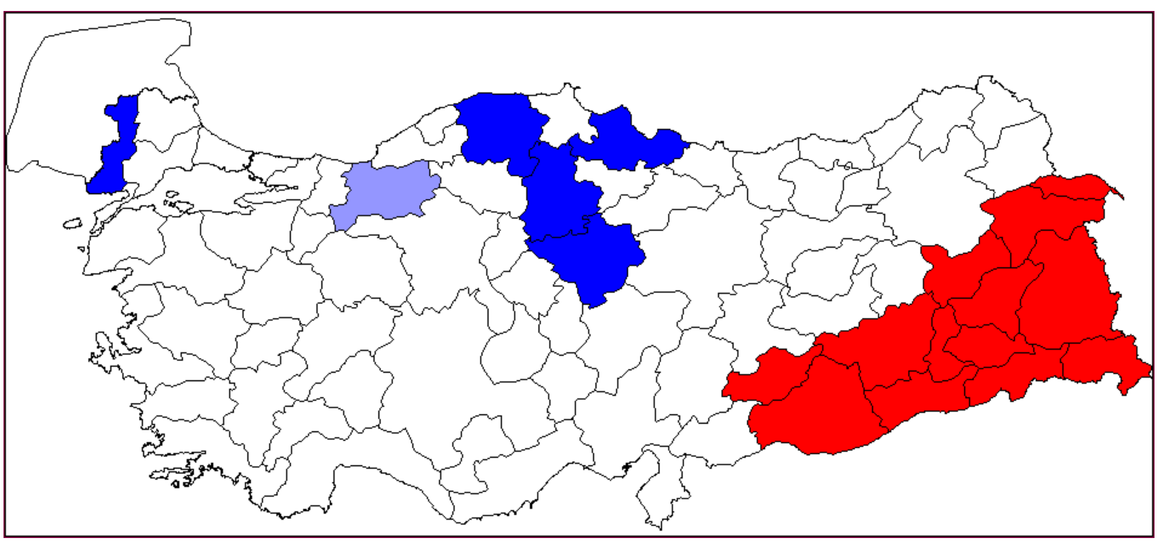
## Appendix A - LISA Analysis -


### Primary Education LISA Cluster Map for 1997



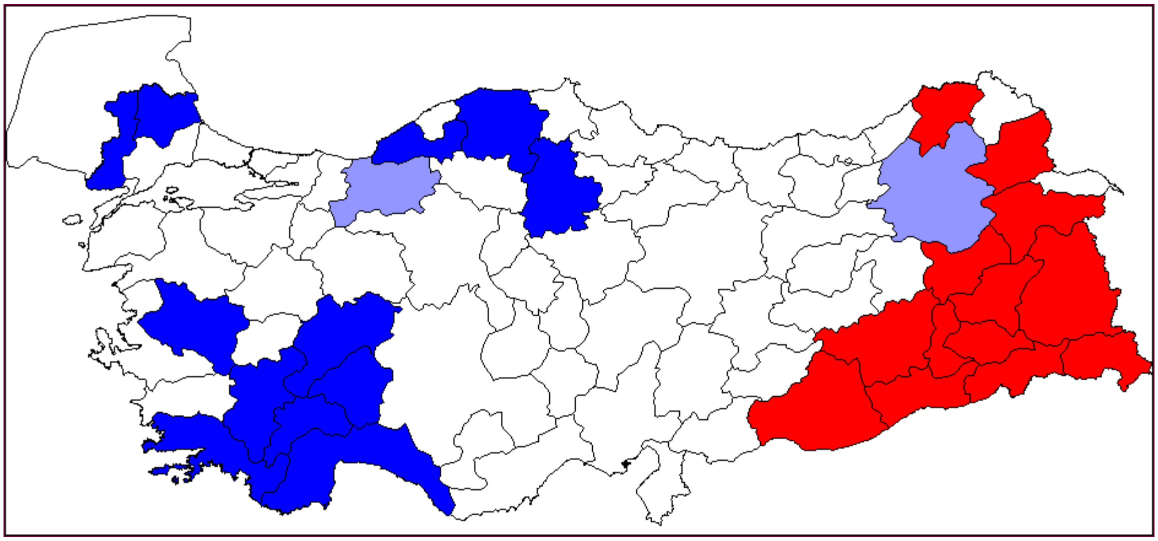
Source: TURKSTAT, own calculations

### Primary Education LISA Cluster Map for 2006



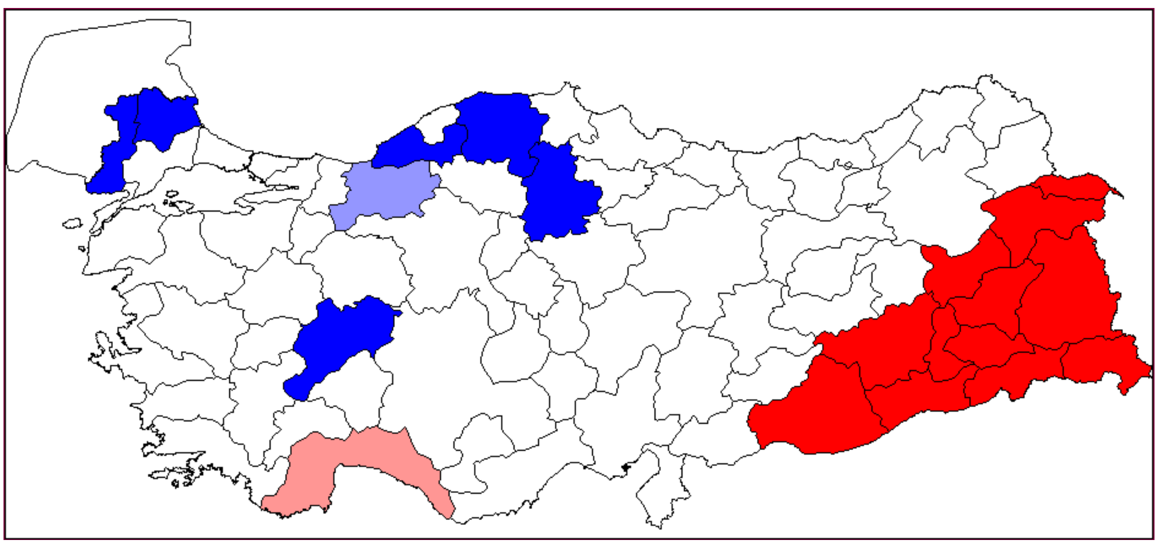
Source: TURKSTAT, own calculations

## Secondary Education LISA Cluster Map for 1997



Source: TURKSTAT, own calculations

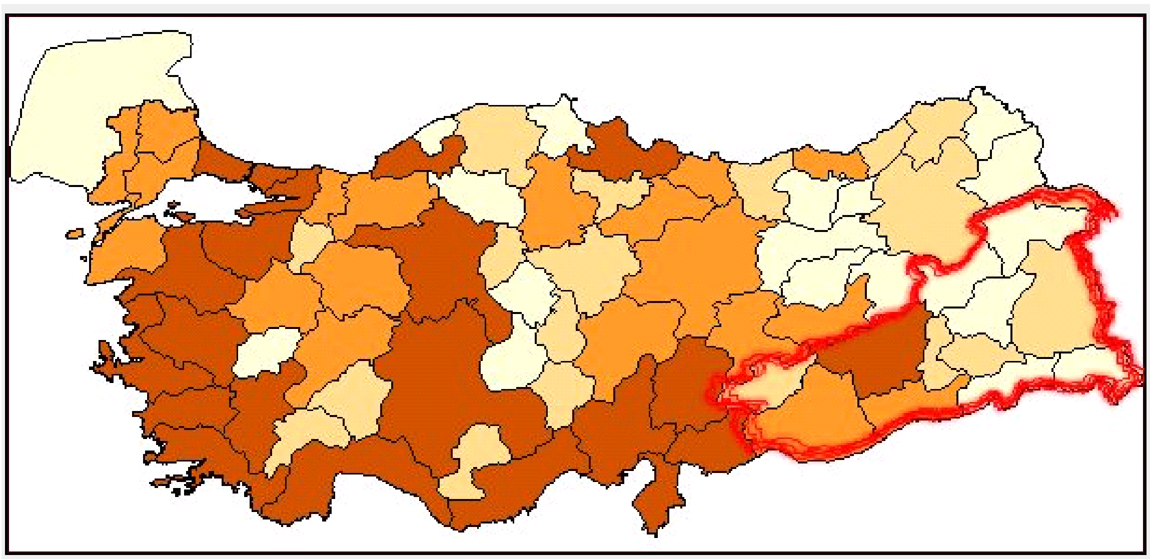
## Secondary Education LISA Cluster Map for 2006



Source: TURKSTAT, own calculations

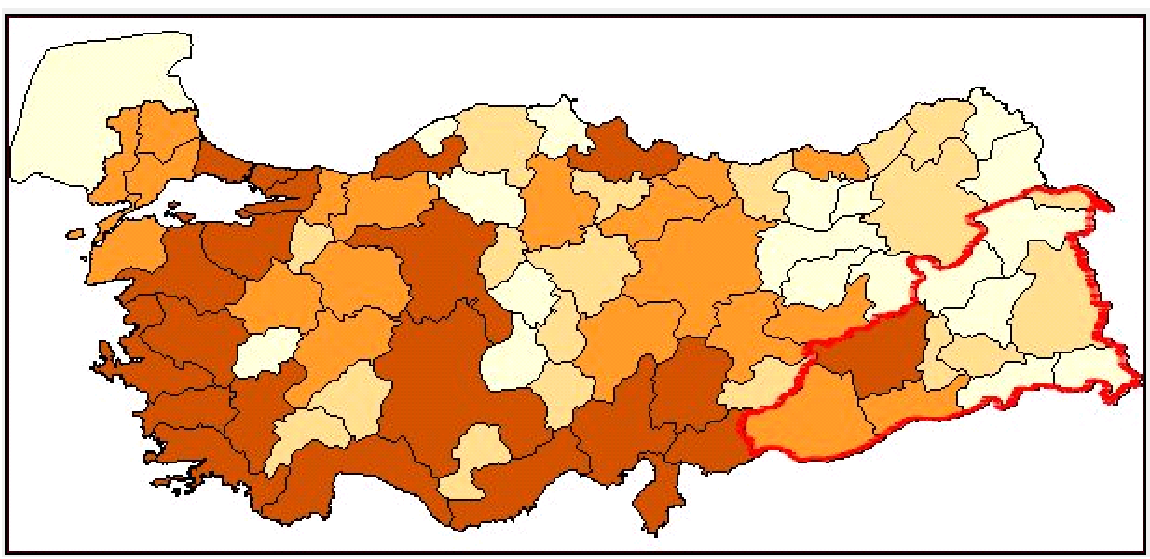
## Appendix B - Distribution Maps -

### Spatial Distribution of Per Capita Income and Primary Education Cluster



Source: TURKSTAT, own calculations

### Spatial Distribution of Per Capita Income and Secondary Education Cluster



Source: TURKSTAT, own calculations