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# Mapping the Educational Attainment in Turkey

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# Mapping the Educational Attainment in Turkey

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*Abstract*

*This study demonstrates the distribution of educational attainment in Turkey based on district level data for 1990 and 2010. Focusing on the economically active working age population (25-64 age band) our results indicate that; even average years of schooling becomes spatially more alike, higher education levels witness an on-going divergence. Additionally our results indicate that different segments of the society realize different levels of improvement in education attainment. Female population and rural population are observed to be the most disadvantageous individuals. These results become even more remarkable once the spatial spill overs and the persistence of spatial heterogeneity is considered.*

*Keywords: education, spatial distribution, Turkey*

*JEL classification: I24, I25, R11*

## 1. INTRODUCTION

Education is an important element of human capital development and has been on the agenda of economists for decades. Modern growth theories define a key role for educational human capital development as it has ability to foster growth through innovation and creation of new ideas (Lucas, 1988; Romer, 1990; Mankiw et al. 1992). It has been widely challenged that cross country differences are explained by the education attainment differences (Barro and Lee, 1992). Additionally evidence from regional studies also pin point the momentous place of education in understanding why some regions lag behind the others (Gennaioli et al., 2013).[1]

Even human capital development and educational progress matters both at national and regional scale, individuals usually do not have the same ability to reach and benefit from educational policies and developments especially within countries (Rodriguez-Pose and Tselios, 2009, 2011; Rosenthal and Strange, 2008). That is, even policies aiming the stimulation of education level at national scale is a popular agenda; level of realization at the regional scale can be questionable. This we believe becomes even more prominent considering the developing world, which to our knowledge has not been considered extensively. Originating from this gap

[1] For different case studies on regional development and human capital progress see also Rouch, 1993; Rodriguez-Pose and Vilalta Bufi, 2005; Di Liberto, 2008; Lopez-Bazo and Moreno, 2008; Bronzini and Piselli, 2009; Faggian and McCann, 2009.

in the urban and regional science literature, this study investigates the distribution of human capital development measured by the educational attainment for the regions of Turkey.

The case of Turkey can be regarded as peculiar in its own structure given the persistence spatial duality for decades. The western regions of Turkey are historically well developed with respect to the eastern regions. The roots of these inequalities goes back to the early years of the foundation of the country, which witness a huge loss in the young population after the First World War as well as a collapse of the ties with eastern countries that has been relatively better during the Ottoman period (Doğruel and Doğruel, 2003). Recently Bilgel and Karahasan (2015) also discuss that this dichotomy is in a way responsible of the internal political conflict that raises security concerns and deteriorates the economic environment in the eastern geography for the post 1980 episode. The dichotomy observed in socio-economic environment of the country received increasing attention from scholars; in general with a clear evidence on the persistence of the imbalances. Filiztekin (1998), Gezici and Hewings (2004 and 2007), Yıldırım and Öcal (2006) remark the failure of the eastern regions to catch up the west in terms of regional growth. Similarly Filiztekin (2009), Celebioğlu and Dall'erba (2010), Yeşilyurt and Elhorst (2014) and Karahasan (2015) underline that this is not a coincidence since they also observe high spatial heterogeneity in the labor market conditions for the regions of Turkey. Given the specific place of human capital development through educational improvements, it is an expected contribution to divert the impact of human capital development in a regional setting for a developing country suffering from persistent inequalities.

This study starts by explaining how educational attainment and inequalities is measured at district level. Educational differences are going to be defined for different segments of the society (female-male and urban-rural separation).Following the initial set of analysis, second set of analysis will divert the attention towards the spatial dependence and heterogeneity concerns, which we believe is going to give a better understanding for the design of right policies at the regional scale. Finally the paper will conclude.

## 2. MEASURING EDUCATIONAL ATTAINMENT AND INEQUALITIES

While measuring the regional educational attainment we use district level data, which we believe will identify the most possible local variations. For 1990 we use the Annual population Census conducted that year and for the year 2010 we use Address Based Population Records.[2] For each of 859 districts we have data on the number of individuals with the latest degree earned by age group, gender and urban-rural residence.[3]

[2] Data is obtained from Turkish Statistics Office (TURKSTAT)

[3] Our districts are based on 1990 division. We have originally 923 districts, however we have aggregated metropolitan areas in large cities. See Rodriguez-Pose and Tselios (2011) for evidence on the importance of metropolitan areas for human capital accumulation.

We consider two different variables to measure the educational attainment of districts. First variable is the average years of schooling. This will give us the degree of the overall education attainment of the regions. The second variable is the share of individuals who have university degree, enabling us to measure the extent of the higher voluntary schooling beyond mandatory as well as high school education. While analyzing the degree of educational attainment instead of observing the aggregate district population, we focus on the economically active population within the age band of 25-64. This age group consists of individuals who are at the working age and mostly finished their educational human capital investment. Comparing the spatial pattern for 1990 and 2010 will explain how each district manage to change its educational attainment, which is linked with the educational investment done in advance. That is to say, comparing 1990 and 2010 figures for this age band will allow us to question how individuals' human capital investment differ during the pre-1990 and 2010 periods in Turkey.

In order to understand the sample and the educational human capital patters we start by implementing a set of descriptive analysis. Table 1 demonstrates the regional patterns of average years of schooling. On an aggregate basis figures indicate the increase in average years of schooling together with a fall in the variation of the distribution. In general, our initial set of results also pin point that females and individuals residing in the rural parts of the districts are the most disadvantageous ones. In all cases the accumulation in the human capital mostly originates from urban areas and male population. However, even the range of the distribution is mostly stable; we realize a significant fall in the coefficient of variation, which we believe indicates some signs of improvement even for the disadvantageous segments of the society.

Our second analysis covers the individuals with university education. We discuss that these individuals have obtained higher education level by passing towards voluntary education. Table 2 demonstrates the results for share of university graduates at different disaggregation. Our results show that similar to the average years of schooling, there is an increase in the share of individuals with university education and the increase mostly originates from the males and individuals residing in the urban centers. However what is more remarkable is that, this time the distinction between male and female individuals as well as individuals in the rural and urban areas become even more visible. In general the range of the distribution is getting larger. Additionally in terms of the variation of the distribution, our results indicate a worsening specifically for rural areas. All these make us feel that developments in the society with higher education level is in a way getting divergent unlike the minor improvement signs observed for the overall education attainment.

Our initial results from the overall education and higher education attainment of the working age population at district level indicate a general tendency towards an improvement in the average years of schooling, but not the same for higher education. In order to better apprehend this patters, we plot the educational human capital improvements with the initial education level of the districts. Our stand is similar to a traditional convergence framework; that for an improvement in the distribution we expect a negative relationship between the regional human capital progress and initial human capital level.[4]

Figure 1 and 2 gives the figures for the average years of schooling and share of university graduates at major disaggregation. Results are interesting and supportive of the first set of analysis. For the average years of schooling there is a convergence pattern and this pattern is observed to be stronger in rural areas and for female population. That is even the first set of analysis identify the dominance of urban and male population, there is a tendency (even minor) for rural and female population to accelerate the human capital accumulation. However our results become even more remarkable once the share of university graduates is investigated. Overall we find a divergence pattern, which is observed to be even more dramatic for the female population.[5]

Finally in order to have a clear idea about the geography of the educational human capital development as well as its improvement (convergence vs. divergence) we map the distribution of average years of schooling and share of university graduates as of 1990 and compare this with the change pattern of the education patterns during the 1990-2010 period. This will give some complementary information on the ability of less educated districts as of 1990 to accumulate human capital in favor of convergence. Figures 3 shows that there is a dual pattern that leaves most of the south-eastern geography of Turkey less educated as of 1990. However these districts realize substantial growth in their average years of schooling during the 1990-2010 period. On contract figure 4 shows that share of university graduates in a way shows a divergence pattern that already high educated districts continue to dominate the human capital accumulation, while south-eastern districts cannot sustain a significant improvement during the period under concern.[6]

## 3. EXPLORATORY SPATIAL DATA ANALYSIS FOR EDUCATIONAL ATTAINMENT

### *3.1 Spatial Dependence*

While the first set of descriptive analysis carried out in the previous section explains the path of regional educational human capital attainment to some extent, the picture does not control for an important dimension; simply spatial spillovers and dependence. As discussed by Rodriguez-Pose and Tselios (2009 and 2011) human capital endowments are subject to

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[4] See Barro and Sala-i Martin (1992) for the details of the traditional convergence frame- work. Also see Babini (1991) for an application for education based human capital differences.

[5] We also replicate the same set of analysis for gender disaggregation within rural and urban population. Our results for average years of schooling as well as share of university graduates are in supportive of the findings obtained so far. They are all available upon request.

[6] Distribution of education attainment for other segments of the society gives much or less similar geographical patterns. To save space, these maps are not reported, however all available from the authors up-on request.

substantial spatial auto- correlation among the regions of the European Countries. Similarly Rosenthal and Strange (2008) indicate possible spatial spillovers among the regions of United States. The overall tendency regarding the examination of the spatial linkages is crucial as it enables us to understand the strength and magnitude of spatial connectivity between regions in terms of social and economic properties. This may contain valuable insight about the way that regions that are in close proximity behaves and inevitably this will shape the regional policy implementations by considering how a specific policy tool on a specific region will affect not only that region but also its surrounding. To our existing knowledge such an examination has not been carried out for examining the intra country spatial connectivity in terms of educational attainment for a developing country. In line with this additional set of analyses are carried out as to clarify the regional distribution of human capital.

The first set of analysis is the analytical examination of spatial autocorrelation for education attainment differences. Any significant information will guide us to understand the magnitude of the relationship. In line with these concerns we start by applying the Exploratory Spatial Data Analysis (ESDA) that questions the existence of the spatial links. Following Cliff and Ord (1981) the usual spatial autocorrelation statistic of Moran's I is computed (equation 1).[7]

(1) $$I_i = \frac{n}{s} \frac{\sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum (x_i - \bar{x})^2}$$

Moran's I statistics has the null hypothesis of spatial randomness; values greater and lower than one indicates positive and negative autocorrelation respectively. In case Moran's I is reported as 0 we can talk on the spatial randomness of the distribution. As represented in equation 1, n represents the number of cross sections; s is the summation of the all elements of the weight matrix. The essential element is the weight matrix (w), which defines basically the way that each cross section is integrated. We start by using a contiguity weight matrix that assigns a value of 1 if districts are adjacent to each other and 0 otherwise. Next in order to account for different dimensions of connectivity, we use three different distance weight matrices; an inverse distance weight matrix, then a binary threshold distance weight matrix that assigns values of 1 to districts in a circle distance of 100 km. And finally a k-nearest weight matrix is constructed, based on the great circle

[7] Similar calculations are also replicated by using Geary's C and Getis, Ord's G statistics, yielding similar results. These results are not reported to save space, yet available from the authors up-on request. All these measures are commonly used most of the time yielding consistent and similar results. In general while Moran's I seems to be more sensitive to extreme values, Gear's C suffers from the sensitivity to differences in small neighbourhoods. As discussed by Cliff and Ord (1981) underlined that results obtained from Moran's I statistics turn out to be more consistent with respect to the ones from Geary's C.

distance between two districts such that each districts has k number of neighbors respectively.

While calculating the extent of the spatial dependence, we follow a way to distinguish different dimensions of the within variability detected in the previous section. That is, we decompose the total district population into its sub-components as to understand not only the path of spatial dependence but also the roots of the spillovers. Results of the Global Spatial Autocorrelation analysis are provided in tables 3 and 4.

Our results contain a number of technical aspects. First of all our findings clarify that there is an overall fall in the spatial dependence both for average years of schooling and share of university graduates from 1990 to 2010. Regarding the weight matrix specifications; spatial ties are observed to be lowest for the inverse distance weight matrix and tend to increase with the use of contiguity, threshold and k-nearest distance weight matrices. However we believe what matters for the spatial analysis rests in the relationship between human capital level, dispersion and the strength of the spatial dependence. Starting with the average years of schooling, we identify that, disadvantageous segments of the society exhibit higher level of spatial dependence. That is, female individuals and rural population seems to realize higher level of spatial clustering. Among all segments it is the female individuals in rural areas that tend to give the highest spatial dependence in terms of overall education attainment. Another important dimension of this remark is related with the convergence analysis carried out in the previous section. Our results not only give clues on the relationship between level of educational development and spatial ties but also enlighten the fact that these individuals with lagging initial conditions and higher spatial dependence realize a period of improvement in their education level together with a fall in the spatial dependence. On the other hand for the share of university graduates we detect lower spatial dependence with respect to average years of schooling. We identify a similar fall in spatial dependence through time, yet this fall seems to be less pronounced in contrast to the average years of schooling. Moreover rural population and female individuals exhibit higher spatial dependence.

A detailed analysis of the spatial dependence figures in tables 3 and 4 indicates that spatial dependence is higher among the population residing in the rural areas as well as female population of each district. Given that both population residing in the rural areas as well as the female population of the district have the more diverse ability to increase their education levels, it is worth underlining that the spatial dependence is observed to be rising towards the groups with higher inequality. In that sense, reminding our earlier evidence on the high inequalities for men and women residing in the rural areas of the districts, we figure out once more that inequalities and spatial dependence has some sort of a pattern. Groups within district population with higher inequalities are realizing higher spatial dependence unlike the district centers. More importantly spatial ties are observed to lessen with the rise in the human capital development, reminding us a Spatial Kuznets curve;

higher spatial dependence in early development phases and declining spatial dependence with rising development. These first set of findings from ESDA indicates the importance of the ties among development, inequalities and spatial dependence; yet still fails in giving a fresh idea on the policy issues as the local variations of the detected spatial spillovers are blurry.

### *3.2 Spatial Heterogeneity and Persistence*

Given the early remarks on the way that inequalities and spatial dependence work our final set of analysis will focus on the issue of spatial heterogeneity. That is we will focus on the local realizations of the global spatial statistics. The idea here is that; even the first set of ESDA statistics contain valuable information about the spatial spillovers, it mostly lacks due its inability to explain the local variations. By doing; so we also aim to make a comparative analysis of the possible ties between the level of development, inequalities and the spatial dependence, all of which is able to vary across space.

As discussed by Anselin (1995) the global spatial autocorrelation statistics may fail to show the local instabilities (outliers) and local concentration (clusters). Anselin (1996) showed that observing the Moran Scatterplot is helpful to evaluate these instabilities but as discussed in Anselin (1995) the significance of the local variability can also be crucial. Equation 3 is the Local Indicator of Spatial Association (LISA), visualizing the local significance and magnitude of the global spatial autocorrelation measure (Moran's I). As explained by Anselin (1995) the sum of all Local Moran values is going to be equal to the global Moran's I statistics.[8]

(2) $$I_i = \left(x_i - \bar{x}\right)\sum_j w_{ij}\left(x_j - \bar{x}\right)$$

The LISA analysis will indicate four groups of local spatial autocorrelation together with their significance. Two set of clusters with high and low educational attainment are defined. Additionally two set of outliers are formed; one indicating the low educational attainment in areas that are in close proximity to high education attainment locations, another showing high educational areas in close proximity to low educational attainment. Here instead of plotting the LISA cluster maps we prefer to implement a set of analysis on the LISA scores obtained for each individual district.[9] We have implemented these

[8] See Anselin (1995) for further details on the other local spatial association statistics such as Local Gamma and Local Geary.
[9] All LISA cluster maps are available from the authors upon request

analysis for various disaggregation levels and report the number of counts for each possible LISA class for 1990 and 2010 in tables 5 and 6. Our initial results for the average years of schooling indicate that number of districts in the High-High and Low-Low clusters decrease from 1990 to 2010 in all segments other than rural females. However regardless of the segment investigated number of districts within the High-High clusters is higher. Additionally gender differences prevail and are influenced from the place of residence. On the other hand our results for the share of university graduates show that even number of districts within High-High and Low-Low clusters decline in general (other than rural-male and rural-female population), in all cases number of districts within the Low-Low clusters is higher. This indicates that even average years of schooling of districts realize more clustering among already educated districts, for higher education level this tends to turn just the reverse. In general we believe this implies that any policy to promote more human capital in general will have higher spillover effects on the already well educated districts; however other policies to influence higher education levels are going to create increasing diffusion effects among the less educated districts. On the other hand for outlier districts we do not observe a clear common pattern.

Even the first set of analysis from the district level LISA scores contain sizable information on the local impact of common education policies, it fails in explaining the possible mobility of districts from one spatial regime to the other. Rey (2001) and Hammond (2004) discuss that applying a basic Markov Chain Approach to spatial analysis will contain sizable information about the persistence of the spatial dependence and heterogeneity. In order to have more idea on the persistence issue, we first implement a transition probability analysis similar to the influential contributions of Quah (1993). Next instead of supplying the full transition matrices for various segments of the districts, we calculate the stability index as offered in Pellegrini (2002). Equation 3 is the stability index (S) for a transition matrix (X) with dimensions of n is given in equation 3. n is the number of classes which represents our spatial regimes in this case. tr is the trace of the matrix. In short stability index will show us the probability of staying in the same spatial regime. Our combined results are given in table 6. We first implement the stability index by including the non- significant districts (A), next we only focus on the stability issue among the only significant districts (B). Our results indicate that with some exceptions stability is observed to be higher among the share of university graduates. Additionally results also indicate that mobility of districts from non-significant local spatial dependence to any spatial regimes seems to over-exaggerate the level of mobility. However once the only significant districts are considered, results indicate higher stability among the spatial regimes from 1990 to 2010.

(3) $$S = \frac{Tr(P)}{n}$$

Even the first set of results identify the persistence of the spatial regimes, they can be further developed by implementing the approach offered by Rey (2001).[10] Similar to the initial set of analysis we start by taking into account the non-significant districts. We identify a number of mobility: Type 0 consists of districts that do not change their regimes, Type I represents the mobility of a district while its proximity stays the same, Type II represents the stability of a district while its proximity tends to move, Type IIIA is the mobility of both the district and the proximity districts in the same direction, Type IIIB is the mobility of the district and the proximity in the opposite directions, Type IV is the mobility of a district from having insignificant local spatial dependence to any other significant spatial regimes and finally type V is the movement of a district from any sort of spatial regime to a case of no local significance. Afterwards we implement the same analysis by only focusing on the significant local LISA scores. This time we use the same types other than the Type IV and V as they represent the mobility in relation with the insignificant local scores. For both cases we also calculate two stability values of Cohesion Index and Flux Index as offered in Rey (2001).[11] In general the higher the cohesion index is the lower the mobility among the spatial regimes. Additionally this will be reflected in the Flux ratio, which inversely related with the cohesion index.

First vital finding which is in line with the previous analysis is that; mobility tends to become higher once the mobility of non-significant districts are allowed for. Additionally share of university graduates is observed to be less mobile throughout the spatial regimes. Interestingly we also detect no mobility for Type IIIA and Type IIIB districts, which indicates that outlier districts do not observe a movement within the distribution. However given the variability observed in tables 5 and 6, it should be noted that outlier districts move to being insignificant in specific cases and vice versa.

In general these final set of findings reveal that, even previous detected spatial spillovers give a pattern in favor of the importance of spatial spillovers, our local analysis indicate that there are different spatial regimes for human capital development in Turkey. Moreover even we realize a dynamic and non- linear link between spatial dependence, development and inequalities in the global analysis, local decompositions show that spatial differences are mostly persistent. Spatial regimes that we detect are in a way show a polarization given the strong stability of the mobility among LISA classes. This we believe remarks that although policy implications are able to influence the overall education attainment (to some extent), local divergence still prevails; which calls for the identification of region specific flexible policies.

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[10] See Technical Appendix for details of the approach.
[11] See Technical Appendix for a brief representation

## 4. CONCLUSION

Educational human capital development seems to be an important determinant of the regional growth and development. Inevitably investigating the way that education bases of regions differ in Turkey means, capturing some hints on the roots of the persistent inequalities evolving in the last couple of decades. Eventually this paper seeks to fill the gap on understanding the spatial distribution of education in a developing country, Turkey.

First of all our evidence on the regional educational inequalities indicate that there is a fall in aggregate term (mostly for average years of schooling, not for higher education levels); yet not each group benefits to the same extent from these improvements. Individuals outside the district centers (rural areas) more specifically female (in general both in and outside the center) seem to be worse off in terms of inequalities. Meanwhile our second set of analysis for the spatial dependence of educational attainment underlines that the highest spatial spillovers are observed among the most unequal groups of the society (rural areas and females). And finally our analysis on the possible spatial instabilities indicates a clear heterogeneous picture for Turkey which becomes more visible for rural population as well as female population. At this stage our evidence on the mobility between spatial regimes are signaling the stability. Districts in given spatial regimes do not move to other regimes that frequently. This becomes even stronger for higher education levels. This finding is consistent with the first set of evidence that validates some levels of improvement in average years of schooling but substantial divergence for share of university graduates.

Originating from these findings design of regional policy in terms of educational developments can be improved further. Given the instability of inequalities and spatial dependence across different groups (gender effects, residence effect etc.) it is clear that one policy will not fit all the regions. Regional and social policies directed to certain groups within the society may have sizable impact with respect to an overall education (or social) policy that may underestimate the possible local dissimilarities. Given higher spatial dependence detected for disadvantageous segments of the society, a direct policy implementation may have higher diffusion effects which will eventually increase the extent of the policy implementation.

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# Appendices

## A Tables

Table 1: District Level Education Attainment: Average Years of Schooling

| | Mean | Min. | Max. | Stdev. | CoV |
|---|---|---|---|---|---|
| Total | | | | | |
| Years of Schooling 1990 | 4.140 | 0.741 | 9.666 | 1.192 | 0.288 |
| Years of Schooling 2010 | 6.970 | 2.593 | 12.420 | 1.469 | 0.210 |
| Urban | | | | | |
| Years of Schooling 1990 | 5.355 | 1.075 | 11.203 | 1.243 | 0.232 |
| Years of Schooling 2010 | 8.530 | 4.547 | 13.867 | 1.407 | 0.165 |
| Rural | | | | | |
| Years of Schooling 1990 | 3.418 | 0.489 | 7.813 | 1.042 | 0.305 |
| Years of Schooling 2010 | 5.593 | 1.629 | 11.447 | 1.091 | 0.195 |
| Male | | | | | |
| Years of Schooling 1990 | 5.444 | 1.403 | 10.457 | 1.143 | 0.210 |
| Years of Schooling 2010 | 8.378 | 3.904 | 13.883 | 1.482 | 0.177 |
| Female | | | | | |
| Years of Schooling 1990 | 2.909 | 0.077 | 8.785 | 1.263 | 0.434 |
| Years of Schooling 2010 | 5.631 | 1.349 | 11.243 | 1.561 | 0.277 |
| Urban Males | | | | | |
| Years of Schooling 1990 | 6.835 | 2.059 | 12.173 | 1.184 | 0.173 |
| Years of Schooling 2010 | 10.256 | 6.268 | 15.067 | 1.464 | 0.143 |
| Urban Females | | | | | |
| Years of Schooling 1990 | 3.850 | 0.154 | 10.134 | 1.389 | 0.361 |
| Years of Schooling 2010 | 6.903 | 2.376 | 12.708 | 1.533 | 0.222 |
| Rural Males | | | | | |
| Years of Schooling 1990 | 4.584 | 0.955 | 9.488 | 0.985 | 0.215 |
| Years of Schooling 2010 | 6.764 | 2.611 | 12.391 | 1.060 | 0.157 |
| Rural Females | | | | | |
| Years of Schooling 1990 | 2.364 | 0.035 | 5.974 | 1.109 | 0.469 |
| Years of Schooling 2010 | 4.463 | 0.701 | 10.522 | 1.209 | 0.271 |

Source: Turkstat, Authors' own calculations

Table 2: District Level Education Attainment: Share of University Graduates

| | Mean | Min. | Max. | Stdev. | CoV |
|---|---|---|---|---|---|
| Total | | | | | |
| University Graduates 1990 | 0.031 | 0.003 | 0.226 | 0.021 | 0.663 |
| University Graduates 2010 | 0.077 | 0.014 | 0.319 | 0.047 | 0.607 |
| Urban | | | | | |
| University Graduates 1990 | 0.053 | 0.002 | 0.294 | 0.028 | 0.532 |
| University Graduates 2010 | 0.128 | 0.018 | 0.400 | 0.053 | 0.418 |
| Rural | | | | | |
| University Graduates 1990 | 0.017 | 0.000 | 0.135 | 0.012 | 0.720 |
| University Graduates 2010 | 0.029 | 0.004 | 0.311 | 0.024 | 0.806 |
| Male | | | | | |
| University Graduates 1990 | 0.050 | 0.006 | 0.279 | 0.028 | 0.551 |
| University Graduates 2010 | 0.105 | 0.023 | 0.371 | 0.056 | 0.534 |
| Female | | | | | |
| University Graduates 1990 | 0.014 | 0.000 | 0.167 | 0.014 | 1.058 |
| University Graduates 2010 | 0.050 | 0.005 | 0.295 | 0.040 | 0.793 |
| Urban Males | | | | | |
| University Graduates 1990 | 0.081 | 0.005 | 0.366 | 0.038 | 0.472 |
| University Graduates 2010 | 0.173 | 0.029 | 0.454 | 0.065 | 0.377 |
| Urban Females | | | | | |
| University Graduates 1990 | 0.025 | 0.000 | 0.215 | 0.020 | 0.798 |
| University Graduates 2010 | 0.085 | 0.005 | 0.348 | 0.047 | 0.549 |
| Rural Males | | | | | |
| University Graduates 1990 | 0.030 | 0.000 | 0.193 | 0.017 | 0.572 |
| University Graduates 2010 | 0.043 | 0.006 | 0.342 | 0.029 | 0.666 |
| Rural Females | | | | | |
| University Graduates 1990 | 0.006 | 0.000 | 0.078 | 0.008 | 1.416 |
| University Graduates 2010 | 0.016 | 0.000 | 0.280 | 0.020 | 1.257 |

Source: Turkstat, Authors' own calculations

Table 3: Global Spatial Auto-Correlation: Average Years of Schooling

| | Inverse Distance | Contiguity (n=1) | Threshold Distance | k-nearest (k=10) |
|---|---|---|---|---|
| Total | | | | |
| Years of Schooling 1990 | 0.234*** | 0.260*** | 0.525*** | 0.589*** |
| | (92.433) | (15.616) | (57.241) | (40.578) |
| Years of Schooling 2010 | 0.133*** | 0.178*** | 0.338 *** | 0.404*** |
| | (52.579) | (10.703) | (36.865) | (27.820) |
| Urban | | | | |
| Years of Schooling 1990 | 0.162*** | 0.206*** | 0.405*** | 0.463*** |
| | (64.356) | (12.374) | (44.172) | (31.898) |
| Years of Schooling 2010 | 0.076 *** | 0.128*** | 0.241*** | 0.287*** |
| | (30.267) | (7.721) | (26.343) | (19.756) |
| Rural | | | | |
| Years of Schooling 1990 | 0.285*** | 0.318** | 0.651*** | 0.710** |
| | (112.449) | (19.089) | (70.924) | (48.909) |
| Years of Schooling 2010 | 0.154*** | 0.213** | 0.397*** | 0.463** |
| | (61.429) | (12.877) | (43.465) | (32.052) |
| Male | | | | |
| Years of Schooling 1990 | 0.143*** | 0.200*** | 0.371*** | 0.450*** |
| | (56.754) | (12.026) | (40.455) | (31.018) |
| Years of Schooling 2010 | 0.067*** | 0.128*** | 0.199*** | 0.266*** |
| | (26.775) | (7.690) | (21.750) | (18.373) |
| Female | | | | |
| Years of Schooling 1990 | 0.299*** | 0.306*** | 0.659*** | 0.706*** |
| | (118.318) | (18.360) | (71.813) | (48.640) |
| Years of Schooling 2010 | 0.210*** | 0.232*** | 0.497*** | 0.555*** |
| | (82.949) | (13.955) | (54.156) | (38.226) |
| Urban Males | | | | |
| Years of Schooling 1990 | 0.076*** | 0.146** | 0.226*** | 0.292** |
| | (30.329) | (8.826) | (24.667) | (20.140) |
| Years of Schooling 2010 | 0.031*** | 0.087** | 0.129*** | 0.179** |
| | (12.487) | ( 5.249) | ( 14.122) | (12.401) |
| Urban Females | | | | |
| Years of Schooling 1990 | 0.245*** | 0.260** | 0.568*** | 0.613** |
| | (96.782) | (15.674) | (62.034) | (42.304) |
| Years of Schooling 2010 | 0.158*** | 0.191** | 0.416*** | 0.457** |
| | (62.678) | (11.475) | (45.369) | (31.492) |
| Rural Males | | | | |
| Years of Schooling 1990 | 0.192*** | 0.276** | 0.516** | 0.595** |
| | (76.242) | (16.624) | (56.283) | (41.029) |
| Years of Schooling 2010 | 0.073*** | 0.155** | 0.220** | 0.289** |
| | (29.846) | (9.524) | (24.441) | (20.294) |
| Rural Females | | | | |
| Years of Schooling 1990 | 0.330*** | 0.342** | 0.749*** | 0.788** |
| | (130.352) | (20.567) | (81.583) | (54.260) |
| Years of Schooling 2010 | 0.249*** | 0.272** | 0.593*** | 0.647** |
| | (98.318) | (16.334) | (64.625) | (44.610) |

Source: Turkstat, Authors' own calculations
Notes: ***, ** and * represent spatial dependence at 1%, 5% and 10% respectively.

Table 4: Global Spatial Auto-Correlation: Share of University Graduates

| | Inverse Distance | Contiguity (n=1) | Threshold Distance | k-nearest (k=10) |
|---|---|---|---|---|
| Total | | | | |
| University Graduates 1990 | 0.074*** | 0.139** | 0.190*** | 0.261** |
| | (29.916) | (8.467) | (20.911) | (18.168) |
| University Graduates 2010 | 0.041*** | 0.097** | 0.120*** | 0.146** |
| | (16.430) | (5.896) | (13.187) | (10.099) |
| Urban | | | | |
| University Graduates 1990 | 0.062*** | 0.141** | 0.165*** | 0.219** |
| | (24.918) | (8.524) | (18.191) | (15.211) |
| University Graduates 2010 | 0.035*** | 0.093** | 0.123*** | 0.144** |
| | (14.211) | (5.659) | (13.496) | (9.957) |
| Rural | | | | |
| University Graduates 1990 | 0.078*** | 0.144*** | 0.204*** | 0.310*** |
| | (31.366) | (8.819) | (22.649) | (21.685) |
| University Graduates 2010 | 0.056*** | 0.137*** | 0.197*** | 0.257*** |
| | (22.829) | (8.394) | (21.936) | (18.065) |
| Male | | | | |
| University Graduates 1990 | 0.053*** | 0.129** | 0.148*** | 0.222** |
| | (21.445) | (7.815) | (16.341) | (15.412) |
| University Graduates 2010 | 0.028*** | 0.086** | 0.089*** | 0.108** |
| | (11.446) | (5.201) | (9.800) | (7.523) |
| Female | | | | |
| University Graduates 1990 | 0.107*** | 0.149** | 0.257*** | 0.319** |
| | (43.141) | (9.100) | (28.392) | (22.269) |
| University Graduates 2010 | 0.061*** | 0.119*** | 0.170*** | 0.205** |
| | (24.656) | (7.198) | (18.673) | (14.173) |
| Urban Males | | | | |
| University Graduates 1990 | 0.041*** | 0.131** | 0.123*** | 0.173** |
| | (16.457) | (7.925) | (13.481) | (11.976) |
| University Graduates 2010 | 0.021*** | 0.082** | 0.082*** | 0.105** |
| | (8.810) | (4.955) | (9.082) | (7.264) |
| Urban Females | | | | |
| University Graduates 1990 | 0.106*** | 0.150** | 0.247*** | 0.295** |
| | (42.378) | (9.094) | (27.177) | (20.487) |
| University Graduates 2010 | 0.059*** | 0.118** | 0.187*** | 0.214** |
| | (23.694) | (7.135) | (20.497) | (14.821) |
| Rural Males | | | | |
| University Graduates 1990 | 0.062*** | 0.138** | 0.183*** | 0.291*** |
| | (25.002) | (8.392) | (20.219) | (20.286) |
| University Graduates 2010 | 0.057*** | 0.139** | 0.208*** | 0.273*** |
| | (22.964) | (8.453) | (22.966) | (19.054) |
| Rural Females | | | | |
| University Graduates 1990 | 0.103*** | 0.153** | 0.254*** | 0.348*** |
| | (41.724) | (9.387 ) | (28.173) | (24.363) |
| University Graduates 2010 | 0.060*** | 0.136** | 0.192*** | 0.243*** |
| | (24.725) | (8.454) | (21.553) | (17.242) |

Source: Turkstat, Authors' own calculations
Notes: ***, ** and * represent spatial dependence at 1%, 5% and 10% respectively.

Table 5: Local Spatial Auto-Correlation (Count): Average Years of Schooling

| | Not Significant | Low-Low Clusters | Low-High Outliers | High-Low Outliers | High-High Clusters |
|---|---|---|---|---|---|
| Total | | | | | |
| Years of Schooling 1990 | 354 | 176 | 28 | 37 | 264 |
| Years of Schooling 2010 | 480 | 134 | 48 | 40 | 157 |
| Urban | | | | | |
| Years of Schooling 1990 | 398 | 155 | 43 | 46 | 217 |
| Years of Schooling 2010 | 537 | 119 | 45 | 33 | 125 |
| Rural | | | | | |
| Years of Schooling 1990 | 289 | 199 | 14 | 30 | 327 |
| Years of Schooling 2010 | 494 | 131 | 12 | 16 | 206 |
| Male | | | | | |
| Years of Schooling 1990 | 433 | 144 | 48 | 35 | 199 |
| Years of Schooling 2010 | 563 | 107 | 37 | 31 | 121 |
| Female | | | | | |
| Years of Schooling 1990 | 320 | 178 | 10 | 33 | 318 |
| Years of Schooling 2010 | 426 | 155 | 28 | 35 | 215 |
| Urban Males | | | | | |
| Years of Schooling 1990 | 541 | 114 | 34 | 36 | 134 |
| Years of Schooling 2010 | 657 | 84 | 13 | 28 | 77 |
| Urban Females | | | | | |
| Years of Schooling 1990 | 332 | 164 | 28 | 37 | 298 |
| Years of Schooling 2010 | 436 | 149 | 44 | 44 | 186 |
| Rural Males | | | | | |
| Years of Schooling 1990 | 400 | 169 | 23 | 21 | 246 |
| Years of Schooling 2010 | 614 | 103 | 10 | 7 | 125 |
| Rural Females | | | | | |
| Years of Schooling 1990 | 537 | 126 | 12 | 23 | 161 |
| Years of Schooling 2010 | 394 | 151 | 8 | 22 | 284 |

Source: Turkstat, Authors' own calculations

Table 6: Local Spatial Auto-Correlation (Count): Share of University Graduates

| | Not Significant | Low-Low Clusters | Low-High Outliers | High-Low Outliers | High-High Clusters |
|---|---|---|---|---|---|
| Total | | | | | |
| University Graduates 1990 | 543 | 156 | 38 | 33 | 89 |
| University Graduates 2010 | 589 | 128 | 27 | 45 | 70 |
| Urban | | | | | |
| University Graduates 1990 | 528 | 155 | 42 | 45 | 89 |
| University Graduates 2010 | 564 | 137 | 39 | 44 | 75 |
| Rural | | | | | |
| University Graduates 1990 | 605 | 139 | 19 | 15 | 81 |
| University Graduates 2010 | 642 | 127 | 9 | 10 | 71 |
| Male | | | | | |
| University Graduates 1990 | 597 | 124 | 28 | 31 | 79 |
| University Graduates 2010 | 628 | 100 | 24 | 37 | 70 |
| Female | | | | | |
| University Graduates 1990 | 469 | 220 | 34 | 29 | 107 |
| University Graduates 2010 | 546 | 156 | 34 | 44 | 79 |
| Urban Males | | | | | |
| University Graduates 1990 | 592 | 121 | 29 | 43 | 74 |
| University Graduates 2010 | 621 | 109 | 26 | 40 | 63 |
| Urban Females | | | | | |
| University Graduates 1990 | 433 | 213 | 46 | 37 | 130 |
| University Graduates 2010 | 499 | 186 | 37 | 51 | 86 |
| Rural Males | | | | | |
| University Graduates 1990 | 658 | 103 | 12 | 8 | 78 |
| University Graduates 2010 | 635 | 122 | 8 | 14 | 80 |
| Rural Females | | | | | |
| University Graduates 1990 | 729 | 59 | 12 | 9 | 50 |
| University Graduates 2010 | 654 | 119 | 10 | 15 | 61 |

Source: Turkstat, Authors’ own calculations

Table 7: Mobility Among Spatial Regimes: Stability Index

| | A | | B | |
|---|---|---|---|---|
| | Years of Schooling | University Graduates | Years of Schooling | University Graduates |
| Total | 0.657 | 0.735 | 0.977 | 0.985 |
| Urban | 0.637 | 0.603 | 0.949 | 0.939 |
| Rural | 0.582 | 0.434 | 0.953 | 0.693 |
| Male | 0.616 | 0.724 | 0.975 | 0.984 |
| Female | 0.724 | 0.725 | 0.983 | 0.989 |
| Urban Males | 0.451 | 0.581 | 0.889 | 0.979 |
| Urban Females | 0.687 | 0.581 | 0.960 | 0.961 |
| Rural Males | 0.424 | 0.480 | 0.914 | 0.928 |
| Rural Females | 0.472 | 0.361 | 0.516 | 0.583 |

Source: Turkstat, Authors' own calculations

Table 8: Markov Chain Analysis for Spatial Regimes A

| | Type 0 | Type I | Type II | Type IIIA | Type IIIB | Type IV | Type V | Cohesion | Flux |
|---|---|---|---|---|---|---|---|---|---|
| Total | | | | | | | | | |
| Average Years of Schooling | 0.729 | 0.015 | 0.000 | 0.000 | 0.000 | 0.055 | 0.201 | 0.729 | 0.271 |
| University Graduates | 0.838 | 0.002 | 0.001 | 0.000 | 0.000 | 0.052 | 0.106 | 0.838 | 0.162 |
| Urban | | | | | | | | | |
| Average Years of Schooling | 0745 | 0.016 | 0.000 | 0.000 | 0.000 | 0.038 | 0.200 | 0.745 | 0.255 |
| University Graduates | 0.724 | 0.010 | 0.002 | 0.000 | 0.000 | 0.111 | 0.153 | 0.724 | 0.276 |
| Rural | | | | | | | | | |
| Average Years of Schooling | 0.698 | 0.005 | 0.002 | 0.000 | 0.000 | 0.028 | 0.267 | 0.698 | 0.302 |
| University Graduates | 0.744 | 0.005 | 0.003 | 0.000 | 0.000 | 0.102 | 0.146 | 0.744 | 0.256 |
| Male | | | | | | | | | |
| Average Years of Schooling | 0.728 | 0.006 | 0.001 | 0.000 | 0.000 | 0.057 | 0.208 | 0.728 | 0.272 |
| University Graduates | 0.854 | 0.002 | 0.002 | 0.000 | 0.000 | 0.052 | 0.088 | 0.854 | 0.146 |
| Female | | | | | | | | | |
| Average Years of Schooling | 0.774 | 0.014 | 0.000 | 0.000 | 0.000 | 0.044 | 0.168 | 0.774 | 0.226 |
| University Graduates | 0.783 | 0.005 | 0.001 | 0.000 | 0.000 | 0.061 | 0.150 | 0.783 | 0.217 |
| Urban Males | | | | | | | | | |
| Average Years of Schooling | 0.682 | 0.006 | 0.005 | 0.000 | 0.000 | 0.086 | 0.221 | 0.682 | 0.318 |
| University Graduates | 0.747 | 0.003 | 0.001 | 0.000 | 0.000 | 0.107 | 0.141 | 0.747 | 0.253 |
| Urban Females | | | | | | | | | |
| Average Years of Schooling | 0.738 | 0.015 | 0.000 | 0.000 | 0.000 | 0.063 | 0.184 | 0.738 | 0.262 |
| University Graduates | 0.655 | 0.014 | 0.002 | 0.000 | 0.000 | 0.126 | 0.203 | 0.655 | 0.345 |
| Rural Males | | | | | | | | | |
| Average Years of Schooling | 0.644 | 0.010 | 0.001 | 0.000 | 0.000 | 0.048 | 0.297 | 0.644 | 0.356 |
| University Graduates | 0.772 | 0.003 | 0.000 | 0.000 | 0.000 | 0.126 | 0.099 | 0.772 | 0.228 |
| Rural Females | | | | | | | | | |
| Average Years of Schooling | 0.671 | 0.001 | 0.034 | 0.000 | 0.000 | 0.231 | 0.064 | 0.671 | 0.329 |
| University Graduates | 0.733 | 0.000 | 0.005 | 0.000 | 0.000 | 0.175 | 0.087 | 0.733 | 0.267 |

Source: Turkstat, Authors' own calculations

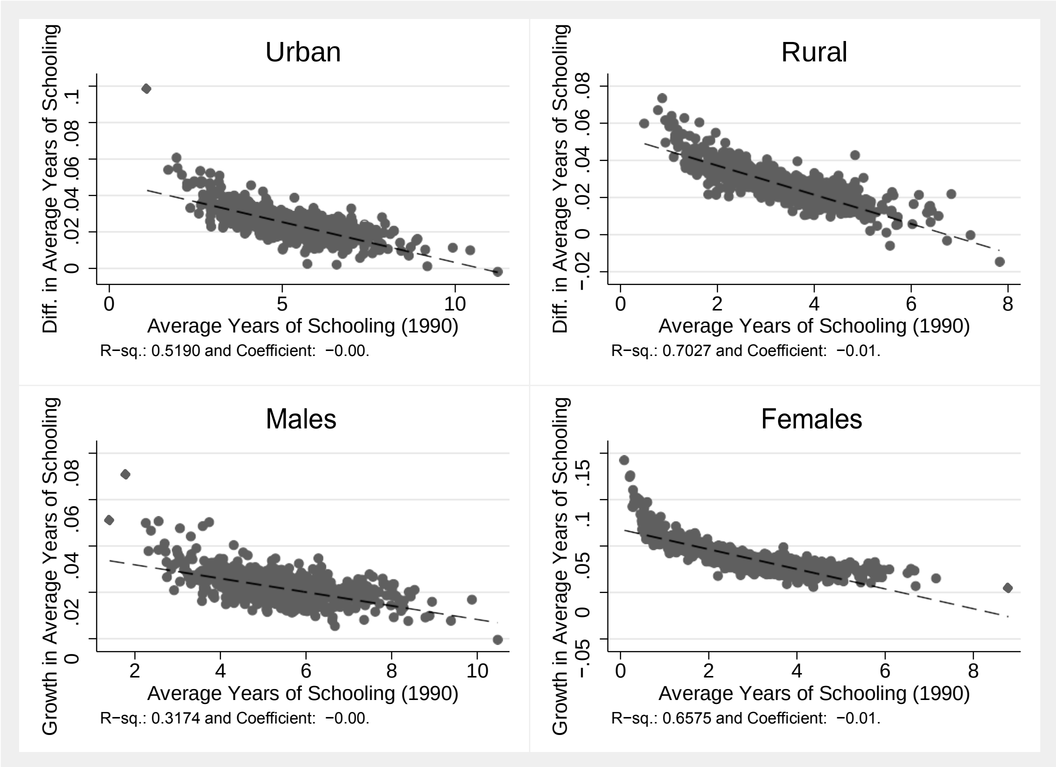
Table 9: Markov Chain Analysis for Spatial Regimes B

| | Type 0 | Type I | Type II | Type IIIA | Type IIIB | Cohesion | Flux |
|---|---|---|---|---|---|---|---|
| Total | | | | | | | |
| Average Years of Schooling | 0.961 | 0.039 | 0.000 | 0.000 | 0.000 | 0.961 | 0.039 |
| University Graduates | 0.987 | 0.009 | 0.004 | 0.000 | 0.000 | 0.987 | 0.013 |
| Urban | | | | | | | |
| Average Years of Schooling | 0.952 | 0.048 | 0.000 | 0.000 | 0.000 | 0.952 | 0.048 |
| University Graduates | 0.945 | 0.045 | 0.010 | 0.000 | 0.000 | 0.945 | 0.055 |
| Rural | | | | | | | |
| Average Years of Schooling | 0.982 | 0.012 | 0.006 | 0.000 | 0.000 | 0.982 | 0.018 |
| University Graduates | 0.946 | 0.031 | 0.023 | 0.000 | 0.000 | 0.946 | 0.054 |
| Male | | | | | | | |
| Average Years of Schooling | 0.976 | 0.020 | 0.004 | 0.000 | 0.000 | 0.976 | 0.024 |
| University Graduates | 0.978 | 0.011 | 0.11 | 0.000 | 0.000 | 0.978 | 0.002 |
| Female | | | | | | | |
| Average Years of Schooling | 0.970 | 0.030 | 0.000 | 0.000 | 0.000 | 0.970 | 0.030 |
| University Graduates | 0.981 | 0.015 | 0.004 | 0.000 | 0.000 | 0.981 | 0.019 |
| Urban Males | | | | | | | |
| Average Years of Schooling | 0.930 | 0.039 | 0.031 | 0.000 | 0.000 | 0.930 | 0.070 |
| University Graduates | 0.973 | 0.021 | 0.007 | 0.000 | 0.000 | 0.973 | 0.027 |
| Urban Females | | | | | | | |
| Average Years of Schooling | 0.965 | 0.035 | 0.000 | 0.000 | 0.000 | 0.965 | 0.035 |
| University Graduates | 0.944 | 0.048 | 0.008 | 0.000 | 0.000 | 0.944 | 0.056 |
| Rural Males | | | | | | | |
| Average Years of Schooling | 0.951 | 0.044 | 0.005 | 0.000 | 0.000 | 0.951 | 0.049 |
| University Graduates | 0.974 | 0.026 | 0.000 | 0.000 | 0.000 | 0.974 | 0.026 |
| Rural Females | | | | | | | |
| Average Years of Schooling | 0.888 | 0.004 | 0.109 | 0.000 | 0.000 | 0.888 | 0.112 |
| University Graduates | 0.927 | 0.000 | 0.073 | 0.000 | 0.000 | 0.927 | 0.073 |

Source: Turkstat, Authors' own calculations

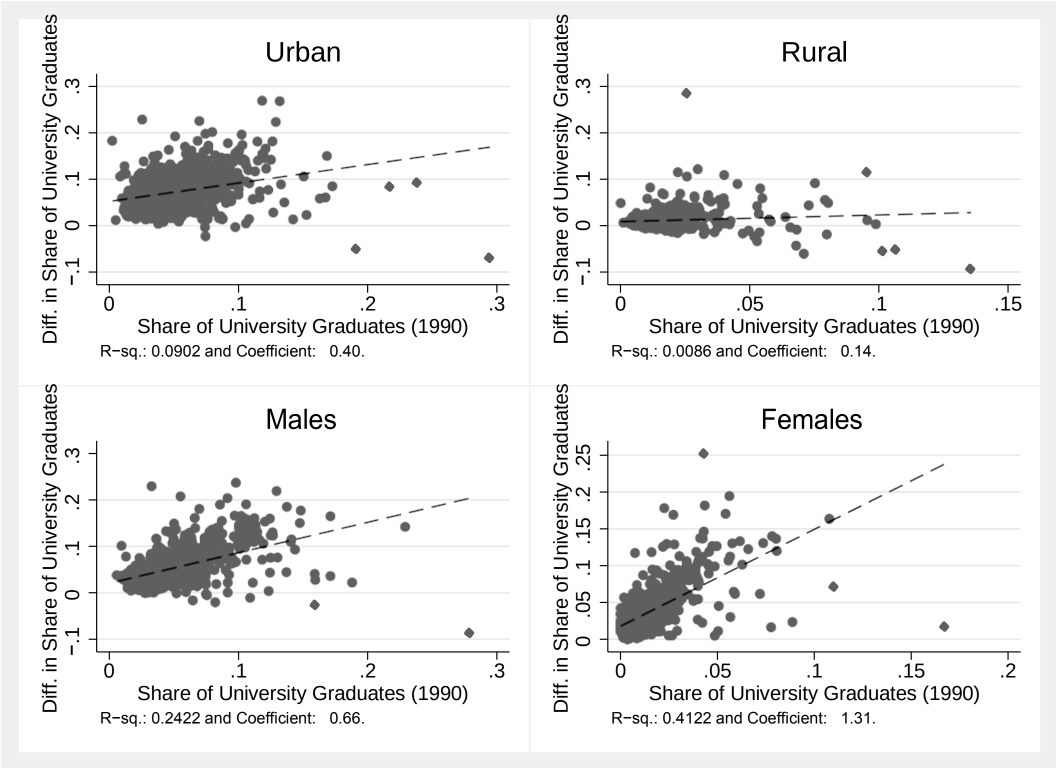
**B Figures**

Figure 1: Convergence: Average Years of Schooling




Source: Turkstat, Authors' own calculations

Figure 2: Convergence: Share of University Graduates




Source: Turkstat, Authors' own calculations

Figure 3: Distribution of Average Years of Schooling: Total District

(a) Years of Schooling-1990


(b) Growth of Average Years of Schooling 1990 2010


Source: Turkstat, Authors' own calculations

Figure 4: Distribution of Share of University Graduates: Total District

(a) University Graduates-1990


(b) Diff. in Share of University Graduates 1990-2010


Source: Turkstat, Authors' own calculations

## C Technical Appendix

$F_{0,t}, F_{I,t}, F_{II,t}, F_{IIIA,t}, F_{IIIB,t}, F_{IV,t}, F_{V,t}$ each represents the number of transitions that experienced a different transition in the period t to t+1. Given that there are n observations; $n = F_{0,t} + F_{I,t} + F_{II,t} + F_{IIIA,t} + F_{IIIB,t} + F_{IV,t} + F_{V,t}$. Cohesion Index measures the case in which both neighbour and the region moves in the opposite direction. Modified version of the cohesion index includes the Type 0 mobility, which is simply the stable regions.

Cohesion Index: $$C_t = \frac{F_{IIIA,t}}{n}$$

Modified Cohesion Index: $$C_t^* = \frac{F_{IIIA,t} + F_{0,t}}{n}$$

Table 10: Classification of LISA Cluster Transitions (Based on Rey, 2001)

| | Not Sign. | Low-Low | Low-High | High-Low | High-High |
|---|---|---|---|---|---|
| Not-Significant | 0 | IV | IV | IV | IV |
| Low-Low | V | 0 | II | I | IIIA |
| Low-High | V | II | 0 | IIIB | I |
| High-Low | V | I | IIIB | 0 | II |
| High-High | V | IIIA | I | II | 0 |

Table 11: Classification of LISA Cluster Transitions (Rey, 2001)

| | Low-Low | Low-High | High-Low | High-High |
|---|---|---|---|---|
| Low-Low | 0 | II | I | IIIA |
| Low-High | II | 0 | IIIB | I |
| High-Low | I | IIIB | 0 | II |
| High-High | IIIA | I | II | 0 |