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Income Inequality and Economic Convergence in Turkey: A Spatial Effect Analysis

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Even though the convergence of regional per capita income has been a highly debated issue internationally, empirical evidence regarding Turkey is limited as well as contradictory. This article is an attempt to investigate regional income inequality and the convergence dynamics in Turkey for the time period 1987–2001. First, the Theil coefficient of concentration index is used to analyze the dispersion aspects of the convergence process. The geographically based decomposition of inequality suggests a strong correlation between the share of interregional inequality and spatial clustering. Then, we estimate convergence dynamics employing alternative spatial econometric methods. In addition to the global models, we also estimate local models taking spatial variations into account. Empirical analysis indicates that geographically weighted regression improves model fitting with better explanatory power. There is considerable variation in speed of convergence of provinces, which cannot be captured by the traditional beta convergence analysis.

Keywords: *regional inequality; economic convergence; spatial analysis; Turkey*

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Introduction

There have traditionally been two opposing views about the expected long-run trajectories of regional development. The neoclassical growth model claims that regions with the same endowments tend to evolve toward a common distribution of income leading to convergence with decreasing inequality in the high-inequality regions and increasing inequality in the low-inequality regions. It is predicted that interregional mobility of capital and labor will eventually correct regional inequalities. However, the existence of significant adjustment costs to inputs flows between spatially distinct regions supports the second view that regional divergence is more likely. Endogenous growth theory predicts divergence and sees government policy as necessary to reduce inequality. In particular, economies of scale, agglomeration of human capital, the institutional framework, and geographical structures of certain regions mean that economic rents tend to accrue in particular areas (Martin and Sunley 1998). The New Economic Geography, however, predicts neither convergence nor divergence but argues that location and agglomeration are among the factors that influence the economic activity of a region (Krugman 1991), as the economic situation of the region will depend on interrelations with its neighbors. Recent studies have revealed that there are economic disparities within countries, which are generally higher than those observed between countries (Barro and Sala-i-Martin 1991; Neven and Gouyette 1995; Fagerberg and Verspagen 1996; Quah 1996; Pekkala 1999; Terrasi 1999; Azzoni 2001; Akita 2003). Empirical studies provide evidence concerning convergence of regional economies, which offer some assistance in planning and evaluating regional policy measures. The challenge for national governments is to provide sufficient incentives to reduce unequal regional development.

Even though there are many studies investigating the relationship between income inequality and economic growth, existing literature does not give a unique answer to what is the nature of the relationship. Kuznets (1955) suggests that inequality increases in the early stages of economic development and declines in the later stages, leading to an inverted U-shaped relationship between income inequality and economic growth. He argues that migration of the abundant labor from the low-income agricultural sector to the high-income industrial sector results in an increase in inequality at the early stage of economic development. Later empirical results have offered mixed conclusions. Evidence provided by Papanek and Kyn (1986), Campano and Salvatore (1988), Bourguignon and Morrison (1990), and Jha (1996) supports the Kuznets's hypothesis. Whereas evidence provided by Ram (1991), Anand and Kanbur (1993), and Deininger and Squire (1998) does not support it.

Different studies have emphasized the importance of different factors in explaining income inequality. Williamson (1997) argues that demographic factors (particularly age distribution) will have an important impact on income inequality. Bourguignon and Morrison (1990) claim that the difference in labor productivity between agriculture and the rest of the economy is an important determinant of income inequality. Durham (1999) argues that institutional factors affect the level of income inequality and reports that more decentralized countries have greater equality. Birdsall, Ross, and Sabot (1995) claim that an export-oriented growth path leads to a decrease in income inequality by stimulating economic growth in the labor intensive export sector. Forbes (2000) states that the results of studies of the growth–inequality relationship depend heavily on the data sets and estimation techniques used.

Persistent disparities in aggregate growth and large differences in the wealth of the Eastern and Western regions have long been among the main concern of policy makers in Turkey. Since 1963, there have been eight Five-Year Development Plans designed to achieve regional convergence, especially in the Eastern and Southeastern part of the country. Although the disparity of income and wealth across Turkish regions and provinces has been a much debated issue, there is paucity of empirical evidence concerning regional economic convergence in Turkey. Atalik (1990; 2002) measures regional income disparities in Turkey and reports that the coefficient of regional income variation increases for the geographical region between the years 1975 and 1985. Filiztekin (1999) investigates convergence across provinces during the period 1975–1995 applying single cross-section methodology and finds divergence of per capita output in all periods except 1990–1995. Tansel and Gungor (1998) repeat the single cross-section studies for the same time period but come up with contradictory results to those of Filiztekin (1999), a difference that may be because of the fact that Filiztekin (1999) is concerned with per capita income, whereas Tansel and Gungor (1998) are concerned with convergence in labor productivity. Using data at province level on labor productivity, Temel, Tansel, and Albersen (1999) provide evidence of polarization around certain highly industrialized regions. Dogruel and Dogruel (2003) report that sigma convergence is achieved only in the developed/rich regions during the period 1987–1999, a result that emphasizes the spatial dualism of Turkey. Gezici and Hewings (2004), however, find no evidence for any convergence of per capita income either across provinces or across the geographical regions in Turkey between 1980 and 1997.

The previous studies present a regional inequality analysis for Turkey at a disaggregated level and mostly ignore the spatial dimension to the pattern of regional growth. Only Gezici and Hewings (2007) consider alternative spatial partitioning, and they report disparities between East and West Turkey during the period 1980–1997. Although existing intraregional inequalities were found to be declining, they argue that spatial dependence on a few wealthier provinces would be persistent in Turkey. Ozmucur and Silber (2002) find similar results for interregional and intraregional inequalities in a study whose primary focus was the impact of migration.

The present study aims to provide a fresh look at the existing regional economic differences in Turkey and to emphasize the fact that regional inequality analysis and regional convergence need to be properly spatialized. The issue has been investigated employing the Theil coefficient of concentration and using spatially disaggregated data for the period 1987–2001. Statistical classification of the regions in Turkey was based on the geographical and administrative division of the country into seven geographical regions and eighty-one provinces. In September 2002, Turkey adopted the European statistical classification of regions (Nomenclature of Units for Territorial Statistics [NUTS]) and a revised regional statistical system whereby Turkey was divided, for statistical and regional development purposes, into twelve NUTS 1 regions, twenty-six NUTS 2 subregions, and eighty-one NUTS 3 provinces. This has enabled four alternative partitionings to be used in this article: NUTS 1, NUTS 2, four large regional groupings, and an East–West partitioning; the latter two being based on a socioeconomic ranking of the provinces of Turkey provided by State Planning Organization (see appendix). The aim is to obtain a partitioning as homogeneous as possible so that development plans can be drafted to reduce interregional inequality and promote convergence. After applying inequality decomposition, we investigate the role of inference in regional inequality analysis following Rey (2004). Then, convergence analysis is performed using provincial per capita income and using global and local estimation methods.

Empirical analysis, using disaggregated data for provincial level per capita GDP, gives evidence in favor of regional convergence at national level. However, there is a statistically significant interregional income inequality, even though within region inequality is relatively small. Inequality decomposition analysis indicates that the shares of interregional and intraregional inequalities are sensitive to the partitioning used. It appears that partitioning by NUTS 2 subregions is the most homogenous, as it has the lowest intraregional inequality. Moreover, empirical analysis suggests that the Theil coefficient has a tendency to increase in periods of economic expansion and to decrease in periods of recession.

We estimate absolute and conditional convergence models by both global and local methods. In addition to ordinary least squares (OLS) estimation, we consider spatial error (SEM) and spatial autoregressive (SAR) models, which take into account spatial autocorrelation and then apply geographically weighted regression (GWR) methodology to model spatial variations in the beta convergence analysis. The results show that for both absolute and conditional convergence models, the spatial error coefficient is statistically significant, indicating that the typical least squares regional convergence model is misspecified. Additionally, the model selection criterion (Akaike information criterion [AIC]) indicates the selection of the GWR model as providing a statistically significant improvement over the OLS model. It is found that there is considerable variation in the speeds of convergence of the provinces together with structural instability. The visualization of the GWR model coefficients and statistics highlights the spatial distribution of the relationship under study. Empirical analysis supports the beta convergence hypothesis, even though the structural differences between the provinces are sustained. The rest of this article is organized as follows: Regional Disparities in Turkey section offers a brief account of the evolution of regional disparities in Turkey. The methodological issues and results of empirical analysis are presented in Methodology and Empirical Results section. The final section concludes the article.

Regional Disparities in Turkey

After the foundation of the Republic of Turkey, special attention was given to Central Anatolia while the problems of the Eastern and Southeastern regions were ignored. It was only after the military coup of 1960, that for the first time development priorities were accorded to these regions. In the third Development Plan (1973–1977), Priority Provinces for Development (PPDs) were defined and all provinces of Eastern and Southeastern Anatolia were given priority in public investment in an attempt to accelerate the process of convergence and to reduce interregional disparities. Subsequently, the number of PPDs has been changed frequently, usually for political reasons. Finally, in 1998, forty-nine provinces in Eastern and Southeastern Anatolia and Black Sea regions were considered as PPDs. They share common characteristics, such as high growth of population, high rates of outward migration, high agricultural employment and relatively low industrial employment, a low urbanization rate, and relatively low GDP per capita. The development plans aimed to increase investment in these provinces both by increased public investment and the offering of investment incentives to the private sector. Particular importance was attached to investment in infrastructure. However, these incentives ought to be temporary; otherwise, they take the form of long-run government transfers from relatively developed regions to the PPDs. In the event, successive governments failed to develop the required infrastructure, and the continued high growth of population along with ethnic disputes has meant that growth has stayed below average in Eastern and Southeastern Anatolia.[1]

Table 1 presents statistics on per capita income, school attendance, financial intermediation, the number of investment incentive certificates issued by the Treasury, and the ownership of private cars for the years 1990 and 2000, along with some growth rates for the ten-year period, all given for the following seven geographical regions of Turkey: Mediterranean, east Anatolia, Aegean, southeast Anatolia, Central Anatolia, Black Sea, and Marmara. East Anatolia is the poorest region in terms of per capita income, whereas Marmara is the richest. Although per capita GDP is also very low in the southeast, this region showed improved school attendance as well as increased financial intermediation in 2000 compared to 1990. The provision of bank loans rose by more than 100 percent (7.5 percent annual average growth). Recent banking literature provides evidence that well-functioning banks spur economic growth by identifying and funding those entrepreneurs with the highest productive possibilities (King and Levine 1993). However, because the utilization of banking services in the region was initially so low, this development did not promote regional output to a great extent in southeast Anatolia. Ozyildirim and Onder (2007)

Table 1
Various Statistics According to Geographical Distribution of Turkey in 1990 and 2000

	Annual Population Growth Rate[a]	Real GDP Per Capita (in Terms of 1987 Prices)[b]			High School Attendance Rate (Percent)		Bank Credits (USD Million)			Number of Investment Incentive Certificates		Number of Private Car Per 10,000 inhabitants	
		1990	2000	Annual Growth	1990	2000	1990	2000	Annual Growth	1990	2000	1990	2000
Mediterranean	0.0216	1722.7	1869.4	0.0082	37.3	42.2	2853	3080	0.0077	156	312	27	614
East Anatolia	0.0139	716.1	738.9	0.0031	27.4	26.3	404	691	0.0551	697	147	13	197
Aegean	0.0165	2119.7	2598.2	0.0206	39.9	39.7	2986	4457	0.0409	129	557	31	797
Southeast Anatolia	0.0247	1035.8	1076.5	0.0039	21.4	27.3	381	787	0.0752	1130	208	14	208
Central Anatolia	0.0159	1586.9	1918.6	0.0192	41.0	41.6	6883	9467	0.0324	205	558	46	882
Black Sea	0.0037	1164.9	1487.9	0.0248	36.4	31.7	2069	3220	0.0452	388	306	17	435
Marmara[c]	0.0266	2644.6	3048.2	0.0143	45.8	41.0	9940	22760	0.0863	423	1360	46	877
Turkey	0.0183	1729.2	2047.5	0.0170	37.7	36.9	25491	44462	0.0572	3139	3521	38	652

[a] Between 1990–2000.
[b] In terms of USD.
[c] Capital city, Ankara, is in the Central Anatolia and Istanbul is in the Marmara.

examine the relationship between provincial banking activities and economic growth for the time period 1990–2001. To account for the spatial dimension of the issue, they argue that the distance between headquarters and the local branches affects the role of financial intermediation in provincial economic growth. Their results indicate a significant positive effect of banking activities on provincial economic growth.

However, the number of investment incentive certificates issued by the Treasury declined significantly. Around 200 certificates were issued in 2000, whereas more than 1,000 had been issued in 1990. Although the number of authorizations does not indicate the value of investment sponsored by the government, there is a critical downturn observed in terms of public support in 2000. Similarly to southeast Anatolia, the Mediterranean region had a higher rate of school attendance than before. Both regions seem to be growing fast in terms of population but sluggishly in terms of income per capita.

In the richest region, Marmara, the growing population (mainly because of inward migration) has caused per capita output to grow less than the national average over the period 1990–2000. Nevertheless, the region had a significantly higher amount of both financial intermediation and certification to invest with government support than before. In the poorest regions such as east Anatolia, southeast Anatolia, and the Black Sea region, government supports seem to have declined significantly by 2000, but financial intermediation has improved. Finally, in all geographical regions of Turkey, ownership of private cars increased substantially in 2000 as compared to 1990, suggesting high urbanization over the decade in Turkey.

Methodology and Empirical Results

Regional Inequalities

This section presents an analysis in which inequality indicators are calculated and their evolution over time is investigated taking spatiality into account. Past regional convergence studies claim that the free mobility of capital and labor within a country tend to make the growth process of provinces/regions more homogeneous over time. However, Terrasi (1999) for Italy, Petrakos and Saratsis (2000) for Greece, Azzoni (2001) for Brazil, Rey (2004) for the United States, and Petrakos, Rodriguez-Pose, and Rovolis (2005) for the European Union countries indicate that there are serious income inequalities among regions, which may show oscillations over time. Although Fagerberg and Verspagen (1996), Fagerberg, Verspagen, and Caniëls (1996), Funke (1995), Chatterji and Dewhurst (1996), Le Gallo (2004), Ertur, Le Gallo, and Baumont (2006), and Ezcurra Pascal, and Rapun (2007) report the existence of selective tendencies, convergence clubs and asymmetric shocks within economies that result in spatial inequalities.

However, the importance of spatial effects on regional inequality analysis has only recently been recognized in the literature.[2] Generally, studies investigating the geographic segmentation of regional inequality within a country or within a group of countries tend to partition the regional units into mutually exclusive groupings and then decompose the total inequality into that which is because of inequality internal to the groupings or inequality across the groupings (Fujita and Hu 2001; Azzoni 2001; Rey 2004; Novotny 2007). Even though the applications of inequality measures are generally descriptive in nature, Rey (2004) provides an inferential basis for inequality analysis at the regional scale that allows for formal hypothesis testing regarding the inequality measures. He argues that a focus on the overall measure of regional inequality may mask important developments, which could have spatially explicit manifestations reflecting poverty traps, convergence clubs, and other forms of geographical clustering, within the distribution. He proposes an approach for inference based on random spatial permutations of actual incomes for a given map pattern.[3]

In this study, the Theil coefficient of concentration index is used to analyze dispersion aspects of the convergence process, and the new approach to inference proposed by Rey (2004) is used to provide a formal explanatory framework for the descriptive analysis. The Theil coefficient of concentration index is popular for analyzing spatial distributions as it is independent of the number of regions and thus compares inequalities of different regional systems (Theil 1967). Additionally, it is decomposable between and within group inequalities. The following formulas are used to calculate the index:

$$T = \sum_i y_i \log(y_i/x_i) = T_W + T_B \tag{1}$$

$$T_B = \sum_r Y_r \log(Y_r/X_r) \tag{2}$$

$$T_W = \sum_r Y_r \left[\sum_i (y_i/Y_r) \log(y_i/Y_r/x_i/X_r) \right] \tag{3}$$

where T denotes the total inequality, T_W within region inequality, and T_B between region inequality; the latter two variables measure intraregional and interregional inequality, respectively. In a spatial context, the intraregional inequality measures differences between the incomes of provinces belonging to the same region, whereas interregional inequality measures the difference between the mean incomes of aggregate regions. y_i and x_i are regional shares of national income and population, respectively, and Y_r and X_r are the same shares for regions.

To perform the inference analysis, Rey (2004) proposes the following steps, after total inequality is decomposed into interregional and intraregional inequality: first, incomes are randomly reassigned to new locations. Then, the decomposition for the permuted map is calculated as follows:

$$T^P = T_W^P + T_B^P, \tag{4}$$

after which these steps are repeated K times.

As the observations are being randomly reassigned to different regional groupings in each permutation (P), the values for the global inequality measure T^P will be the same for any permutation in a given time period. The values for the intraregional (T_W^P) and interregional (T_B^P) inequalities, however, are likely to vary across the permutations. The expected value of the global inequality measure can be obtained as the average of the empirically generated measures as follows:

$$\bar{T}_W = \frac{1}{K}\sum_{P=1}^{K} T_W^P, \tag{5}$$

which can be compared to the actual inequality measure T_W. There are two ways to compare the differences between the actual statistic and its expected value against the empirical sampling distribution. The first is based on the assumption that the empirical sampling distribution is approximately normal, in which case the variance for that distribution, is given as follows:

$$S_{Tw} = \frac{1}{K}\sum_{P=1}^{K}(T_W^P - \bar{T}_W)^2 \tag{6}$$

and can be used to construct the confidence interval (CI).

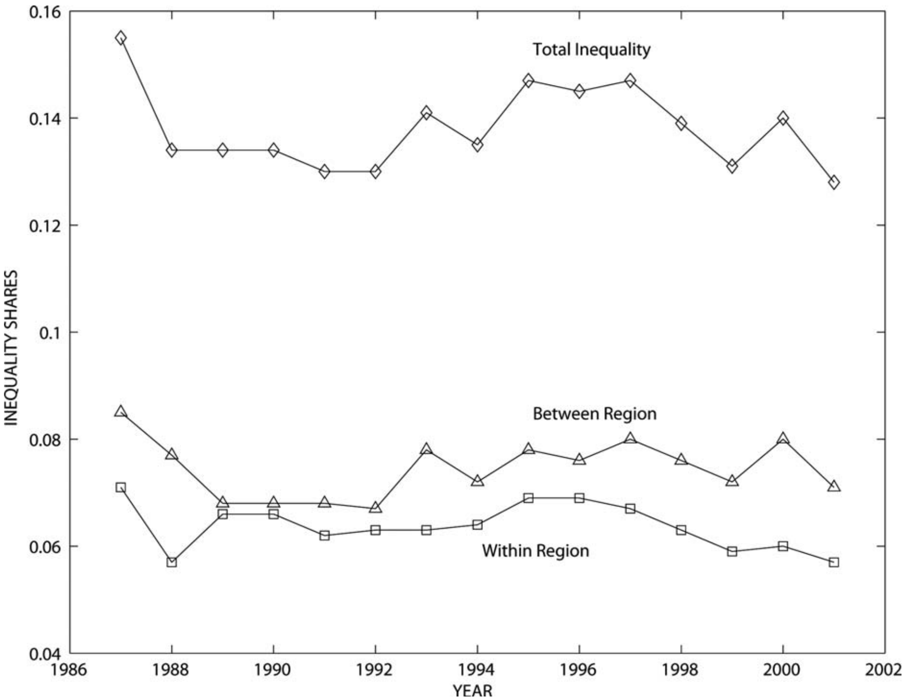
Alternatively, a percentile approach can be used to make inferences using the random spatial permutations. This approach develops a pseudo significance level by calculating the share of the empirical values that are more extreme than the actual value, after sorting the empirically generated (T_W^P) values as follows:

$$p(T_W) = \frac{1}{K}\sum_{P=1}^{K}\psi_P \tag{7}$$

where $\psi_P = 1$ if T_W^P is more extreme than T_W and $\psi_P = 0$ otherwise. Rey (2004) notes that the advantage of this approach over the alternative is that it avoids the problem of inadmissible interval bounds. However, as the global inequality measure is invariant to the spatial arrangement of regional incomes, the random permutation approach cannot be used to test inferences regarding the global measure.

In this article, to investigate the relationship between regional income inequality and spatial dependence, alternative partitions have been implemented relating to the sixty-seven provinces of Turkey for the time period 1987–2001.[4] Real GDP and population data have been obtained from the Turkish Statistical Institute. Population data are derived from the 1990 and 2000 official censuses with interpolations made for

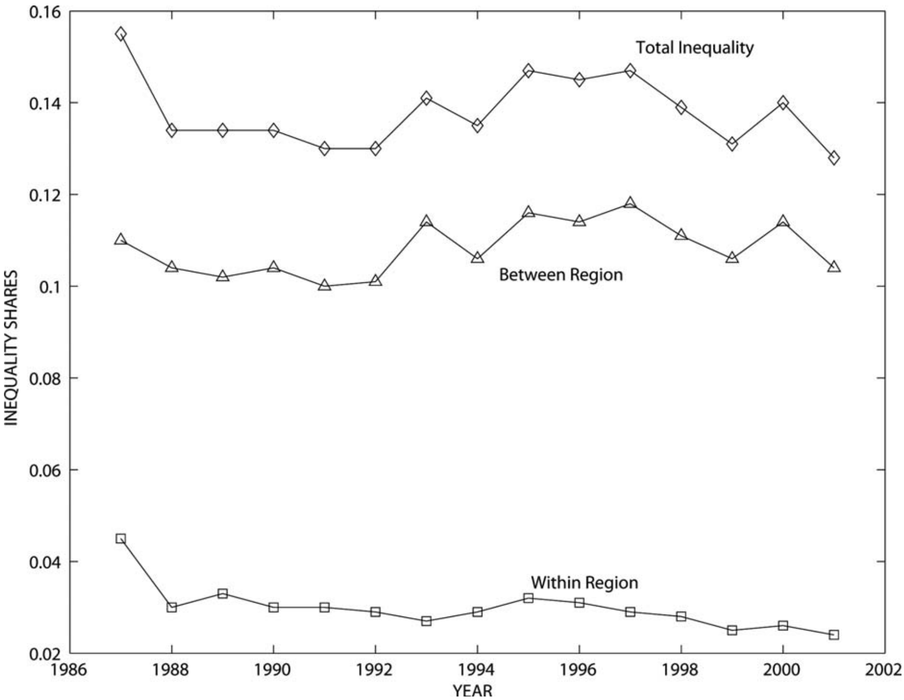
Figure 1
Regional Inequality Decomposition Nomenclature of Units for Territorial Statistics 1



noncensus years. The main objective of this section is to explore the relationship between regional inequality and spatial dependence. Then changes in spatial scale are allowed to explore how these affect measured regional inequality.[5] For this purpose, four alternative partitions of the provinces are considered. The first one is the NUTS level 1 partition that groups the sixty-seven provinces into twelve regions. The second is the NUTS level 2 partition that groups provinces into twenty-six subregions. As an alternative to NUTS classifications, two more partitions have been investigated as follows: four large regional groupings and the traditional East–West divide.[6]

Figure 1 presents the global Theil index and its decomposition into the interregional and intraregional components for NUTS 1 partitioning. It appears from the analysis that interregional and intraregional inequalities are almost equal to each other, throughout the period under consideration. Even though intraregional inequality seems stable, oscillations are observed in interregional inequality and hence also

Figure 2
Regional Inequality Decomposition Nomenclature of Units for Territorial Statistics 2

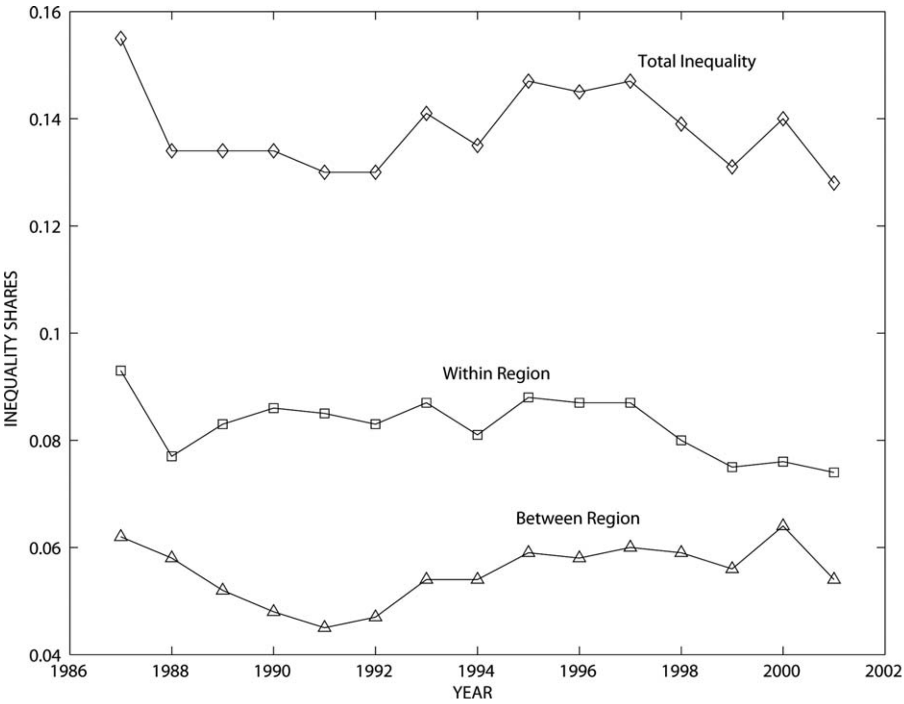


in the global Theil index that has a tendency to increase in periods of economic expansion and to decrease in periods of recession or years of economic crises such as 1994, 1999, and 2001.

The results for income inequality analysis for the NUTS 2 partitioning are presented in figure 2. When compared with NUTS 1 partitioning, it now appears that interregional inequality has gained importance as it is higher than intraregional inequality. However, similarly to the NUTS 1 partitioning, oscillations are observed in the interregional inequality.

Figure 3 shows the effect of partitioning the country into four large regions. The decomposition analysis suggests that intraregional inequality now dominates, reflecting that there has been a decrease in the internal homogeneity of the regions compared to the previous partitioning schemes. This could be because of an increase in the number of provinces in each of the four regions.

Figure 3
Regional Inequality Decomposition Four Large Regions

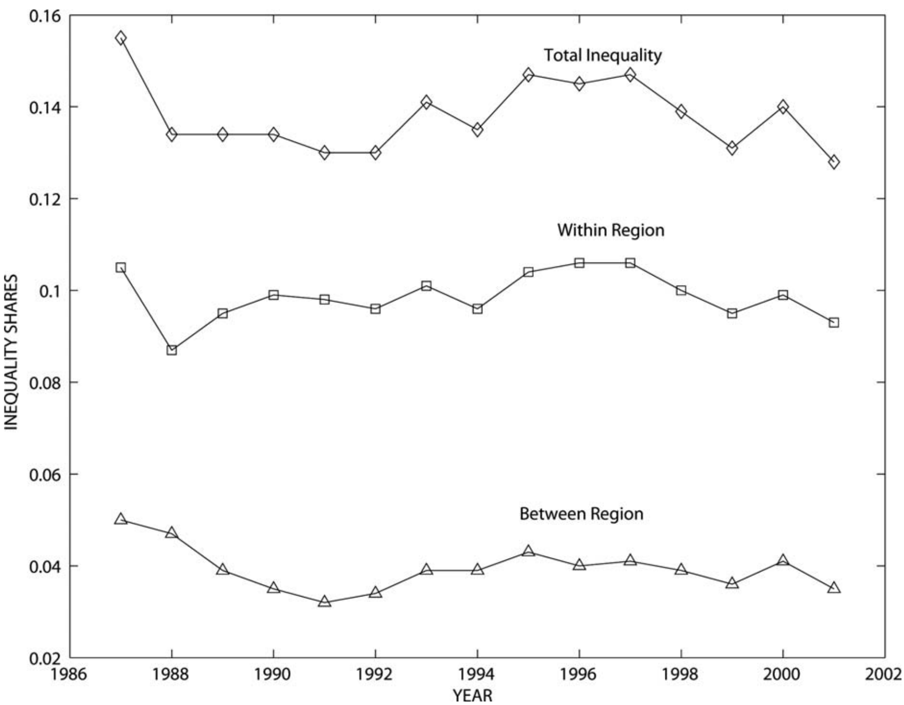


A similar pattern can be observed in figure 4, where analysis for the traditional division of Turkey into East and West is presented. Each of the components of the global Theil index show almost identical oscillations both for the partition into the four regions and for the East–West split. However, intraregional inequality is the highest for the East–West partitioning and interregional inequality is the lowest one. This indicates that within all the partitioning schemes examined, the traditional East–West partitioning has the lowest internal homogeneity.

Figure 5 gives the share of interregional inequality for the regions using alternative partitions and shows that the share of interregional inequality associated with the NUTS 2 partitioning is the highest of the four partitioning schemes. As the NUTS 2 partitioning has the largest number of regional areas of all the partitions, it is reasonable to obtain a larger interregional component here.

The rankings of the four alternative partitionings with respect to the share of interregional inequality do not change throughout the sample period. However, they all

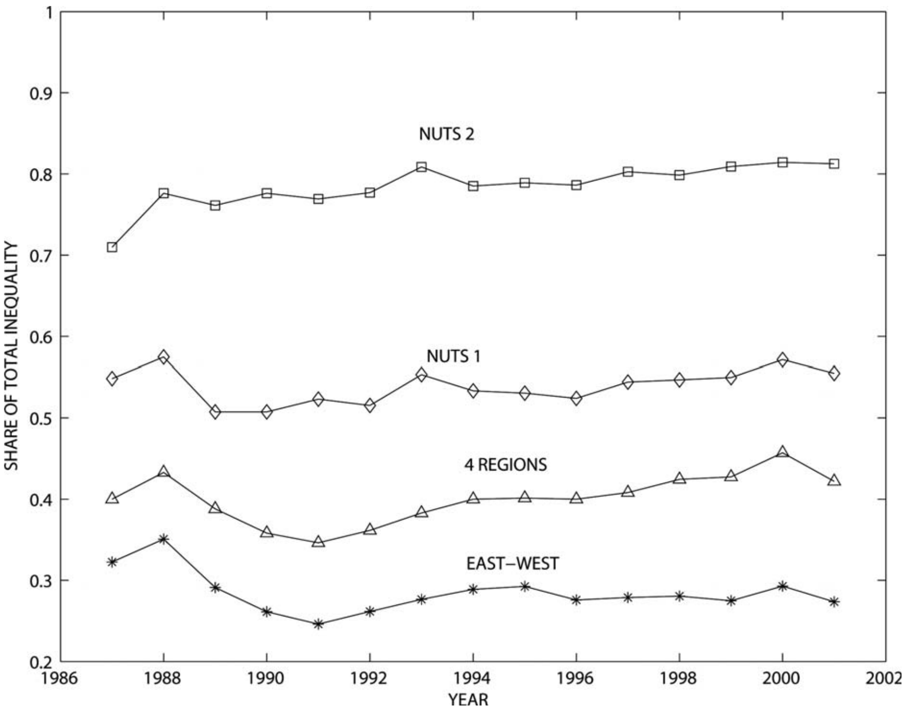
Figure 4
Regional Inequality Decomposition East/West



tend to increase in periods of expansion and to decrease in periods of recession, with the exception of that based on a NUTS 2 partitioning. Thus, not only these twenty-six subregions have a stronger homogeneity compared to the other partitioning schemes but also the inequality does not seem to be affected by the cyclical periods of recessions and expansions.

Next, the role of inference in regional inequality analysis is examined. In figures 6–9, actual values of the interregional inequality component for the regions are depicted together with the error bars associated with ± 2 standard deviations around average values for the shares from 1,000 random spatial permutations of the income per capita for each year and for each partitioning scheme. It appears that the interregional share is significantly greater than what would be expected if incomes each year were randomly distributed in space, indicating the importance of spatial structure regardless of the partitioning scheme used, that is, to say physical location and geographical spillovers matter as well as traditional macroeconomic factors. The

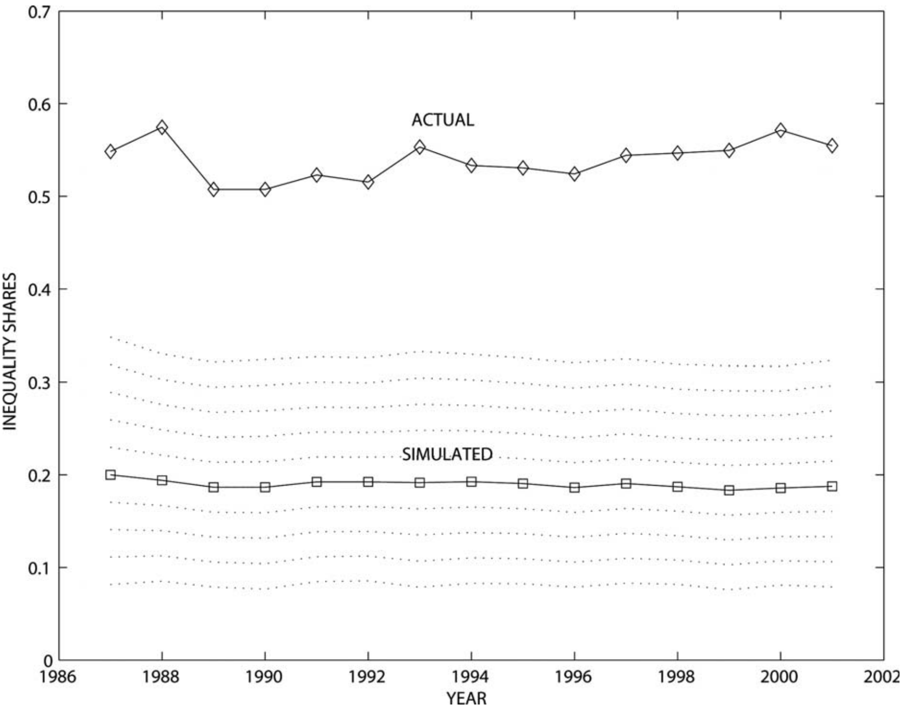
Figure 5
Interregional Inequality Shares



importance of this result becomes clearer when we consider that the traditional East–West partitioning had the smallest interregional share compared to the other partitioning schemes. The extension of the traditional decomposition analysis to include an inferential component enables the analysis to capture the fact that the measure of inequality appears to be sensitive to the spatial arrangement of provincial incomes, in spite of the fact the interregional inequality component is relatively small and can be ignored otherwise. This also supports the findings of Rey (2004) who reports that without the inferential test, this partition might have been viewed as irrelevant or misspecified, given that the interregional share was found to be stronger in the other partitions.

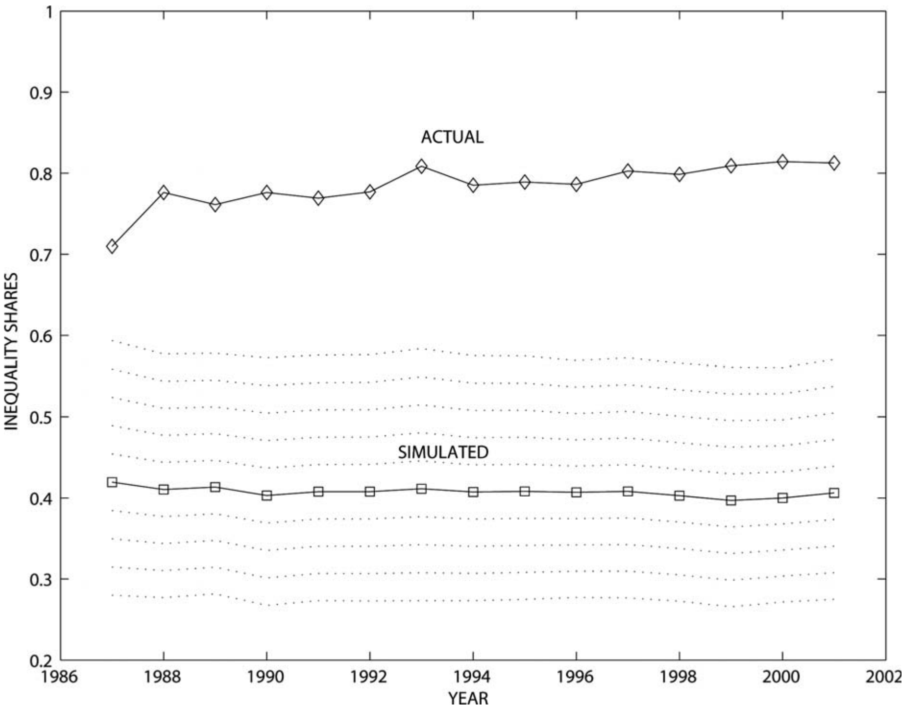
Overall, the inequality analysis indicates that, for the period under consideration, income inequality tends to increase in periods of economic expansion and to decrease in periods of recession, which raises an important question concerning the relationship between regional inequalities and economic performance. Moreover,

Figure 6
Simulated versus Actual Interregional Inequality Nomenclature of Units for Territorial Statistics 1



even though the overall income inequality decreased, regional disparities are observed. Until 1993, the Theil index exhibits an increasing trend; but in 1994, when Turkey experienced an economic crisis, it dropped by almost 5 percent. Similar behavior can be observed for the crisis years of 1999 and 2001, supporting the hypothesis that in expansion periods, income rises more in richer regions than poorer regions, thus increasing inequality. However, in recession periods, richer areas would be affected more quickly and more severely than poorer regions. This finding is in line with Petrakos and Saratsis (2000) and Gezici and Hewings (2007) who report that regional inequalities have a pro-cyclical nature in Greece and Turkey, respectively. Additionally, the analysis suggests that there has been a decrease in income inequality throughout the period under consideration. Even though there are differences in the magnitudes, three of the four partitioning schemes yield inter-regional inequality shares declining over time; the exception being the NUTS 2

Figure 7
Simulated versus Actual Interregional Inequality Nomenclature of Units for Territorial Statistics 2

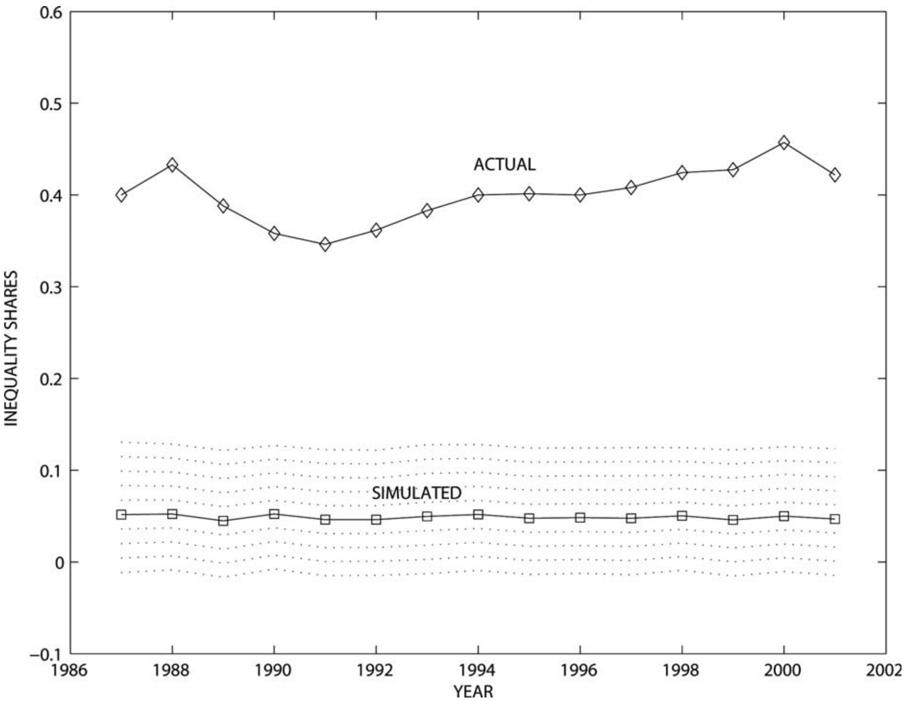


partitioning. The interregional inequality share of total inequality based on NUTS 2 partitioning has an increasing trend, indicating that homogeneity of provinces decreases over time in the groupings of this partitioning. The next part of the article investigates the convergence dynamics of per capita income to explore whether decreasing income inequality has been accompanied by economic convergence.

Spatial Analysis

The issue of economic convergence at a subnational level has attracted a lot of attention in recent years. Following on from the seminal work of Romer (1986) and Barro and Sala-i-Martin (1991), a large number of studies have investigated variations in the economic performance of countries. These studies have reported huge economic disparities within countries. Such studies have generally used beta

Figure 8
Simulated versus Actual Interregional Inequality Four Large Regions



convergence analysis to investigate convergence across economies or regions using cross-sectional data and by implementing the following equation:

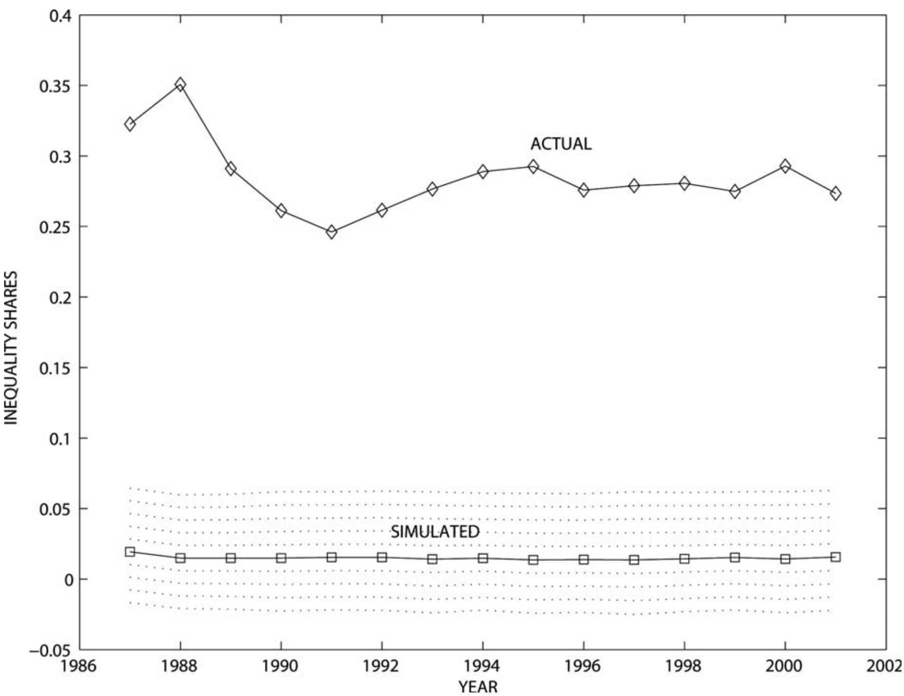
$$\log(y_{it}/y_{i0}) = \alpha + \beta \log y_{i0} + u_i \tag{8}$$

where y_{it} denotes income or GDP per capita at time t in region/province i; y_{i0} denotes income or GDP per capita at some initial time 0; α is the intercept term, which may incorporate any rate of technological progress; and u is random error term distributed iid(0, σ^2), which may represent random shocks to technology or tastes. A negative value of β signifies the beta convergence.[7]

In addition to the absolute convergence model, presented in equation (8), conditional convergence models have been estimated where additional explanatory variables are introduced to the right-hand side of equation (8)

$$\log(y_{it}/y_{i0}) = \alpha + \beta \log y_{i0} + \psi X_{i0} + v_i \tag{9}$$

Figure 9
Simulated versus Actual Interregional Inequality East/West



where X_{io} is a vector of explanatory variables at some initial time 0 and v is random error term distributed iid(0, σ^2).

This approach assumes that all regions or economies under consideration have the same steady-state income path. However, this is a highly restrictive assumption because it may induce significant heterogeneity bias in estimates of the convergence coefficient. Moreover, as Quah (1993) points out, the traditional cross-sectional approach does not reveal the dynamics of the growth processes.

In the empirical literature, two alternative approaches have been introduced to correct the heterogeneity bias associated with traditional cross-sectional analysis. The first is to employ time series analysis to investigate rates of convergence by looking for common stochastic trends in the individual regional time series data. However, this approach can only be used if long series of data are available at both regional and national level. However, long runs of time series data and reliable proxy data often do not exist, especially in developing countries such as Turkey. Alternatively, control variables that can proxy or capture the differences in the paths of steady-state incomes of regions, such as rates of accumulation of physical capital, rates of net migration, and differences in industrial structure, can be included in the traditional cross-sectional estimates.

Another dimension of convergence analysis is that regional economic growth may follow a spatial pattern and so it is important to investigate spatial patterns that may indicate spillover effects among regions. Gezici and Hewings (2007) point out that if the growth rates of poorer regions are higher than growth rates of the richer regions, the spatial inequality may decrease over time, which may result in convergence. Even though the neoclassical model assumes perfect mobility of factors of production, there may be significant adjustment costs or barriers to mobility for labor and possibly for capital as well. In cases where regions pursue their own growth-promoting policies, there may be spillover effects from those regions to adjacent regions. Cheshire and Gordon (1998) indicate that economic rents from research, development, and other sources may be more likely to accrue locally, where regions are more self-contained. Moreover, Fagerberg, Verspagen, and Caniëls (1996) claim that rates of technological diffusion may follow a spatial pattern, as regions may have different capacities to create or absorb new technologies. Thus, incorporating spatial effects into the analysis may have a significant impact on any estimated convergence effects.

Spatial dependence can be handled in beta convergence analysis in alternative ways.[8] The first approach—SEMs—assumes that the spatial dependence operates through the error process. Any random shock follows a spatial pattern so that shocks are correlated across adjacent regions; thus, the error term in equation (9) may reveal a significant degree of spatial covariance, which can be represented as follows:

$$\begin{aligned} \log(y_{it}/y_{i0}) &= \alpha + \beta \log y_{i0} + u_i \\ u_i &= \lambda W u_i + \varepsilon_i \end{aligned} \tag{10}$$

where λ is the spatial error coefficient, ε is a white noise error component, and W is a spatial weighting matrix. W may be constructed using information on physical distance between pairwise combinations of economic areas in the sample or may be defined as in this article, such that element $w_{ij} = 1$, if i and j are physically adjacent and 0 otherwise.

The second approach—SAR models—examines the extent to which regional growth rates depend on the growth rates of adjacent regions, conditioning on the level of initial income as follows:

$$\log(y_{it}/y_{i0}) = \alpha + \beta \log y_{i0} + \rho W \log(y_{it}/y_{i0}) + u_i \tag{11}$$

where ρ denotes the spatial autoregressive parameter, which reflects the spatial dependence inherent in the sample data (Le Sage 1999). Anselin (2002) notes that spatial error dependence often arises when the geographical level of aggregation does not match the geographic level at which the process under study occurs and can be thought of as nuisance dependence. The spatial error parameter, ρ is assumed to correct for this dependence of neighboring provinces that shows in adjacent error terms.

Another way to investigate spatial dependence in coefficient estimates across regions is to estimate a GWR model. This approach can directly assess error residuals using measured and predicted values. GWR produces local parameter values for each area in the data set rather than simply estimating global coefficient values over the whole data set. In the individual regression for each province, other provinces in the sample are weighted by their spatial proximity. Thus, the spatial variation in parameters is smoothed by spatial weighting, revealing broad regional differences in the parameters. An ordinary linear regression model can be expressed as follows:

$$Y_i = \alpha_0 + \sum_{k=1}^{p} \alpha_k X_{ik} + \varepsilon_i, \quad i = 1, \ldots, n, \tag{12}$$

where the dependent variable Y is represented as a linear combination of explanatory variables X_k, $k = 1, \ldots, p$; and ϵ_i are independent normally distributed error terms with 0 mean and constant variance. Usually, OLS is used to estimate the regression parameters, which can be expressed in matrix form as follows:

$$\hat{\alpha} = (X^T X)^{-1} X^T Y$$

Even though the parameters in equation (8) are assumed to be the same across the study area, this may not be true as different locations may have different parameters. GWR, however, extends the OLS regression model in equation (8) by assigning weights to observations, which are functions of the distance between the region for which the coefficient estimates are required and all other regions. Thus, the parameter estimates become specific to location i (Fotheringham, Charlton, and Brunsdon 1997b). The GWR model can be expressed as follows:

$$Y_i = \alpha_{io} + \sum_{k=1}^{p} \alpha_{ik} X_{ik} + \varepsilon_i \tag{13}$$

Then, the parameter vector at location i is estimated as follows:

$$\hat{\alpha}_i = (X^T W_i X)^{-1} X^T W_i Y, \quad i = 1, \ldots, n$$

where W_i is an n-by-n matrix of local spatial weights, which is depicted by the w_{ij} terms that denote the connectivity of observation j with observation i. In estimating the parameters in the GWR equation, it is important to choose a criterion for the weighting matrix, which will represent the importance of each observation among locations. A common way to choose the matrix at location i is to exclude observations that are further than a specified distance. This is equivalent to setting a 0 weight on observation j if the distance from i to j is greater than a threshold distance d.

$$W_{ij} = 1 \quad \text{if } d_{ij} = d,$$

$$W_{ij} = 0 \quad \text{if } d_{ij} > d,$$

for $ij = 1, \ldots ,n$.

To overcome the discontinuity problem that the above equation exhibits, Fotheringham, Charlton, and Brunsdon (1997a; 1997b) specify W_{ij} as a continuous and decreasing function of d_{ij}. It is assumed that more proximate locations are more alike, and the weights are allowed to decay with distance following a Gaussian decay function for a fixed kernel or a bi-square decay function for an adaptive kernel. The most commonly used weighting function is the Gaussian function:

$$W_{ij} = \exp\left(\eta d_{ij}^2\right), \quad i = 1, \ldots , n$$

where η is a nonnegative distance decay parameter. Generally, the cross-validation score or AIC test is used to determine the optimal bandwidth distance or the optimal number of neighboring units used in each observation's regression.

When compared to standard approaches, GWR analysis has some advantages. One of the main ones is that it accounts for region-specific effects, as each region has its own constant term. Moreover, any outlier estimates that may occur are offset, because the GWR approach produces literally thousands of regressions, examining the median and the entire range of estimates. Additionally, Fotheringham, Brundson, and Charlton (2002) note that the GWR approach can greatly reduce spatial error correlation when there is heterogeneity in the coefficients. In other words, because global convergence models, such as OLS, SEM, and SAR regressions, estimate one fixed global set of regression coefficients, there may be spatially clustered groups of regions/provinces with residuals that are either over- or underestimated.

In global OLS regressions, it may not be possible to distinguish the ensuing spatial correlation (caused by the underlying heterogeneity in the regression coefficients) from standard spatial error correction (generated by shocks originating in one region impacting others). The GWR approach, however, directly corrects for the underlying spatial heterogeneity. In global models, spatial processes are assumed to be stationary and as such are location independent. The economic growth literature generally assumes that all regions share the same steady-state characteristics and are therefore converging to the same long-run growth path. However, empirical evidence indicates that there are regional disparities in the growth regression relationship, which necessitates a local rather than a global estimation to obtain location-specific parameter estimates. Local models, such as the GWR model, decompose the global model and produce results that are location dependent. These models address the spatial nonstationarity directly as they allow relationship to vary over space, that is, regression coefficients need not be the same everywhere over the space. The employment of spatial data techniques enables researchers to identify spatial regimes and

Table 2
Absolute Convergence Estimations

	Minimum (1)	Lower Quartile (2)	Median (3)	OLS (4)	SEM (5)	SAR (6)	Upper Quartile (7)	Maximum (8)
Constant	−0.336	0.189	0.995	0.987*	1.604*	1.044*	2.167	4.910
				(0.001)	(0.000)	(0.000)		
$\log y_{1987}$	−0.800	−0.469	−0.180	−0.157**	−0.259*	−0.169*	−0.049	0.060
				(0.020)	(0.000)	(0.000)		
λ					0.832*			
					(0.000)			
ρ						0.465		
						(0.120)		
R^2			0.54	0.10	0.24	0.14		
AIC			−136.83	−114.73	−122.20	−113.48		
LM_λ				24.100*				
				(0.000)				
LM_ρ				15.910*				
				(0.000)				
F statistics			7.72*					

Note: Dependent Variable: $\log(y_{2001}/y_{1987})$. The number of nearest neighbors in geographically weighted regression model is 8. Values in parentheses are the p values and (*), (**), and (***) denote significance at 1, 5, and 10 percent, respectively. AIC = Akaike information criterion; OLS = ordinary least squares; SEM = spatial error model; SAR = spatial autoregressive model.

convergence clubs. Therefore, GWR technique is used in an attempt to measure variations in annual growth rates of provincial per capita income.

Table 2 presents descriptive statistics of parameter estimates from OLS, SEM, SAR, and GWR models of the absolute model presented in equation (8), and table 3 presents the corresponding statistics for the conditional model presented in equation (9). The dependent variable for all models is the growth rate of provincial real per capita income. The explanatory variables used in the conditional model are per capita income in the base year 1987 ($\log y_{1987}$), average level of education (E), the average fertility rate (F), the average level of unemployment (U), and regional per capita government expenditure in 1987 (G). All variables are obtained from Turkish Statistical Institute and all monetary variables are real at 1990 prices. The spatial weight matrix that has been used in the SEM and SAR models is defined such that element $w_{ij} = 1$, if i and j are physically adjacent and 0 otherwise. In both tables, R^2 denotes the coefficient of determination and AIC denotes Akaike information criterion. Moreover, to test the null hypothesis of no spatial dependence against alternatives of spatial error and spatial lag dependence, two Lagrange Multiplier tests (LM_λ and LM_ρ) are presented (Florax, Folmer, and Rey 2003). If the results

Table 3
Conditional Convergence Estimations

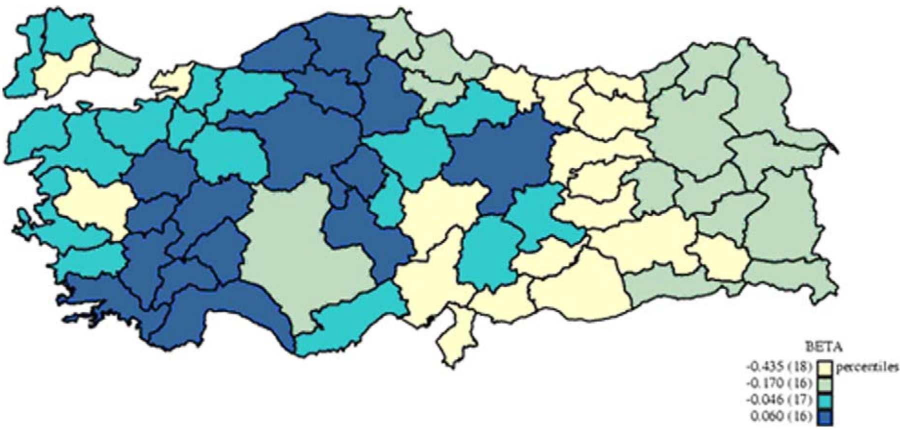
	Minimum (1)	Lower Quartile (2)	Median (3)	OLS (4)	SEM (5)	SAR (6)	Upper Quartile (7)	Maximum (8)
Constant	0.806	1.017	1.353	1.408*	1.626*	1.407*	1.711	2.079
				(0.000)	(0.000)	(0.000)		
log y_{1987}	−1.211	−1.209	−1.205	−1.172*	−1.099	−1.172*	−1.193	−1.116
				(0.000)	(0.000)	(0.000)		
E	0.026	0.040	0.052	0.044**	0.029	0.044***	0.054	0.057
				(0.080)	(0.230)	(0.070)		
F	−0.029	−0.018	−0.010	−1.017	−0.016	−0.017	−0.005	−0.002
				(0.370)	(0.360)	(0.340)		
U	−0.017	−0.016	−0.013	−0.012*	−0.007	−0.012***	−0.009	−0.004
				(0.000)	(0.280)	(0.060)		
G	0.799	0.881	0.950	−0.925*	0.824*	0.926*	1.021	1.078
				(0.000)	(0.000)	(0.000)		
λ					1.080*			
					(0.000)			
ρ						−0.0322		
						(0.950)		
R^2			0.49	0.42	0.41	0.42		
AIC			−135.21	−134.14	−134.20	−132.15		
LM_λ				5.193**				
				(0.020)				
LM_ρ				4.966**				
				(0.020)				
F statistics			5.57*					

Note: Dependent variable: log (y_{2001}/y_{1987}). The number of nearest neighbors in GWR model is 8. Values in parentheses are the *p* values and (*), (**), and (***) denote significance at 1, 5, and 10 percent, respectively. AIC = Akaike information criterion; OLS = ordinary least squares; SEM = spatial error model; SAR = spatial autoregressive model.

from the two multipliers are significant, the larger value is used to indicate which dependence to control for.

The OLS estimates of the absolute model presented in equation (8) and given in the 3rd column of table 2 suggest that there is a convergent trend in regional per capita income for the time period under consideration. The results from LM_λ and LM_ρ tests do indicate strong evidence of spatiality in the residuals of the OLS estimations. Accordingly, the SEM and SAR models were then estimated in turn, and the results are presented in the 5th and the 6th columns of table 2. In the SEM model, the spatial error coefficient is statistically significant, indicating that the typical least squares regional convergence model is misspecified. The model selection criterion (AIC) indicates the selection of the GWR model. Additionally, the *F* statistics

Figure 10
Spatial Distribution of Beta Coefficient for Geographically Weighted Regression Absolute Model



reported at the bottom of the table 2 reveals that the GWR specification is a statistically significant improvement over the OLS model.

The interquartile range −0.469, −0.049 of the GWR local parameter estimates is outside the range (−0.160, −0.207) of ± 1 standard error of the OLS parameter estimate. The 95 percent CI (−0.258, −0.055) of the OLS estimate of the beta coefficient is outside the range (−0.469, −0.049) between the 25 percent quartile and 75 percent quartile of the GWR estimate of the beta coefficient, indicating that the OLS parameter estimate is smaller than the local beta coefficient values. It appears that only about 25 percent of all GWR parameter estimates fell within the 95 percent CI of the OLS parameter. Moreover, since the GWR model takes the spatial dimension into account, it produces a better fit for the model. Additionally, the variable denoting the initial level of per capita income has statistically significant parametric variability across the sample.

Even though the global OLS regression suggests a convergent trend for per capita income growth, GWR analysis reports a divergent trend for some regions. The spatial distribution of beta coefficients for each region is shown in figure 10 where the estimates of the local coefficients range from −0.800 to 0.060, instead of a constant −0.157 for the OLS estimate. Based on the spatial distributions of the parameter estimates, there appears to be significant variation in speeds of convergence across Turkey, confirming the belief that structural differences between provinces are sustained. The economically less developed Eastern and Southeastern provinces have lower parameter estimates, while the Western and Central provinces of Turkey have higher parameter estimates. This indicates that less developed provinces have higher convergence rates, whereas some of the relatively more developed provinces exhibit a divergent trend in their per capita income growth.

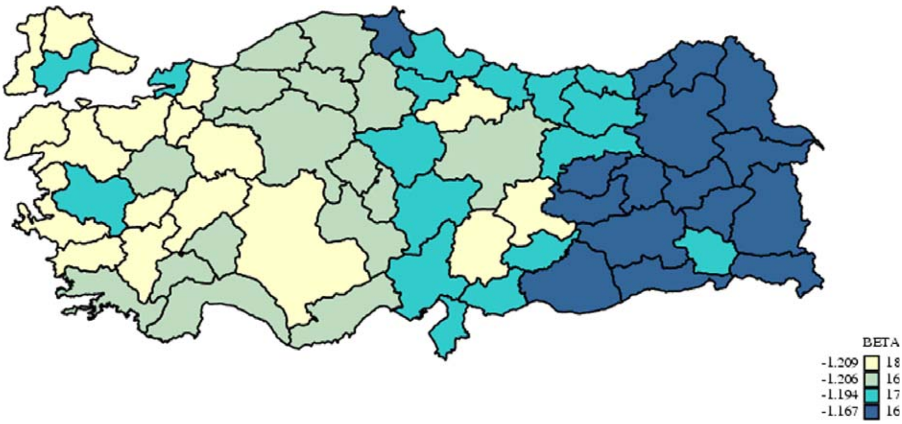
The conditional model estimates, presented in table 3, confirm the estimated results of the absolute convergence model in the sense that there is a convergent trend for per capita income for the time period under consideration for all types of specifications. Moreover, all variables have the expected signs and are statistically significant. The results from LM_λ and LM_ρ tests reject the null hypothesis of no spatial correlation on the residuals of the OLS estimations. The estimates of SEM and SAR models are presented in the 5th and the 6th columns of table 3, respectively. The statistically significant spatial error coefficient in the SEM model suggests that the typical least squares regional convergence model is misspecified and the model should be estimated taking spatial dimension into account. For both models, the AIC criterion is systematically smaller for SEM model compared to that of the SAR model, indicating that any random shock occurring in a specific province will diffuse across the adjacent provinces. The model selection criterion (AIC) indicates the selection of the GWR model. Additionally, the *F* statistics reported at the bottom of the table 3 indicates the rejection of the null hypothesis (*p* value 0.00 for the partial *F* test), suggesting that the GWR model delivers a significant improvement in goodness of fit over the OLS model.

For the initial level of per capita income, the interquartile range (−1.211, −1.167) of the GWR local parameter estimates is outside the range (−1.436, −0.908) of ± 1 standard error of the OLS parameter estimate. The 95 percent CI (−0.655, −1.690) of the OLS estimate of the beta coefficient is outside the range (−1.209, −1.193) between the 25 percent quartile and 75 percent quartile of the GWR estimate of the beta coefficient, indicating that the OLS parameter estimate is smaller than the local beta coefficient values. A similar pattern is observed for all explanatory variables indicating that at least 75 percent of the GWR parameter estimates are statistically different from the OLS parameter estimates, suggesting that the model parameters indeed vary from subareas to subareas within the plot.

Even though GWR estimates of the absolute convergence model report a divergent trend for some provinces, the conditional model estimates indicate that there is a convergent trend for provincial per capita income for all provinces (figure 11). However, significant variations in provincial speeds of convergence are observed. As with the results of the absolute model, the beta convergence hypothesis that poorer provinces will have higher speeds of convergence than richer ones is supported; the Eastern and Southeastern provinces have higher speeds of convergence. Considering the efforts made to promote income equality between the Eastern and Western provinces, it is reasonable to expect higher growth rates for Eastern and Southeastern provinces. These results tend to confirm Yildirim (2006).

When the additional explanatory variables are considered, the East–West dichotomy can be observed once more. The analysis indicates that an increase in the

Figure 11
Spatial Distribution of Beta Coefficient for Geographically Weighted Regression Conditional Model



average level of education (E) helps economic growth especially in southeast and east Anatolia, whereas it has a lesser effect in the Western provinces (figure 12). This is reflected by the positive and significant effects in the global models and a positive median GWR coefficient supporting the human capital and spillover hypotheses. The average level of education in Eastern Turkey is already low because children are usually employed in family-run agricultural activities. Moreover, girls are generally not educated because traditionally it is believed that there is no value to be gained by educating the girl, as girls will be married off early and leave the maternal home. Therefore, it is plausible that the favorable influences on economic growth of increases in the level of education are greater in these provinces than in the Western provinces.

The average fertility rate variable (F) appears to hinder economic growth more in the Eastern provinces than in the Western provinces (figure 13). This could be because of the fact that the provinces in southeast and east Anatolia have higher fertility rates than elsewhere. However, the detrimental effects on economic growth of unemployment is more pronounced in Western provinces, with the effect gradually declining as one moves East (figure 14). The harsh weather conditions and lack of arable land in the poverty-stricken Eastern and Southeastern provinces of Turkey limit the production possibilities for both agriculture and industry. The main livelihood of the residents of these provinces is husbandry and transport. Thus, coupled with high fertility rates, these provinces already have lower levels of GDP per capita than Western provinces. Most industrial and agricultural production is concentrated

Figure 12
Spatial Distribution of Average Education Level Coefficient

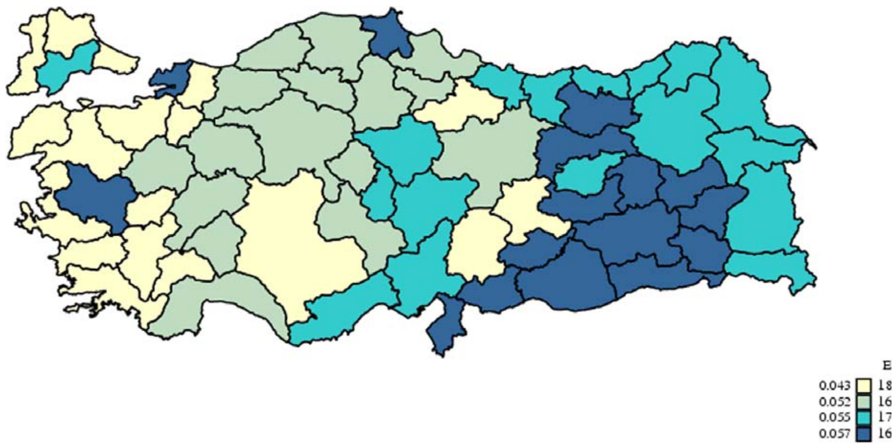
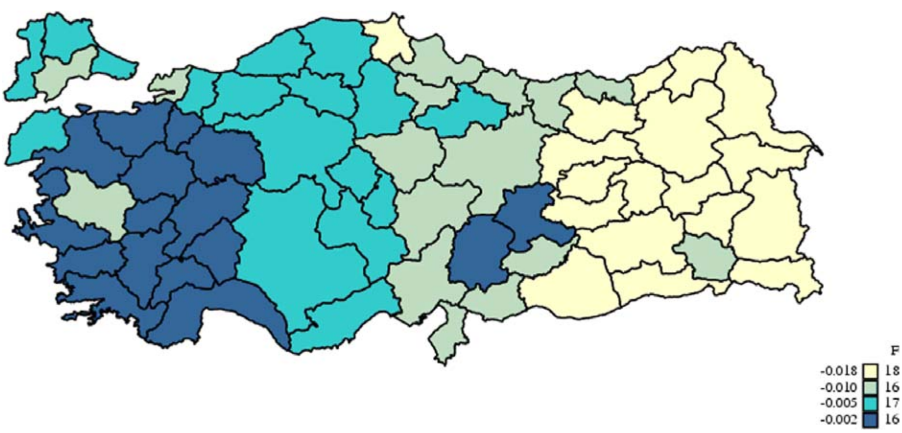
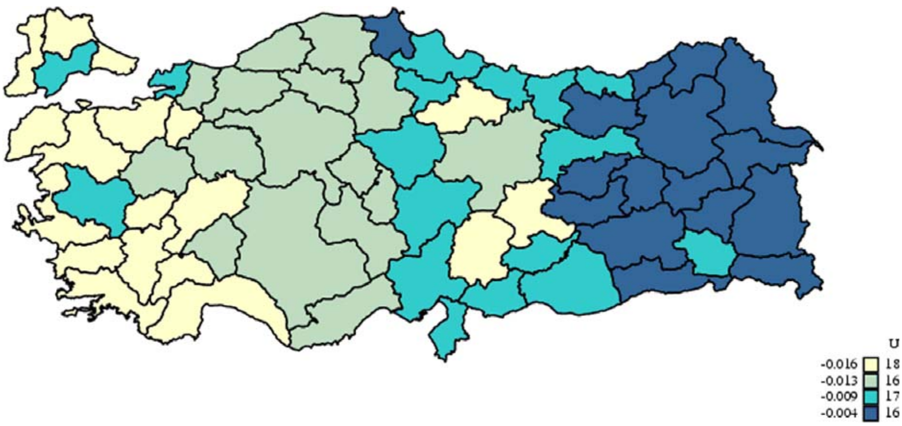


Figure 13
Spatial Distribution of Average Fertility Rate Coefficient



in the more developed Western and North Western provinces of the country with Istanbul being the financial center. Accordingly, any increases in levels of unemployment and in fertility rates impact severely the more limited production opportunities in the Eastern provinces.

Figure 14
Spatial Distribution of Average Unemployment Coefficient

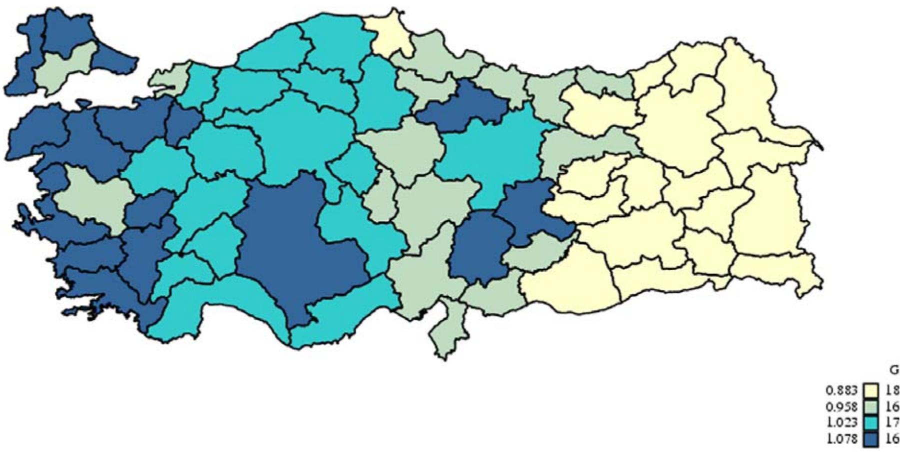


The empirical results from both local and global model estimates indicate that the variable measuring real government expenditure per capita (*G*) enhances provincial economic growth. It appears that there is spatial variation, but the coefficient is always positive as far as the GWR estimates are concerned. However, its effect is much stronger in the Central and Western provinces (figure 15) contrary to our expectations. Considering that government expenditures are the main policy variable to promote income equality between East and West, it appears that this instrument of policy is far from having the effects intended.

Conclusions

The issue of economic convergence at subnational level has attracted much attention in recent years. The existence of wealth disparities across Turkish regions and provinces is a well known and debated issue. However, the limited empirical evidence concerning regional economic convergence in Turkey has not settled any of the arguments on this issue. Previous studies have used data relating to seven large geographical regions of Turkey. However, since 1990, the Turkish Statistical Institute has published disaggregated NUTS data, and these have been used in this article. The aim of this study was twofold: first, we employed the Theil coefficient of concentration to investigate regional inequality using spatially disaggregated data for the period 1987–2001. This was complemented by a new approach to inference as developed by Rey (2004). Then,

Figure 15
Spatial Distribution of Government Expenditures Coefficient



convergence analysis was performed by taking spatiality into account using alternative global and local estimation methods.

In addition to the NUTS 1 and NUTS 2 partitionings, the traditional East–West division and a partitioning into four large regions have been considered. It appears that the Theil coefficient has a tendency to increase in periods of economic expansion and to decrease in periods of recession. The inequality decomposition analysis reveals that measured inequality shares are sensitive to the partitioning used. NUTS 2 partitioning provides the smallest intraregional inequality, indicating a homogenous partitioning. This finding can help future regional policy making.

In the second part of the article, the estimated results from absolute and conditional convergence models were presented. The global OLS estimations indicated the existence of spatiality, which we then attempted to capture by using SEM and SAR models. In addition to the global models, a local estimation method, GWR, was used. Empirical analysis suggests that a GWR specification provides a significantly better fit than the OLS model with better explanatory ability. Local parameter estimates appear to have considerable variations across provinces, indicating that the linear relationship between the growth rate of per capita income and all explanatory variables is not constant across the geographical area of the sample. Empirical findings support the beta convergence hypothesis that poorer provinces will have a higher speed of convergence than richer provinces, as Eastern and Southeastern provinces showed higher speeds of convergence. Higher average unemployment and a higher fertility rate appear to hinder economic growth, whereas a higher level of education enhances it for all provinces though the parameters exhibit spatial variability. Moreover, the beneficial impact of real per capita government expenditures are more prominent in the more developed Western provinces. Considering that government expenditures are the main policy variable to achieve income inequality, it appears that public spending under successive government may have had the effect of widening the gap between Western and Eastern provinces, even though economic convergence has been achieved for the time period under consideration confirming the findings of Gezici and Hewings (2004).

Appendix

Economic Rankings of Provinces of Turkey and Alternative Partionings

Province	Rank	NUTS 1	NUTS 2	Four Large Regions	East/West
İstanbul	1	R1	R1	R1	R1
Ankara	2	R5	R9	R2	R1
İzmir	3	R3	R4	R2	R1
Kocaeli	4	R4	R8	R1	R1
Bursa	5	R4	R7	R1	R1
Eskişehir	6	R4	R7	R1	R1
Tekirdağ	7	R2	R12	R2	R1
Adana	8	R6	R12	R2	R1
Antalya	9	R6	R11	R2	R1
Kirklareli	10	R2	R2	R1	R1
Denizli	11	R3	R5	R2	R1
Muğla	12	R3	R5	R2	R1
Bolu	13	R4	R8	R1	R1
Balikesir	14	R2	R3	R1	R1
Edirne	15	R2	R2	R1	R1
İçel	16	R6	R12	R2	R1
Bilecik	17	R4	R7	R1	R1
Kayseri	18	R7	R15	R2	R1
Gaziantep	19	R12	R24	R3	R1
Zonguldak	20	R8	R16	R4	R1
Aydin	21	R3	R5	R2	R1
Sakarya	22	R4	R8	R1	R1
Çanakkale	23	R2	R3	R1	R1
Manisa	24	R3	R6	R2	R1
Konya	25	R5	R10	R2	R1
Isparta	26	R6	R11	R2	R1
Hatay	27	R6	R13	R2	R1
Uşak	28	R3	R6	R2	R1
Burdur	29	R6	R11	R2	R1

(continued)

Province	Rank	NUTS 1	NUTS 2	Four Large Regions	East/West
Samsun	30	R8	R18	R4	R2
Nevşehir	31	R7	R14	R4	R2
Elaziğ	32	R11	R22	R3	R2
Rize	33	R9	R19	R4	R2
Trabzon	34	R9	R19	R4	R2
Amasya	35	R8	R18	R4	R2
Kütahya	36	R3	R6	R4	R2
Malatya	37	R11	R22	R3	R2
Kirşehir	38	R7	R14	R4	R2
Artvin	39	R9	R19	R4	R2
Afyon	40	R3	R6	R3	R2
Çorum	41	R8	R18	R4	R2
K. Maraş	42	R6	R13	R3	R2
Niğde	43	R7	R14	R4	R2
Giresun	44	R9	R19	R4	R2
Kastamonu	45	R8	R17	R4	R2
Tunceli	46	R11	R22	R3	R2
Sivas	47	R7	R15	R4	R2
Sinop	48	R8	R17	R3	R2
Erzincan	49	R10	R20	R3	R2
Çankiri	50	R8	R17	R4	R2
Erzurum	51	R10	R20	R3	R2
Tokat	52	R8	R18	R4	R2
Ordu	53	R9	R19	R4	R2
Diyarbakir	54	R12	R25	R4	R2
Yozgat	55	R7	R15	R4	R2
Adiyaman	56	R12	R24	R3	R2
Kars	57	R10	R21	R3	R2
Şanliurfa	58	R12	R25	R3	R2
Gümüşhane	59	R9	R19	R4	R2
Mardin	60	R12	R26	R3	R2
Siirt	61	R12	R26	R3	R2
Van	62	R11	R23	R3	R2
Bingöl	63	R11	R22	R3	R2
Hakkari	64	R11	R23	R3	R2
Bitlis	65	R11	R23	R3	R2
Ağri	66	R10	R21	R3	R2
Muş	67	R11	R23	R3	R2

Note: NUTS = Nomenclature of Units for Territorial Statistics.

Notes

1. See Balkir (1995), Akyuz and Boratav (2003), Boratav and Yeldan (2006), and Tekeli (2008) for elaborate reviews of post 1980 economic developments and regional policy in Turkey.

2. See Abreu, de Groot, and Florax (2005) and Rey and Janikas (2005) for an extensive review of the empirical literature on the role of space in explaining variation in economic growth.

3. For an detailed analysis of inference in spatial inequality analysis, see Rey (2004).

4. In 1990 onward, the number of officially defined provinces was increased from 67 to 81. However, we have used the original sixty-seven provinces in this analysis, as data relating to the newly defined provinces is not available for the whole of the time period under consideration.

5. The empirical analysis was carried out using the package STARS (Rey 2004), version 0.8.2.

6. The groupings of the provinces for each partition are presented in the appendix.

7. See, for example, Salai-Martin (1996) for a detailed description of estimation methods.

8. For a detailed analysis of spatial econometric techniques and methods, please see Anselin (1988) and Rey and Montouri (1999) who first outlined the application of these methods to the convergence question.

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