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Absolute Convergence of the Regions and Provinces of Turkey

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ABSOLUTE CONVERGENCE OF THE REGIONS AND PROVINCES OF TURKEY

by

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1. Introduction

The convergence prediction of neoclassical growth theory has been tested regarding the provinces of Turkey in a number of studies, the latest representatives of which are Doğruel and Doğruel (2003), Karaca (2004), Öztürk (2004) and Erlat (2005). The first two uses the cross-section and panel data approaches, respectively, while the last two are based on the time series approach. The time series studies take as their starting point Carlino and Mills (1993) so that both test for conditional convergence but differ in focusing on testing for unit roots under structural shifts in the deterministic terms (Öztürk) and under correlation between the series involved (Erlat).

In the present study, we focus on investigating unconditional convergence. There appears to be conflicting evidence on convergence in the Turkish context, both conditional and unconditional. The absence of convergence appears to be the general conclusion of more than half of the studies but there are those that claim the existence of unconditional convergence (Tansel and Güngör, 1998) while others find evidence of conditional convergence (Filiztekin, 1998 and Doğruel and Doğruel, 2003). Our time series approach to testing for conditional convergence has indicated that one may obtain evidence of conditional convergence in an aggregate of national context (via panel unit root tests) but convergence results regarding individual provinces or regions may not provide support for this conclusion.

The approach we have used is due to Nahar and Inder (2002) which is based on considering (as in Carlino and Mills) the logarithmic difference in the per capita income of a region or province from the per capita income of the country as a whole, but, instead of testing for a unit in this difference, its square is taken and regressed on a polynomial in time, and the average slope of this polynomial is tested to see if it is significantly negative, since a negative slope would indicate an approach towards zero. The rationale underlying this approach is that one may find evidence of convergence even when the series in question has a unit root. It has been used, so far, by Bentzen (2003) to test for gasoline price convergence in OECD countries, by Bentzen and Smith (2003) to investigate regional income convergence in the Scandanavian countries, by Alexiadis and Tomkins (2004) to see if convergence clubs exist among the regions of Greece, and by Giles and Feng (2005) to test for convergence of "well-being" across countries.

We have applied this test to the seven geographical regions of Turkey, to its provinces and to the deviation of provincial per capita incomes from their regional per capita incomes. As opposed to the studies cited, we also took into account the likely high correlation between

the equations used to carry out the tests. This aspect was taken into account also in Erlat (2005) when carrying out both individual and panel unit root tests and it did lead to certain changes in the results. However, in the present context, this was only possible in testing the convergence of geographical regions and convergence of provinces within their respective regions but not in testing the national convergence of provinces, since estimating the seemingly unrelated regression (SUR) model used in this case was not feasible because the number of provinces exceeded the number of time series observations.

Finally, following Bentzen (2005), we tested if the estimated equations were structurally stable for the period in question and then we investigated if the average slopes were significantly different between the two subsamples for those regions or provinces that exhibited structural instability.

Hence, the plan of the paper is as follows. In the next section, we describe the procedures used. In doing so we not only explain the Nahar and Inder test but also the unit root test used in Erlat (2005) that takes the correlation between the series into account, due to Pesaran (2005), since we shall present these results also to provide a basis of comparison. In section 3 we describe the data and present the empirical results in section 4. The final section will contain our conclusions.

2. The Test Procedures

Let x_{it} be the log of per capita income in region i and x_t the log of the target level of per capita income towards which x_{it} is expected to converge. Let $y_{it} = x_{it} - x_t$. Then one may say that the i^{th} region converges if

$$\lim_{s \to \infty} E(y_{i,t+s} \mid I_t) = \mu_i \tag{1}$$

where I_t indicates all the information at time t. In other words, convergence will take place if the long-run forecast of output differences tends to a constant, μ_i, as the forecasting horizon tends to infinity. Convergence is absolute if $\mu_i = 0$ for all i and conditional if $\mu_i \neq 0$ for some i. This definition has been traditionally tested by means of unit root tests because it is taken to imply the stationarity of the y_{it}. Nahar and Inder (2002) argue, however, that this may not always be true and show that if

(2) $$y_{it} = \frac{\theta}{t} + u_{it}$$

where y_{it} is nonstationary and u_{it} is stationary with mean zero, then as $t \to \infty$, $\theta / t \to 0$ so that x_{it} is converging. But a unit root test may well indicate that y_{it} is nonstationary and, therefore, lead to the conclusion that the i^{th} region is not converging.

Thus, Nahar and Inder (2002) developed an alternative procedure that would cover situations of this sort. Let $w_{it} = y_{it}^2$. Then, in order for convergence to take place, w_{it} should be approaching zero, implying that the rate of change in w_{it} with respect to time should be negative. Then, the definition of absolute convergence, as implied by (1) becomes, in terms of w_{it},

(3) $$\lim_{s \to \infty} E(w_{i,t+s}) = 0$$

Since $w_{it} > 0$, its negative slope with respect to *t* will be consistent with $w_{i,t-s}$ tending to 0 as $s \to \infty$. Denoting this slope by $\partial w_{it} / \partial t$, we may investigate the convergence of a region by checking the sign of $\partial w_{it} / \partial t$. Taking w_{it} as a function of time, *t,* we may approximate it by a polynomial in *t* as,

(4) $$w_{it} = \beta_0 + \beta_1 t + \beta_2 t^2 + \ldots + \beta_{k-1} t^{k-1} + \beta_k t^k + u_{it}, \quad i = 1, \ldots, N$$

where u_{it} is assumed to satisfy the usual assumptions of a linear regression model. The slope function may readily be obtained form (4) as,

(5) $$\frac{\partial w_{it}}{\partial t} = \beta_1 + \beta_2 (2t) + \ldots + \beta_{k-1}((k-1)t^{k-2}) + \beta_k (kt^{k-1}), \quad t = 1, \ldots, T$$

However, not all $\partial w_{it} / \partial t$'s may be negative, but it is sufficient that their average be negative. We may obtain this average from (5) as,

(6)
$$\frac{1}{T}\sum_{t=1}^{T}\frac{\partial w_{it}}{\partial t} = \beta_1 + \beta_2 r_2 + \ldots + \beta_{k-1} r_{k-1} + \beta_k r_k = r'\beta$$

where

$$r_2 = \frac{2}{T}\sum_{t=1}^{T} t \quad ,\ldots,\quad r_{k-1} = \frac{k-1}{T}\sum_{t=1}^{T} t^{k-2},\quad r_k = \frac{k}{T}\sum_{t=1}^{T} t^{k-1},$$

$$r = \begin{pmatrix}0 & 1 & r_2 & \ldots & r_k\end{pmatrix}' \qquad \text{and} \qquad \beta = \begin{pmatrix}\beta_0 & \beta_1 & \ldots & \beta_k\end{pmatrix}'$$

Thus, the hypothesis to be tested may be formulated as,

$$H_0 : r'\beta \geq 0 \quad vs. \quad H_1 : r'\beta < 0$$

To test this hypothesis the equations in (4) need to be estimated. If the disturbances of these equations are uncorrelated, then ordinary least squares (OLS) would be the appropriate estimator to use. But, if the disturbances are contemporaneously correlated, then they would constitute a SUR model and they would need to be estimated jointly. But the estimators available require the estimation of the contemporaneous covariance matrix of the disturbances and this is only feasible when the number of equations, N, is less than the sample size T.[1] Thus, we used OLS whenever N > T and jointly estimated the SUR model using maximum likelihood (ML) under the assumption of normality. Hence, the test statistic based on the OLS estimates will have a t-distribution under the null, while the same statistic based on the ML-SUR estimates will have a standard normal distribution asymptotically.

We also noted the fact, following Bentzen (2005), that the coefficients in (4) may exhibit instability and this implies a shift in the slope of the function in (4). In other words, the existence of subperiods with different average slope functions would imply different

[1] Of course, when N > T, one may still estimate the equations by OLS but use the estimated variance and covariances from the system covariance matrix of the OLS estimator. Formally, if $y = (y_1',\ldots,y_N')'$, $X = diag(X_1,\ldots,X_N)$, $\beta = (\beta_1',\ldots,\beta_N')'$, $u = (u_1',\ldots,u_N')'$, and Σ is the NxN matrix with typical element $\sigma_{ij} = E(u_{it}u_{jt})$, then the OLS estimator of β will be $\hat{\beta}_{OLS} = (X'X)^{-1}X'y$ and its estimated covariance matrix will be obtained as $Cov(\hat{\beta}_{OLS}) = (X'X)^{-1}X'(\hat{\Sigma}\otimes I_T)X(X'X)^{-1}$ where '$\otimes$' denotes the Kreonecker product of two matrices and the σ_{ij} are estimated using the OLS residuals. The variance and covariance information required to form the test statistic should be obtained from this $Cov(\hat{\beta}_{OLS})$ expression. This idea has recently been implemented by Jonsson (2005) and by Breitung and Das (2005) within the context of panel unit root testing using SUR models. We also intend to use it in future work.

speeds of convergence. In order to investigate this aspect we carried out a two-step procedure. In the first step, we tested for instability in the slope coefficients of (4) using a sequential approach initially due to Quandt (1960), the distribution of which was derived and critical values tabulated by Andrews (1993). This involves applying the Wald test by sequentially changing the subsamples. Letting $D_t(j)$ represent a dummy variable that takes on the value '0' for t = 1,...,j and '1' for t = j+1,...,T, the equations to be estimated to provide us with the sequential Wald statistics are

(7) $$w_{it} = \beta_0 + \sum_{i=1}^{k} \beta_i t^i + \sum_{i=1}^{k} \alpha_i (D_t(j).t^i) + u_{it}, \quad j = T_0, \ldots, T - T_0$$

where T_0 is chosen to represent a fraction of the sample size that we shall call the trimming factor. For each *j* the hypothesis $\alpha_i = \ldots = \alpha_k = 0$ will be tested using the Wald statistic. The test will be based on the maximum of these sequential Wald statistics, which we shall call *Max-W*. The date at which the maximum is found is taken to be the shift point.

Once this shift point (which we shall denote by $\hat{T}_0$) is determined, in the second step the sample is divided into two subsamples at that point and the average slope is calculated for each subsample as $r_I'\beta$ and $r_{II}'\beta$, respectively, where

$$r_I = \begin{pmatrix} 0 & 1 & r_{I,2} & \ldots & r_{I,k} \end{pmatrix}' \quad \text{with} \quad r_{I,i} = \frac{i}{\hat{T}_0} \sum_{t=1}^{\hat{T}_0} t^{i-1}, \quad i = 2, \ldots, k$$

$$r_{II} = \begin{pmatrix} 0 & 1 & r_{II,2} & \ldots & r_{II,k} \end{pmatrix}' \quad \text{with} \quad r_{II,i} = \frac{i}{T - \hat{T}_0} \sum_{t=\hat{T}_0+1}^{T} t^{i-1}, \quad i = 2, \ldots, k$$

The hypothesis to be tested is then specified as,

$$H_0 : r_I'\beta - r_{II}'\beta = 0 \quad vs. \quad H_1 : r_I'\beta - r_{II}'\beta \neq 0$$

and a t-test may be applied if (4) has been estimated by OLS.

We mentioned, in the Introduction, that we would also present some unit root test results obtained by Erlat (2005) for comparison purposes. The unit root test used in that paper is due to Pesaran (2005) and takes the correlation between the time series into account in a rather simple fashion. Pesaran (2005) starts by assuming that the disturbance term in the autoregressions used to obtain the augmented Dickey-Fuller (ADF) statistic can be decomposed into an unobserved common effect and an idiosyncratic component. He goes on

to show that the unobserved common component may be accounted for if the autoregressions are augmented as follows:

(8) $$\Delta y_{it} = c_{i0} + c_i t + \beta_i y_{i,t-1} + \sum_{j=1}^{p} \gamma_{ij} \Delta y_{i,t-j} + \varphi_i \bar{y}_{t-1} + \sum_{j=0}^{p} \eta_{ij} \Delta \bar{y}_{t-j} + u_{it}$$

where $\bar{y}_t = \sum_{i=1}^{N} y_{it} / N$. The t-ratio of β_i is used as the test statistic for a unit root and it is now called the *Cross-Sectionally Augmented ADF (CADF)* statistic. Its critical values have been generated by Monte Carlo and are tabulated in Pesaran (2005).

3. The Data[2]

The data used in this study comes from two different sources. Regional GDP's for Turkey were calculated by Özütün (1980, 1988) for the period 1975-1986 using the methodology employed by the State Institute of Statistics (SIS) at the time. For the period after 1986, the SIS itself started calculating regional GDP's using the new methodology it had started implementing for the national series from 1987 onwards. Due to the difference in these methodologies; in particular, due to the fact that the new approach encompassed a wider range of economic activities, these two series needed to be linked by making certain adjustments. We followed Filiztekin (1998) in making these adjustments, a detailed account of which is given in Filiztekin and Tunalı (1998). We summarize it below.

Even though the SIS had constructed regional GDP's using its new approach only for the post-1986 period, it had calculated national GDP figures from 1968 onwards. Thus, let Z_{it} stand for the income of the i^{th} province at year t, and Z_t, the national income in year t, both from Özütün (1980, 1988). Finally, let W_t be the corresponding national income at t from the SIS database. Then, the income of province i for the pre-1987 period is obtained as,

$$X_{it} = \left(\frac{Z_{it}}{Z_t} \right) W_t$$

A second adjustment had to be made to the data starting in 1990. During the 1990-2000 period, new provinces were carved out of the older ones. In 1990 Aksaray was formed out of Niğde, Karaman out of Konya and Bayburt out of Gümüşhane. This was followed, in

[2] This section derives, to a great extent, from Erlat (2001) and Erlat (2005) where the same data set had been utilized.

1991, by Batman and Şırnak being formed out of Siirt[3], in 1992, by Bartın being formed out of Zonguldak, in 1993, by Ardahan and Iğdır being formed out of Kars, in 1996 Yalova being formed out of İstanbul, Karabük out of Zonguldak and Kilis out of Gaziantep, in 1997, by Osmaniye being formed out of Adana and, in 2000, by Düzce being formed out of Bolu. These new provinces were not considered separately in the series and they were added back to their parent provinces. For example, after 1990, the figures for Niğde refer to Niğde *plus* Aksaray.

In deflating the series to obtain real figures, we utilized the implicit price deflators for the subsectors of the GDP series for Turkey as a whole. The base year for all deflators was 1987. Thus, for example, the real agricultural output for the j^{th} province was calculated by deflating Agriculture and Livestock Production, Forestry and Fishing separately, using their sectoral implicit GNP deflators, and then summing them up.

All SIS data mentioned above were obtained from their electronic database.

4. Empirical Results

The results given in Tables 1 to 3 refer to tests of convergence. Even though our primary objective was to use the Nahar-Inder approach to testing for absolute convergence, we also provided results of conditional convergence tests from Erlat (2005) based on Pesaran (2005)'s approach. For both approaches a specification problem needed to be solved; namely, for the unit root tests the lag length 'p' in equation (8) and, for the Nahar-Inder approach, the polynomial degree 'k' in equation (4) needed to be chosen. In both cases, we applied a general-to-specific approach and based our choices on the outcomes of the Akaike Information Criterion, the Schwartz Information Criterion and the t-ratio corresponding to the last lag or the highest polynomial degree, as the case may be. We sought a consensus between these criteria and, when none was forthcoming, we preferred the outcome that indicated the largest lag in the case of equation (8) and the smallest polynomial degree in the case of equation (4).[4]

The results regarding the convergence of the seven geographical regions are given in Table 1. We note that Central Anatolia converges conditionally. As for absolute convergence, the OLS results only indicate that the Marmora region is converging, while when the correlation between the series are taken into account through a SUR model, we find that

[3] Strictly speaking, Batman and Şırnak also contain sections of Hakkari and Mardin. Hence, in our applications we combined Batman, Şırnak, Siirt and Hakkari and called the resultant "province" SMH.
[4] The choice of the model with the largest lag reduces the likelihood of the residuals in (8) being autocorrelated, while choosing the polynomial with the lowest degree enhances the degrees-of-freedom and, thereby, the power of the t-tests used in testing for convergence.

Table 1								
Convergence of Regions								
	p	**CADF**	**k**	**Ave. Slope (OLS)**	t_{OLS}	**Ave. Slope (SUR)**	t_{SUR}
Mediterranean	3	-2.483	2	0.00008	0.911 (0.814)	0.00008	0.966 (0.832)
Southeast Ana.	0	-1.693	6	-0.00586	-0.887 (0.193)	-0.00639	-1.238 (0.108)
Central Ana.	5	-3.582[a]	7	0.00002	0.004 (0.501)	-0.00064	-2.431 (0.008)[c]
East Anatolia	0	-3.195	9	0.00225	2.900 (0.995)	0.00893	1.661 (0.949)
Aegean	5	-1.409	5	0.00078	1.625 (0.940)	0.00076	1.846 (0.968)
Black Sea	2	-2.290	5	-0.00035	-0.475 (0.320)	-0.00034	-0.529 (0.299)
Marmora	0	-2.344	5	-0.00660	-5.091 (0.000)[c]	-0.00675	-7.562 (0.000)[c]

Notes:

1. The figures in parentheses are the p-values. For t_{OLS}, they have been calculated using the t distribution; for t_{SUR}, they are based on the standard normal distribution.
2. The CADF results are from Erlat (2005). The critical values for the CADF test are from Pesaran (2003), Tables A and 1c.

Critical Values for the CADF Test, p = 0 (Table A)

0.10	0.05	0.01
-3.39	-3.70	-4.29

Critical Values for the CADF Test, p > 0, N = 10, T = 30 (Table 1c)

0.10	0.05	0.01
-3.49	-3.87	-4.67

[a] Significant at the 10 percent level
[c] Significant at the 1 percent level

Central Anatolia is also converging absolutely. The average rates of convergence are not very high, however. They are 0.66% and 0.68% from the OLS and SUR results, respectively, for the Marmora region, while the OLS results indicate a very slow rate of divergence for Central Anatolia, which becomes a rather slow rate of convergence (0.06%) when the SUR results are considered. There are two other regions with negative average slopes; Southeast Anatolia and the Black Sea region. Both t-ratios are statistically insignificant for the Black Sea region and the average slopes are very low in both cases (0.03%). Southeast Anatolia also has insignificant t-ratios but the improvement in the SUR results brings this figure close to the 10% level. What is of interest here is the average rate of convergence (0.60%) which is higher than that of Central Anatolia and close to that of the Marmora region.

The convergence results regarding the per capita incomes of provinces to the national per capita income are in Table 2. They are presented as regional groupings. We note that there are 13 provinces that converge conditionally, with Central Anatolia containing the highest number, 4. None of the provinces in Southeast Anatolia converge while only one province converges in the Aegean and Marmora regions; Muğla and Edirne, respectively. When we turn to the absolute convergence results, we find that now 14 provinces show convergence.

Table 2					
National Convergence of Provinces					
	p	**CADF**	**k**	**Average Slope**	t_{OLS}
Mediterranean					
Adana	0	-2.385	2	-0.000166	-2.043 (0.026)[b]
Antalya	0	-2.434	7	0.000896	1.809 (0.957)
Burdur	0	-1.862	5	0.000893	1.847 (0.961)
Hatay	1	-3.960[b]	1	-0.000410	-2.765 (0.005)[c]
Isparta	0	-1.718	7	0.000167	0.850 (0.797)
Mersin	2	-4.477[b]	7	-0.00111	-1.773 (0.046)[b]
Kahramanmaraş	0	-3.381	1	-0.00439	-2.329 (0.014)[b]
Southeast Anatolia					
Adıyaman	0	-1.945	7	-0.00294	-0.202 (0.421)
Diyarbakır	0	-1.879	6	0.00294	0.471 (0.678)
Gaziantep	0	-2.770	3	0.00460	2.055 (0.974)
SMH	0	-1.847	5	-0.00234	-1.427 (0.084)[a]
Şanlıurfa	2	-1.157	2	0.00932	2.525 (0.991)
Central Anatolia					
Ankara	0	-1.475	5	0.00308	2.841 (0.995)
Çankırı	2	-2.879	8	0.00128	1.881 (0.962)
Eskişehir	2	-0.116	8	0.00268	2.917 (0.995)
Kayseri	0	-4.506[b]	2	0.00222	4.878 (0.999)
Kırşehir	0	-3.101	3	0.00405	2.297 (0.984)
Konya	1	-4.884[c]	5	0.00607	7.817 (0.999)
Nevşehir	3	-2.278	7	-0.00220	-3.110 (0.003)[c]
Niğde	0	-4.884[c]	5	0.000912	0.317 (0.623)
Sivas	0	-3.536[a]	5	-0.00864	-2.382 (0.009)[c]
Yozgat	0	-3.401	1	0.00189	7.612 (0.999)
East Anatolia					
Ağrı	0	4.569[b]	9	0.00720	2.417 (0.986)
Bingöl	0	-2.779	8	0.00769	0.445 (0.669)
Bitlis	5	-1.879	5	0.00396	4.453 (0.999)
Elazığ	0	-3.839[a]	2	0.00536	8.748 (0.999)
Erzincan	0	-1.649	5	0.01440	3.307 (0.998)
Erzurum	5	-3.205	6	0.00119	1.856 (0.951)
Kars	0	-2.973	2	0.00317	5.648 (0.999)
Malatya	3	-2.847	4	0.00127	0.343 (0.634)
Muş	0	-4.074[b]	6	0.00573	3.695 (0.999)
Tunceli	4	-3.008	6	-0.00361	-0.362 (0.361)
Van	0	-2.017	5	0.00533	0.526 (0.698)

Table 2 (Continued)					
	p	CADF	K	Average Slope	t_{OLS}
Aegean					
Afyon	2	-2.328	2	0.00893	7.533 (0999)
Aydın	4	-2.316	6	-0.000191	-0.917 (0.185)
Denizli	5	-0.583	4	0.00183	6.873 (0.999)
İzmir	4	-1.632	6	-0.00210	-1.083 (0.140)
Kütahya	0	-3.319	1	0.00152	2.259 (0.984)
Manisa	0	-1.271	6	0.00533	5.650 (0.999)
Muğla	0	-4.642[c]	1	0.00581	7.874 (0.999)
Uşak	0	-3.019	5	0.00545	0.526 (0.698)
Black Sea					
Amasya	0	-3.076	8	0.00170	2.948 (0.996)
Artvin	1	-3.179	6	-0.00460	-2.042 (0.027)[b]
Bolu	0	-2.584	5	-0.00123	-0.776 (0.223)
Çorum	0	-3.011	6	-0.00711	-2.232 (0.019)[b]
Giresun	2	-0.691	2	0.00113	3.929 (0.999)
Gümüşhane	0	-2.932	8	-0.00136	-0.148 (0.442)
Kastamonu	0	-4.556[b]	7	-0.00021	-0.010 (0.496)
Ordu	2	-0.734	4	-0.0117	-2.850 (0.005)[c]
Rize	5	-4.530[b]	1	0.00356	4.487 (0.999)
Samsun	0	-2.742	3	-0.00084	-1.091 (0.143)
Sinop	5	-1.971	7	-0.00751	-2.110 (0.024)[b]
Tokat	0	-2.044	10	-0.0147	-1.427 (0.086)[a]
Trabzon	0	-2.000	5	-0.00194	-0.560 (0.291)
Zonguldak	0	-1.058	1	-0.00232	-4.649 (0.000)
Marmora					
Balıkesir	0	-2.676	1	0.00007	0.922 (0.817)
Bilecik	0	-4.394	2	0.0117	10.330 (0.999)
Bursa	5	-1.803	6	0.00051	0.434 (0.666)
Çanakkale	0	-2.229	5	0.00102	1.166 (0.872)
Edirne	1	-3.824[a]	5	-0.00076	-1.765 (0.046)[b]
İstanbul	0	-1.229	5	-0.0189	-6.806 (0.000)[c]
Kırklareli	0	-2.177	1	0.0103	7.276 (0.999)
Kocaeli	4	-0.781	6	-0.00530	-0.610 (0.277)
Sakarya	0	-2.950	5	-0.00118	-0.920 (0.184)
Tekirdağ	0	-2.317	1	-0.00003	-0.012 (0.143)

Notes:

1. The figures in parentheses are the p-values. For t_{OLS}, they have been calculated using the t distribution.
2. The CADF results are from Erlat (2005). The critical values for the CADF test are from Pesaran (2003), Tables A and 1c.

Critical Values for the CADF Test, p = 0 (Table A)

0.10	0.05	0.01
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Critical Values for the CADF Test, p > 0, N = 10, T = 30 (Table 1c)

0.10	0.05	0.01
-3.49	-3.87	-4.67

[a] Significant at the 10 percent level
[b] Significant at the 5 percent level
[c] Significant at the 1 percent level

Only four of these, Hatay, Mersin, Sivas and Edirne, also converge conditionally. Now, East Anatolia and the Aegean region have no provinces that converge absolutely. The hybrid province SMH is the only one exhibiting absolute convergence in Southeast Anatolia. The Black Sea region has the highest number of provinces converging absolutely; Artvin, Çorum, Ordu, Sinop and Tokat with Tokat exhibiting the highest average rate of convergence (1.47%) and Ordu coming in a close second (1.17%). The province with the highest average convergence rate is İstanbul.

The results pertaining to the convergence of provinces within regions are presented in Table 3. The conditional convergence results based on the CADF test indicates that there is only one converging province in Southeast Anatolia (Şanlıurfa), East Anatolia (Erzurum) and the Marmora Region (Bilecik). This number is only two in the Aegean region (Afyon and Aydın), three in Central Anatolia (Ankara, Kırşehir and Niğde) and four each in the Mediterranean region (Adana, Isparta, Mersin and Kahramanmaraş) and the Black Sea region (Bolu, Çorum, Rize and Samsun). Since these convergence results pertain to different steady state levels indicated by the per capita incomes of different geographical regions, one may conclude that the converging provinces in the Aegean, Central Anatolia, Mediterranean and Black Sea regions constitute convergence clubs.

Such a conclusion appears to be even stronger in the case of absolute convergence. We first note that the OLS and SUR results are all the same except for the case of Ankara, which becomes convergent when considered as a part of a SUR model. This, however, does not change the fact that no other province converges absolutely to its regional per capita income in Central Anatolia as is also the case in East Anatolia. On the other hand, three provinces converge in the Mediterranean (Burdur, Mersin and Kahramanmaraş) and Aegean (Denizli, İzmir and Muğla) regions and four in the Southeast Anatolia (Adıyaman, Diyarbakır, Gaziantep and SMH) and Black Sea (Ordu, Rize, Sinop and Zonguldak) regions. The highest number of convergences is in the Marmora region; seven out of ten provinces converge absolutely to the regional per capita income. These are Bilecik, Bursa, Çanakkale, İstanbul, Kırklareli, Sakarya and Tekirdağ. In fact, the four provinces that converge in Southeast Anatolia also constitute the majority of the provinces in that region. Thus, these may be taken as stronger evidence for the existence of convergence clubs, particularly in these two regions.

The last two tables contain the results of the tests for structural shift in equation (4) for the regions and provinces showing both national (Table 4) and regional (Table 5) convergence and the associated tests of a shift in the slope function. In implementing the Max-W statistic

Table 3							
Convergence of Provinces Within Regions							
	p	**CADF**	**k**	**Ave. Slope (OLS)**	t_{OLS}	**Ave. Slope (SUR)**	t_{SUR}
Mediterranean							
Adana	1	-3.793[a]	8	0.00032	0.897 (0.809)	0.00057	2.005 (0.978)
Antalya	2	-1.711	9	0.00219	2.219 (0.986)	0.00102	2.353 (0.108)
Burdur	0	-3.340	4	-0.00039	-1.435 (0.083)[a]	-0.00039	-1.588 (0.056)[a]
Hatay	1	-2.838	3	0.00006	0.003 (0.501)	0.00006	0.004 (0.501)
Isparta	5	-4.247[c]	5	0.00387	2.135 (0.978)	0.00217	1.846 (0.968)
Mersin	5	-6.025[c]	7	-0.00104	-1.916 (0.035)[b]	-0.00780	-2.089 (0.018)[c]
Kahramanmaraş	0	-4.849[c]	3	-0.0102	-3.810 (0.000)[c]	-0.0102	-4.128 (0.000)[c]
Southeast Anatolia							
Adıyaman	0	-1.664	4	-0.00045	-3.152 (0.002)[c]	-0.00435	-3.492 (0.000)[c]
Diyarbakır	5	0.477	4	-0.00227	-2.985 (0.003)[c]	-0.00227	-3.307 (0.000)[c]
Gaziantep	0	-1.723	5	-0.00405	-1.982 (0.030)[b]	-0.00440	-2.478 (0.006)[c]
SMH	0	-2.823	5	-0.00532	-1.538 (0.070)[a]	-0.00612	-2.037 (0.021)[b]
Şanlıurfa	5	-4.247[c]	5	-0.00305	-1.006 (0.163)	-0.00071	-0.317 (0.375)
Central Anatolia							
Ankara	0	-3.466[a]	5	0.00258	3.284 (0.998)	-0.20521	-5.726 (0.000)[c]
Çankırı	2	-3.399	4	0.0112	1.786 (0.892)	0.01398	3.716 (0.999)
Eskişehir	0	-2.911	3	0.00388	3.910 (0.999)	0.00388	4.234 (0.999)
Kayseri	2	-1.738	3	0.00057	1.150 (0.869)	0.00057	1.246 (0.894)
Kırşehir	0	-3.723[b]	7	0.00163	0.595 (0.720)	0.00275	1.510 (0.934)
Konya	0	-2.866	6	0.00492	9.666 (0.999)	0.00501	10.933 (0.999)
Nevşehir	1	-1.962	7	0.00114	0.680 (0.748)	0.00249	2.188 (0.986)
Niğde	0	-3.724[b]	4	0.00327	1.754 (0.952)	0.00327	1.943 (0.974)
Sivas	0	-1.848	3	0.00078	0.434 (0.666)	0.00078	0.470 (0.681)
Yozgat	0	-2.871	3	0.00969	2.697 (0.994)	0.00969	2.922 (0.998)
East Anatolia							
Ağrı	0	-2.490	2	0.0160	7.533 (0.999)	0.0160	7.990 (0.999)
Bingöl	0	-3.206	7	0.00156	0.239 (0.593)	-0.00043	-0.105 (0.458)
Bitlis	5	-0.045	5	0.00544	1.516 (0.928)	0.00861	4.013 (0.999)
Elazığ	0	-2.234	5	0.00055	0.096 (0.538)	0.00348	0.926 (0.823)
Erzincan	2	-2.775	2	-0.00065	-1.070 (0.148)	-0.00065	-1.135 (0.128)
Erzurum	0	-4.633[b]	2	-0.00002	-0.221 (0.413)	0.00002	-0.234 (0.407)
Kars	0	-2.000	2	0.00099	0.794 (0.783)	0.00099	0.843 (0.800)
Malatya	1	-1.910	7	0.0106	2.848 (0.995)	0.0117	5.203 (0.999)
Muş	1	-1.908	4	0.0115	3.490 (0.999)	0.0140	5.382 (0.999)
Tunceli	4	-1.071	9	0.00097	0.393 (0.650)	0.00736	5.216 (0.999)
Van	0	-2.913	7	0.00419	0.844 (0.795)	0.00368	1.633 (0.849)

Table 3 (Continued)							
	p	CADF	k	Ave. Slope (OLS)	t_{OLS}	Ave. Slope (SUR)	t_{SUR}
Aegean							
Afyon	5	-7.450[c]	5	0.00093	1.933 (0.967)	0.00968	2.299 (0.989)
Aydın	0	-3.668[a]	3	0.00253	3.467 (0.999)	0.00252	3.752 (0.999)
Denizli	1	0.183	5	-0.00228	-3.387 (0.001)[c]	-0.00239	-4.275 (0.000)[c]
İzmir	4	-2.155	7	-0.00476	-4.941 (0.000)[c]	-0.00495	-7.523 (0.000)[c]
Kütahya	0	-2.534	7	0.00359	1.193 (0.876)	-0.00002	-0.010 (0.496)
Manisa	0	-2.565	7	-0.00017	-0.266 (0.396)	0.000003	0.006 (0.502)
Muğla	0	-1.918	2	-0.00127	-3.888 (0.000)[c]	-0.00127	-3.594 (0.000)[c]
Uşak	0	-3.110	4	0.0112	10.064 (0.999)	-0.0112	11.525 (0.999)
Black Sea							
Amasya	0	-2.706	3	0.00145	3.402 (0.999)	0.00159	4.718 (0.999)
Artvin	0	-2.704	1	0.00469	3.941 (0.999)	0.00469	4.095 (0.999)
Bolu	0	-4.176[b]	11	-0.00053	-0.190 (0.426)	-0.00083	-0.688 (0.246)
Çorum	0	-3.527[a]	6	-0.00105	-1.136 (0.135)	0.00024	0.375 (0.646)
Giresun	0	-2.622	2	0.00413	2.626 (0.993)	0.00413	2.784 (0.997)
Gümüşhane	5	-3.328	1	0.00064	2.883 (0.996)	0.00716	3.957 (0.999)
Kastamonu	0	-2.318	7	0.00016	0.438 (0.667)	-0.00007	-0.281 (0.389)
Ordu	2	-0.287	4	-0.00809	-3.645 (0.001)[c]	-0.00883	-5.142 (0.000)[c]
Rize	0	-3.416[a]	1	-0.00119	-2.238 (0.017)[b]	-0.00119	-2.326 (0.010)[b]
Samsun	3	-5.646[c]	1	0.00006	0.326 (0.627)	0.00006	0.339 (0.633)
Sinop	5	-2.703	5	-0.00583	-5.224 (0.000)[c]	-0.00573	-6.993 (0.000)[c]
Tokat	0	-2.914	3	0.00338	2.095 (0.976)	0.00418	3.244 (0.999)
Trabzon	0	-1.511	6	0.00028	0.287 (0.612)	0.00086	1.484 (0.931)
Zonguldak	0	-0.854	5	-0.0130	-2.801 (0.005)[c]	-0.0101	-4.087 (0.000)[c]
Marmora							
Balıkesir	2	-2.557	5	-0.00075	-0.221 (0.414)	0.00291	1.085 (0.861)
Bilecik	0	-4.924[c]	2	-0.00939	-11.549 (0.000)[c]	-0.00939	-12.248 (0.000)[c]
Bursa	5	-0.391	6	-0.00231	-2.803 (0.005)[c]	-0.00220	-3.388 (0.000)[c]
Çanakkale	5	-1.746	5	-0.00710	-3.792 (0.001)[c]	-0.00747	-5.206 (0.000)[c]
Edirne	0	-3.070	1	0.00095	0.601 (0.723)	0.00095	0.625 (0.734)
İstanbul	0	-1.699	2	-0.002	-16.093 (0.000)[c]	-0.00200	-17.068(0.000)[c]
Kırklareli	0	-2.199	7	-0.0106	-6.651 (0.000)[c]	-0.00801	-7.193 (0.000)[c]
Kocaeli	0	-2.405	6	0.00366	0.793 (0.781)	-0.00014	-0.051 (0.480)
Sakarya	0	-1.557	5	-0.0119	-1.846 (0.040)[b]	-0.00918	-2.087 (0.018)[b]
Tekirdağ	0	-2.134	3	-0.00859	-5.780 (0.000)[c]	-0.00850	-7.602 (0.000)[c]

Notes:

1. The figures in parentheses are the p-values. For t_{OLS}, they have been calculated using the t distribution; for t_{SUR}, they are based on the standard normal distribution.
2. The CADF results are from Erlat (2005). The critical values for the CADF test are from Pesaran (2003), Tables A and 1c.

Critical Values for the CADF Test, p = 0 (Table A)

0.10	0.05	0.01
-3.39	-3.70	-4.29

Critical Values for the CADF Test, p > 0, N = 10, T = 30 (Table 1c)

0.10	0.05	0.01
-3.49	-3.87	-4.67

[a] Significant at the 10 percent level
[b] Significant at the 5 percent level
[c] Significant at the 1 percent level

Table 4					
Tests of Structural Shift and Shift in the Slope Function for Regions and Provinces Converging Nationally					
	k	**Max-W**	**Date of Break**	**Shift in Average Slope**	**t_{OLS}**
Regions					
Central Anatolia	7	39.440[c]	1987	0.00139	4.257 (0.000)[c]
Marmora	5	57.731[c]	1988	-0.00091	-5.496 (0.000)[c]
Provinces					
Adana	2	1.233	1983	-0.00058	-4.510 (0.000)[c]
Artvin	6	99.805[c]	1987	0.00433	4.302 (0.000)[c]
Çorum	6	25.507[c]	1988	0.00221	4.582 (0.000)[c]
Edirne	5	43.970[c]	1988	0.00270	6.224 (0.000)[c]
Hatay	1	47.851[c]	1987	-0.01403	-6.917 (0.000)[c]
İstanbul	5	30.640[c]	1988	0.00108	3.024 (0.006)[c]
Kahramanmaraş	1	10.722[c]	1988	0.01078	3.274 (0.003)[c]
Mersin	7	346.749[c]	1983	0.00768	0.925 (0.366)
Nevşehir	7	15.383	1992	0.00212	3.043 (0.007)[c]
Ordu	4	7.256	1983	-0.01482	-1.654 (0.112)
Sinop	7	20.482[b]	1989	-0.00227	-3.464 (0.003)[c]
Sivas	5	12.946	1988	0.00411	8.824 (0.000)[c]
SMH	5	26.782[c]	1985	0.10391	7.538 (0.000)[c]
Zonguldak	1	5.949[a]	1983	0.00446	2.439 (0.022)[b]

Notes:

1. The figures in parentheses are the p-values. For t_{OLS}, they have been calculated using the t distribution.
2. The critical values for the Max W statistic are from Andrews (1993), Table 1 and refer to a trimming factor of 0.35.

k	0.10	0.05	0.01
1	5.59	7.05	10.53
2	8.06	9.67	13.63
3	10.16	12.05	15.71
4	12.10	14.12	18.54
5	13.86	15.93	19.19
6	15.56	17.75	22.23
7	17.09	19.34	24.10

[a] Significant at the 10 percent level
[b] Significant at the 5 percent level
[c] Significant at the 1 percent level

we chose the trimming factor to be 34% of the sample. A smaller factor would not have allowed us to estimate the equations with polynomials of degree 7. Hence, the critical values from Andrews (1993) reported in these tables correspond to a trimming factor of 0.35. We further note that only Adana, Hatay, Ordu and Sinop show a decrease in the average rate of convergence after their respective shift dates. The largest decrease is in the convergence rates of Hatay and Ordu, after 1987 and 1983, respectively. The majority of the provinces show an increase in the average rates of convergence. The highest increases are exhibited by SMH (10.4%) and Kahramanmaraş (0.11%).

Table 5					
Tests of Structural Shift and Shift in the Slope Function for Provinces Converging Regionally					
	k	**Max-W**	**Date of Break**	**Shift in Average Slope**	t_{OLS}
Mediterranean					
Burdur	4	21.915[c]	1991	0.00021	0.874 (0.391)
Kahramanmaraş	3	8.510	1988	-0.00096	-2.064 (0.050)[a]
Mersin	7	168.990[c]	1983	0.00746	1.034 (0.314)
Southeast Anatolia					
Adıyaman	4	27.396[c]	1991	0.00472	3.591 (0.002)[c]
Dıyarbakır	4	64.814[c]	1989	0.00022	1.624 (0.119)
Gaziantep	5	20.814[c]	1986	0.00689	5.340 (0.000)[c]
SMH	5	50.238[c]	1985	0.00976	3.202 (0.004)[c]
Central Anatolia					
Ankara	5	20.111[c]	1988	-0.00048	-4.779 (0.000)[c]
Aegean					
Denizli	5	7.303	1991	0.00242	5.701 (0.000)[c]
İzmir	7	85.429[c]	1984	0.00153	1.359 (0.190)
Muğla	2	10.966	1983	-0.00192	-3.228 (0.004)[c]
Black Sea					
Ordu	4	5.927	1983	-0.01261	-2.597 (0.017)[b]
Rize	1	2.050	1989	-0.00138	-1.432 (0.165)
Sinop	5	34.847[c]	1984	0.00097	1.444 (0.163)
Zonguldak	5	119.820[c]	1988	-0.00283	-4.764 (0.000)[c]
Marmora					
Bilecik	2	11.650[b]	1984	-0.00517	-4.907 (0.000)[c]
Bursa	6	24.878[c]	1986	0.00301	2.919 (0.009)[c]
Çanakkale	5	12.816	1983	0.00282	1.006 (0.325)
İstanbul	2	3.237	1987	-0.00041	-7.658 (0.000)[c]
Kırklareli	7	51.608[c]	1988	0.00002	0.055 (0.956)
Sakarya	5	49.930[c]	1988	0.00363	4.381 (0.000)[c]
Tekirdağ	3	9.473	1984	-0.00833	-3.579 (0.000)[c]

Notes:

3. The figures in parentheses are the p-values. For t_{OLS}, they have been calculated using the t distribution.
4. The critical values for the Max W statistic are from Andrews (1993), Table 1 and refers to a trimming factor of 0.35.

k	0.10	0.05	0.01
1	5.59	7.05	10.53
2	8.06	9.67	13.63
3	10.16	12.05	15.71
4	12.10	14.12	18.54
5	13.86	15.93	19.19
6	15.56	17.75	22.23
7	17.09	19.34	24.10

[a] Significant at the 10 percent level
[b] Significant at the 5 percent level
[c] Significant at the 1 percent level

Table 5 contains the results for the provinces showing regional convergence. We note that in the regions that we regard as having the highest likelihood of forming convergence clubs, all provinces in Southeast Anatolia and four provinces in the Marmora region show

significant structural shifts. In Southeast Anatolia, three of these provinces (Adıyaman, Gaziantep and SMH) exhibit significant increases in average convergence rates. On the other hand, of the four provinces in the Marmora region, Bursa and Sakarya show significant increases in their rates of convergence while Bilecik shows a significant decrease. Kırklareli shows a very low increase in its average convergence rate which is also statistically insignificant. On the other hand, İstanbul and Tekirdağ, which do not have significant Max-W statistics, nevertheless show significant decreases in their average rates of convergence.

5. Conclusions

We investigated the absolute or unconditional convergence of the geographical regions and provinces of Turkey using a time series approach which involved testing if the squares of the differences of regional and provincial per capita incomes from a target income, which is national and regional per capita incomes for the provinces, had significant negative average slopes when regressed on polynomials in time, and whether there were structural shifts in these slopes. Our findings are as follows.

1. Only the Marmora region shows absolute convergence when OLS results are used; Central Anatolia also becomes convergent when a SUR system is estimated. The average rates of convergence are not very high, however. Both regions exhibit structural instability and their average rates of convergence are significantly different between the two subperiods.

2. The number of provinces that nationally converge unconditionally is 14 out of 65 , which, of course, hardly constitutes evidence that there is absolute convergence of the provinces of Turkey. The picture is not any different regarding conditional convergence based on the CADF results. The number of provinces that show conditional convergence is now 13 and only four of them also converge absolutely. This, of course, constitutes evidence in favour of using the Nahar-Inder approach, which argues that convergence may take place even when the difference series are nonstationary.

3. Most of these fourteen provinces exhibit structural shifts in both the polynomial specifications and the average convergence rates. Most of the significant changes in the average convergence rates are positive, indicating an increase in the speed of convergence after the shift dates.

4. The reason for the national nonconvergence of the majority of the provinces may either be because their per capita incomes, on the average, lie so much below the national per capita income level or because they have moved beyond it. The first point would work for those nonconvergent provinces in the East Anatolia, Southeast Anatolia and Black Sea

regions, but the reason none of the provinces in the Aegean region and number of those, like Kocaeli, in the Marmora region may be the second point. We intend to take a closer look at this aspect of our results in future work.

5. The results obtained for the convergence within regions point to the possible formation of convergence clubs. This can be observed for the Central Anatolia, Mediterranean and Black Sea regions when the conditional convergence results are considered, but is more pronounced in the light of the absolute convergence results. In the latter case, the majority of the provinces in Southeast Anatolia and the Marmora regions converge so that one may consider the existence of convergence clubs in two extreme locations of Turkey; one, in a less, if not the least, developed region and the other, the most developed and industrialized region. Almost all provinces in both regions show significant structural shifts and their average convergence rates appear to be increasing.

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