NON-LINEAR REGIONAL INCOME DIVERGENCE AND POLICIES: TURKEY CASE

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Abstract

The literature on economic convergence is strongly influenced by Neo-Classical Growth model. It describes a monotone saddle path along which each economy converges towards a unique steady state. Commonly employed method in convergence analysis is the linear cross-sectional regressions which links the annual growth rate of regions to their initial income level. Ignoring the non-linearities is important from a policy perspective that implications obtained from a linear regression can be very different to the policies learned from a non-linear case. Aim of the present study is to analyze regional income convergence in Turkey by using nonparametric convergence regressions. We implement our study for 67 provinces and a period 1975-2000. We find that the relationship between initial income and growth takes a inverted-U shape which means that the very low-income and high-income group of provinces experince a slow growth pattern compared to middle-income group. This has several implications for regional economic policies. First, middle-income provinces are able to stimulate their economies and fulfill their potential for convergence by market forces. Second, however, the very low-income provinces need a substantial help and assistance.It, therefore, becomes a natural necessity to direct policy instruments such as subsidies, direct and indirect income transfers, tax exemptions and other resources to these areas. In this way, nonparametric estimations provide a very useful guide to the way how the resources should be allocated across provinces.

Keywords: Convergence, nonparametric regressions, Regional Policies
JEL classification: R11, R12

1. Introduction

The literature on economic convergence is strongly influenced by Neo-Classical Growth model. (Solow, 1956; Barro, and Sala-i Martin, 1991;1992). It describes a monotone saddle path along which each economy converges towards a unique steady state (Solow, 1965; Barro and Sala-i Martin, 1991;1992) . At the steady state, each economy will have an equalized level of per capita income (Solow, 1965; Barro and Sala-i Martin, 1991;1992). From a regional perspective, convergence process is present only if initially poorer regions experience higher growth rates than richer ones. (Barro and Sala-i Martin, 1991;1992). This catch-up proposition has been tested by a large number of empirical studies. The most famous ones are implemented by Barro and Sala-i Martin (1991) who examine the regional convergence across 48 contigous U.S. states from 1880 to 1988 , Rey and Montouri (1999) across 48 States over a period 1929-1994, Armstrong (1995) across EU regions for a period 1950-1990, Mankiw et al. (1992) across 121 countries over a period 1960-1985. All have reported evidence in favor of converging patterns except Mankiw et al. (1992).

From a methodological point of view, commonly employed tool is the cross-sectional regressions in this field. In detail, it links the annual growth rate of regions to their initial income level (Barro and Sala-i Martin, 1991;1992). This is known as beta-convergence in terminology. A negative (positive) relationship indicates the presence of income convergence (divergence) (Barro and Sala-i Martin, 1991;1992).

So far, in the literature, this relationship is assumed as parametric and linear in variables. Ignoring the non-linearities, however, creates two major drawbacks. First, convergence speed found in linear form can be excessively lower or higher than the non-linear form. In such a

case, speed of "convergence" can be overly or underestimated. Second drawback is related to regional policies. The policy implications obtained from a linear model can be very different to the policy lessons learned from a non-linear case.

Therefore, in this study, we find it valuable to investigate the possible non-linearities in convergence (or divergence) processes. Aim of the present study is to analyze this issue for 67 Turkish provinces for a period 1975-2000 and understand how non-linearity can significantly alter the policy implications.

With regard to our place for study, Turkey is a very interesting case among others. It includes large spatial and economic imbalances. A number of studies on regional income inequalities and convergence has been implemented over the last few decades Their findings in general point to the lack of convergence and highly persistent regional inequalities between east and west part of the country.

There are number of empirical papers that evaluate the regional convergence in Turkey. Filiztekin (1999), for instance, has analyzed the convergence patterns among Turkish provinces from 1975 to 1995 and found a persistent pattern of inequalities with a club convergence and polarization. Karaca (2004) has analyzed the same issue for Turkish provinces for a period 1975-2000 and found evidence of diverging regional incomes. Kırdar and Sirinoglu (2006;2008) has found divergence among 67 provinces for a period 1975-2000. Similarly, Gezici and Hewings (2007) point to an increase in interregional disparities from 1980 to 1997. Finally, Yıldırım et. al. (2009) have investigated the evolution of disparities across regions (NUTSI and NUTSII) and reported evidence of declining inequalities from 1987 to 2001.

A number of reasons behind the observed inequalities and divergence patterns in Turkey were discussed in the literature. Liberal economic policies during 1980s and 1990s are claimed to favor the already developed urban areas (i.e. metropolitan cities) while leaving the rural and backward regions unfavoured (Gezici and Hewings, 2007, Yıldırım et al. 2006;2009, Karaca, 2004; Filiztekin, 1999). Intensity of trade openess and massive financial liberalization in recent decades are claimed to create several growth poles which has led to the further widenning of the gap between poor and rich areas. Cohesion policies, such as five-year development plans and subsidy programs targeting the priority places in development have been in force since the 1960s which are often criticised to be inadequate to maintain economic and territorial equality (Gezici and Hewings, 2007, Yıldırım et al. 2006;2009, Karaca, 2004; Filiztekin, 1999). Moreover, migration patterns can also be referred as an important factor behind divergence as the backward regions loose their human capital base through the out-migration (Kırdar and Sirinoglu (2008)).

Structural problems of underdeveloped regions such as lack of developed infrastructure, inadequacy of human and physical capital are among the reasons of backwardness (Gezici and Hewings, 2007, Yıldırım et al. 2006;2009, Karaca, 2004; Filiztekin, 1999)

With regard to the methdology adopted in this paper, we employ various parametric and non-parametric regressions such as LOESS (Cleveland, 1979; 1981, Cleveland and Devlin, 1988) Kernel Regressions, Nadaraya-Watson (Nadaraya, 1964; Watson, 1964) and Local Polynomial Regressions (Fan and Gijbels (1996))

Remaining part of the paper is organized in a following way: in section 2, we adopt a linear framework to test the absolute beta and sigma-convergence. in section 3, we introduce nonlinearity in regressions. Finally, we conclude our study in section 4.

2. Regional convergence tests, linear model.

The first step in our empirical analysis is to choose a variable of interest . It is per capita real GDP for 67 provinces. The dataset used in this paper has been obtained from Kasman and Turgutlu (2009) and Karaca (2004) who constructed it using resources from Özötün (1980;1988) SPO (State Planning Organization) and Turkstat (Turkish Statistical Institute).

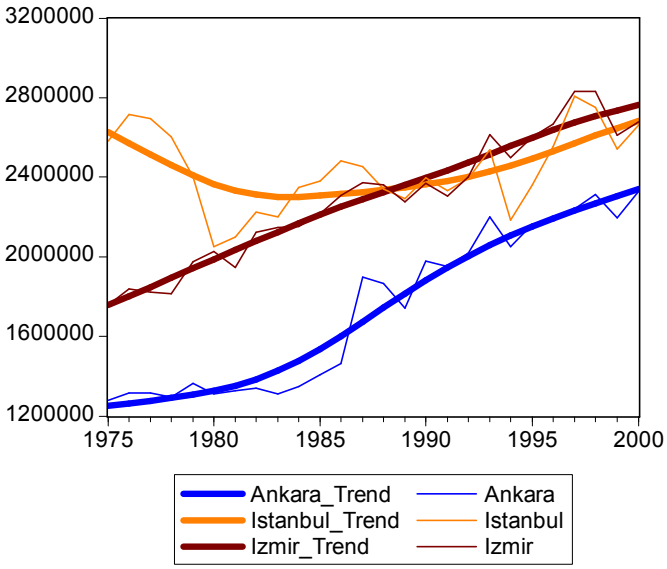
Before starting our convergence analysis, a technical concern should be cleared. In general, per capita incomes are subject to business cycle fluctuations in the short-run which might significantly bias the long-run convergence results. This distortion has been clearly shown in Magrini et al. (2015) and Gerolimetto and Magrini (2014). To handle this, we apply a Hodrick-Prescott (1997) (HP) filtering to 67 provincial incomes which removes the cyclical fluctuations and focus solely on the long-term trend.

In detail, let y be the income, then HP filter minimizes the following term with respect to long term trend of the variable (τ) (Hodrick-Prescott, 1997; Duran, 2014):

$$\min \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} \left[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1}) \right]^2$$

The first component shows the deviations of income from its trend while second part demonstrates the variation of trend in time. λ is the penalty parameter which determines the degree of trend smoothness. We set λ=100 as commonly accepted in the literature. As an example, we present graphically the provincial income and trends of 3 biggest cities which cover approaximately 1/3 of country's population. The HP filtered long term trend of incomes $(\hat{y})$ are depicted in smoothed thick lines where fluctuating ones are the actual incomes (Figure 1).

Figure 1. Income trends of 3 biggest provinces



In order to test the regional income convergence, we follow the conventional regression equation (Barro and Sala-i Martin 1991; 1992):

$$\frac{1}{T}\log\left(\frac{\hat{y}_{i,2000}}{\hat{y}_{i,1975}}\right) = \gamma - \left(\frac{1-e^{-\beta t}}{T}\right)\log \hat{y}_{i,1975} + e_i \quad (1)$$

in which β is commonly estimated using a nonlinear least squares approach in the literature (Karaca, 2004; Ersungur and Polat, 2006; Kırdar and Sirinoglu, 2006;2008). However, the result of equation (1) produces only a unique parameter β and, thus, it gives us a linear relationship between initial income and growth, although the estimation procedure is nonlinear. To illustrate the nonlinearity explicitly, we follow a nonparametric regression approach in section 2.

However, for the linear case, we use a simplified version of equation (1)

$$\log\left(\frac{\hat{y}_{i,2000}}{\hat{y}_{i,1975}}\right) = \delta + \rho \log \hat{y}_{i,1975} + e_i \quad (2)$$

The independent variable $\hat{y}_{i,1975}$ is the trend-income (logged) of province i at year 1975 (initial year). The dependent variable is the growth rate of provinces, logged differences of per capita trend -income between year 2000 and 1975. e_i is the error term that is assumed to follow an independent, identical normal distribution with zero mean and constant variance. Hence, a negative (positive) and significant estimation of β would indicate the evidence of converging (diverging) provincial incomes.

Table 1. Beta-convergence Regression Results

	model (1)	model (2)	model (3)	Model (4)
constant	-0.84	-0.80	-1.27*	-1.10
log_yt	0.17*	0.196*	0.236*	0.215*
log_pop		-0.033	0.009	0.0015
d_istanbul			-0.295***	
d_three				-0.09
R_Squared	0.05	0.06	0.12	0.07
F_Stat	3.75*	1.98	2.83**	1.63
White	2.34	4.09***	2.62**	2.84**
Breuch-Godfrey	0.68	0.60	1.30	1.01
N	67	67	67	67

Notes: *** significance at 1%, ** at 5 %, * at 10 %, in models (2), (3),(4), White-heteroskedasticity robust standard errors are used.

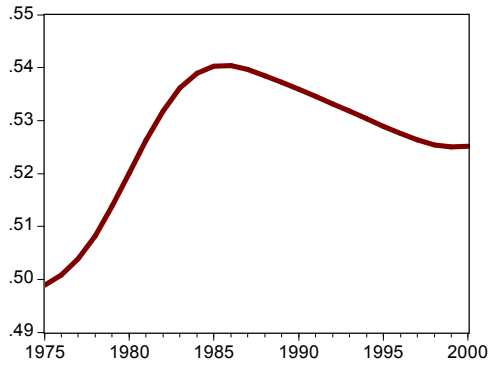
The results are summarized in table 1. In the first column, equation (1) is fitted, in the second, third and fourth columns, population of provinces, dummies for istanbul and three biggest provinces are added respectively. In all cases, β is positive and significant. So, it indicates evidence of income divergence, hence, increasing disparities across provinces.

To support this finding, we analyze the validity of divergence using also a time series approach; sigma-convergence. We calculate coefficient of variation (CV) across 67 provinces:

$$CV = \frac{\sigma(\bar{y})}{\bar{y}}$$

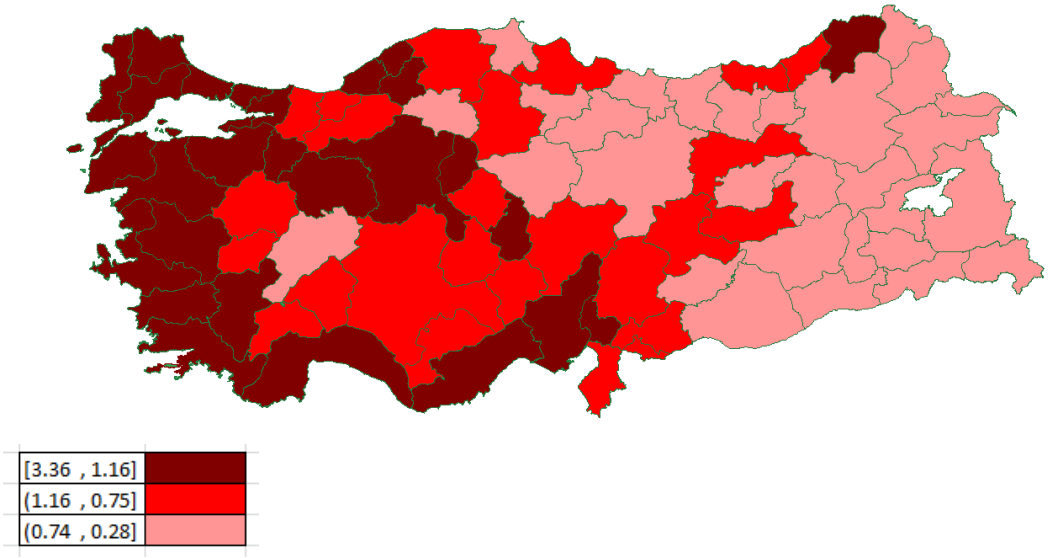
which CV is calculated by dividing cross-sectional standard deviation of income $\sigma(\bar{y})$ into its mean, $\bar{y}$. We calculate CV for each year. Its evolution is presented in Figure 2. It follows a very clear upward trend until the late 1980s and a small decline afterwards. It therefore respresent a confirmation of income divergence found in beta-convergence analysis.

Figure 2. Coefficient of Variation, Evolution of income disparities



To illustrate the geographical distribution of income over time, we map the relative incomes (averaged over the period 1975-2000) of provinces by categorising them into 3 sub-groups (high-medium and low incomes) (Figure 3):

Figure 3. Geographical Distribution of relative income, average=1



A very important feature appears to emerge from the map. It is the severity of income gap between low and high income group. Such that the richest province has real relative income 3.36 times more than an average province. Moreover, the poorest province has only 20 % of income relative to an average province.So, the richest has real income about 11 times more than the poorest one which indicates a dramatic imbalances across regions.

3. Non-linear convergence patterns

As anticipated, introducing the nonlinearities might give quite different implications than the linear case. Hence, we pursue this analysis in the present section.

In terms of methdology, we use several non-parametric fitting techniques. For all techniques, the following function is estimated:

$$\log\left(\frac{\hat{y}_{i,2000}}{\hat{y}_{i,1975}}\right) = F\left(\log \hat{y}_{i,1975}\right) + u_i$$

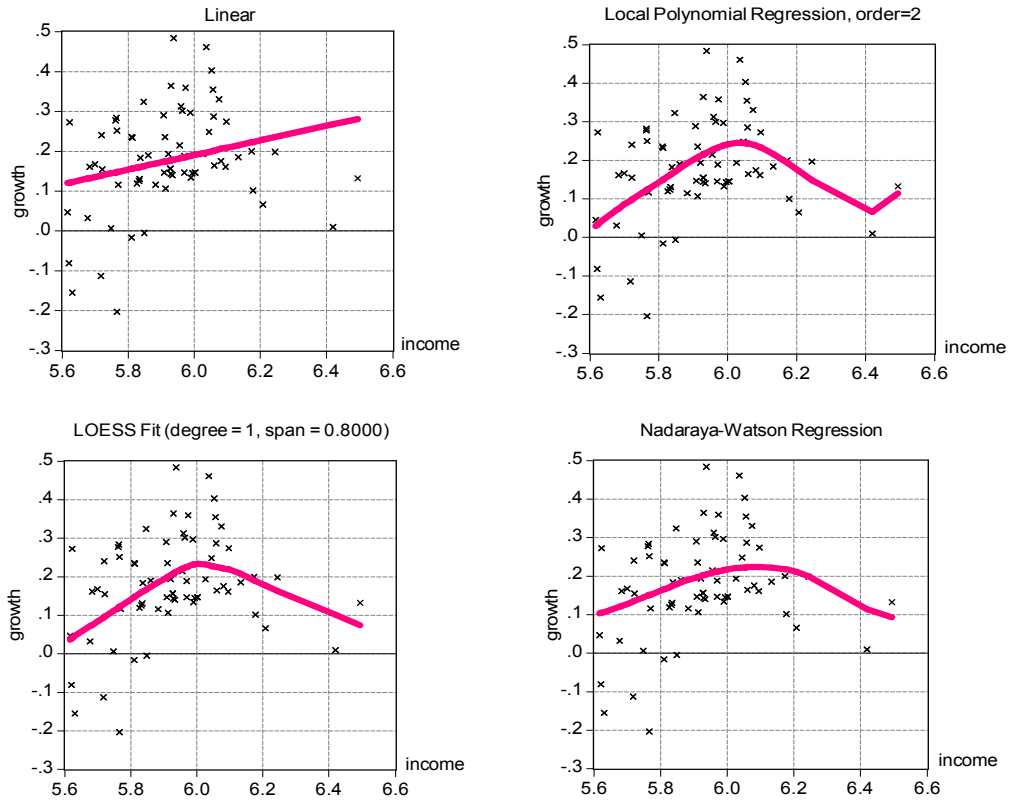
Specifically, we employ the following fitting techniques; linear regression, LOESS nonparametric regression, local polynomial regression of second order and Nadaraya-Watson regression which is a type of Kernel regression. (Cleveland, 1979; 1981, Cleveland and Devlin, 1988; Nadaraya, 1964; Watson, 1964; Fan and Gijbels,1996). The estimations are presented in Figure 4.

Linear case exhibits a clear positive relationship, as found before. However, in others, the relationship between initial income and growth takes a inverted-U shape. This bell shaped relationship is consistently present in all nonparametric estimations

It basically means that the low-income and high-income group of provinces experince a slow growth pattern compared to middle-income group which seem to grow quite fast. This has several implications for regional economic policies.

First, middle-income provinces are able to stimulate their economies and fulfill their potential for convergence by market forces. Hence, additional resources shall not be directed to these areas.

Figure 4. Nonparametric Convergence Regression Results



Second, however, the very low-income provinces need a substantial help and assistance.It, therefore, becomes a natural necessity to direct policy instruments such as subsidies, direct and indirect income transfers, tax exemptions and other resources to these areas. Moreover, structural problems of these backward regions should also be solved by improving the physical and social infrastructure, health, education, physical and social capital formation.

In this way, nonparametric estimations provide a very useful guide to the way how the resources should be allocated across provinces which contrasts with the linear case.

4. Conclusions

This paper has investigated the tendency of provincial inequalities in Turkey and importance of nonlinearities in the divergence process. In terms of methodology, we used both a cross sectional linear model, a time series approach and non parametric regressions.

The study reaches to two important conclusions. First, income disparities across provinces tend to intensify over the period 1975-2000 which indicates a long run divergence pattern. This finding has been robustly shown with a cross sectional (beta-convergence) and a time series method (sigma-convergence).

Second, once we introduce the nonlinearities in regressions, an inverted-U shaped relationship between intial income and growth rate of provinces is observed. Hence, it implies that middle-income provinces are growing at the fastest pace while the very poor and rich ones grow slower.

Overall, it has been clearly shown that nonlinear pattern can significantly change the policy implications compared to the linear case. According to this, additional public sources like subsidies, tax exemptions, direct and indirect transfers, should be directed to the very-underdeveloped areas instead of middle income places which will help maintaining social and territorial cohesion.

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