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IS THERE AN INCOME CONVERGENCE ACROSS PROVINCES OF TURKEY?

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IS THERE AN INCOME CONVERGENCE ACROSS PROVINCES OF TURKEY?

Sumru Öz*

May 24, 2017

Abstract

In this paper, whether there is a convergence of per capita incomes across Turkish provinces during 2004-2014 period is examined following the availability of per capita incomes of Turkish provinces for this period as of December 2016. Considering that firms and households of different regions within a country tend to have access to similar technologies, share a common central government, therefore have similar institutional setups and legal systems, and they can be assumed to have roughly similar tastes and cultures, absolute income convergence is expected to hold across regions of a country. The results of the nonlinear least squares regression show that the absolute convergence across 81 Turkish provinces, which is estimated as 1.2 per cent per year, is lower than those estimated for the US states, Japan prefectures, and the members of the EU. However, once a proxy for human capital is included besides the initial level of per capita income as a second explanatory variable in the regression equation, the speed of convergence increases to 2.2 per cent per year. This implies that once the differences in educational attainment across Turkish provinces are held constant, there exists conditional income convergence of similar magnitude found in studies on convergence across regions of other economies. Taking into consideration the evidence that the attitude towards, especially girls' education differs to a large extent between eastern and western regions of Turkey, the same regressions are repeated for 41 western and 40 eastern provinces, separately. The results show that the estimated conditional convergence reaches as high as 4 per cent across eastern provinces, while it is around 2 per cent across western provinces once the human capital is controlled for. This result implies that an effort to change attitude towards education in eastern Turkey is critical in increasing the speed of convergence, thus reducing income inequality across Turkish provinces.

Keywords: Growth, Output Convergence, Human Capital, Turkey

JEL classifications: O15, O18, O47

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1 Introduction

Measuring per capita income convergence across countries is important in order to assess whether developing economies tend to catch up with developed ones, thus help reduce global inequality. The neoclassical theory of growth predicts absolute income convergence across countries, i.e. poorer economies grow faster than rich ones, due to the diminishing returns to capital. However, the subsequent empirical research showed that neoclassical growth model could not explain totally the observed differences in growth across countries. On the one hand, there is evidence of a considerable convergence across, e.g. twenty original OECD (Organization for Economic Cooperation and Development) members, especially during the postwar period and a catching-up of some East Asian countries in recent decades. But on the other hand, income divergence, or at best, non-convergence, appears to characterize the behavior of most cross-country variation in income per person when the analysis is broadened to include a wider spectrum of countries. Many poor countries, particularly those in Sub-Saharan Africa, not only fail to grow faster than the rich countries, they, in fact, experience negative per capita growth. Therefore the gap between these countries and the rich ones widens more.

Since the central prediction of the neoclassical growth model that all countries would converge towards the same level of productivity, was not borne out by the facts, decades-long effort has been exerted, ending up with the new growth models pioneered by Romer (1986, 1990) and Lucas (1988). The studies on the new growth theory view commercially oriented innovation efforts that respond to economic incentives as the major engine of technological progress and growth. In this view, innovation feeds on knowledge that results from cumulative R&D experience on the one hand, and it contributes to this stock of knowledge on the other. Consequently an economy's growth depends on its cumulative R&D effort and on its effective stock of knowledge, with the two feeding each other. These models provide a convincing explanation for the per capita income divergence observed across a wide range of countries by emphasizing the importance of technological progress as the main source of output expansion in contrast to the neoclassical theory of growth, which assumes that technology is a public good, i.e. something available to everyone everywhere free of charge. According to the new growth theory, anything that enhances the technological level of a country, such as investing in education, R&D efforts, openness, and all government policies that support these, are important determinants of growth rate.

Considering that absolute convergence does not hold across wider spectrum of countries and benefiting from the literature on new growth theory, Barro and Sala-i-Martin (1992) introduce the notion of conditional convergence. According to this notion, countries differ in their long run per capita income levels and each country tends to grow more rapidly the greater is the gap between its initial and its own long-run per capita income levels. The long-run per capita income level of each country is assumed to be a function of certain structural variables, such as human capital, government policies, institutions, and other variables first mentioned by the new growth literature. Once these variables are accounted for, there appears to be a strong evidence of convergence even across wider spectrum of countries. Accordingly, conditional convergence predicts that an economy that starts out proportionately further below its own steady-state position tends to grow faster (Barro and Sala-i-Martin, 1995), where the own steady-state is determined by preferences, institu-

tions, technologies, etc. This implies that countries with similar preferences, technologies, and institutions converge to the same steady-state level. Therefore, the evidence for the absolute convergence found across the twenty original members of the OECD during the post-World War II period can be explained by the notion of conditional convergence. Relatively poor OECD countries grew faster than rich ones so that income differentials are found to lessen through time without taking into account any explanatory variable other than the initial level of the per capita income, because these countries are similar with respect to preferences, technologies, and institutions.

Barro and Sala-i-Martin (1992) demonstrate that absolute convergence also holds across U.S. states, which are even more homogenous relative to OECD members, at least during sub-periods of no major structural changes, such as the Great Depression and oil price hikes. The first reason is that firms and households of different regions within a country tend to have access to similar technologies. Second, the regions of a country share a common central government and therefore have similar institutional setups and legal systems. Finally, they can be assumed to have roughly similar tastes and cultures. This relative homogeneity implies that absolute convergence is more likely to apply across regions within countries than across countries. Barro and Sala-i-Martin (1995) test absolute convergence not only across different states within US but also across Japan prefectures and regions within the EU. The results indicate that there is absolute convergence within each economy, for the period 1930-90 in case of Japan and 1950-80 for EU. Furthermore, they find similar speeds of convergence across regions within each of these economies, which is around 2 per cent per year.

In this paper, whether there is convergence of per capita income across Turkish provinces during 2004-2014 period is examined following the availability of per capita incomes of Turkish provinces for this period as of December 2016. The results show that the absolute convergence between Turkish provinces, which is estimated as 1.2 per cent is lower than those estimated for the US states, Japan prefectures, and the members of the EU. However, once a proxy for human capital is included besides the initial level of the per capita income as a second explanatory variable in the regression equation, the speed of convergence increases to 2.2 per cent per year. This implies that once the differences in educational attainment across Turkish provinces are held constant, there exists conditional convergence of similar magnitude found in cross sectional studies on other economies. The rest of the paper is organized as follows: The next section describes the notion of convergence, its theoretical background, and how to estimate the speed of convergence, while Section 3 presents data and the methodology. The estimated speeds convergence values for different specifications are given in Section 4 and Section 5 concludes.

2 Estimating the Speed of Convergence

Two concepts of convergence across countries or regions are discussed in this paper. The first one is called the absolute β -convergence and applies if a poor economy tends to grow faster than rich one, so that the poor country tends to catch up with the rich one in terms of the level of per capita income without taking into account any explanatory variable other than the initial level of the per capita income. The second concept, termed as condi-

tional β -convergence, considers variables first put forward by the new growth theory, such as technological level, R&D efforts, openness, educational attainment, and government policies besides the initial level of income while estimating the speed of convergence.

Absolute β -convergence: In the neoclassical growth model as laid out by Solow at the beginning of 1950s, the productivity growth results from increases in the amount of capital that each worker is set to operate. As capital per worker increases, the marginal productivity of capital declines, and with it the scope for further increases in the capital-labor ratio. Ultimately, the capital-labor ratio approaches a constant, and the productivity growth ceases. The only factor left within this framework that can explain differences in per capita growth across countries is transitional dynamics. Since initial conditions generally differ, countries may grow at different rates in the process towards long-run equilibrium. Specifically, countries where capital is scarce compared to labor, i.e. where the capital-labor ratio is low, are expected to have a higher rate of profit on capital, a higher rate of capital accumulation, and higher per capita growth. To the extent that capital is internationally mobile and moves to the countries where returns to capital are higher, this tendency should be considerably strengthened. Therefore, the gap in income levels of rich and poor countries is expected to narrow and ultimately disappear, which is called as absolute convergence. In the neoclassical growth framework, the speed of convergence is estimated as follows:

Starting from the Cobb-Douglas production function of the form

$$Y = AK^\alpha(L)^{1-\alpha}, \quad (1)$$

where K is capital, L is labor, $A > 0$ is the level of technology, and α is a constant with $0 < \alpha < 1$, the log linearized per capita income, y , expanded around the steady-state position is derived in Appendix 2A of Barro and Sala-i-Martin (1995) as

$$\log[\hat{y}(t)] = \exp^{-\beta t} \log[\hat{y}(0)] + (1 - \exp^{-\beta t}) \log(\hat{y}^*), \quad (2)$$

where $\beta > 0$. For any $t \geq 0$, $\log[\hat{y}(t)]$ is a weighted average of the initial and steady-state values, $\log[\hat{y}(0)]$ and $\log(\hat{y}^*)$, respectively, with the weight on the initial value declining exponentially at the rate β . The Equation 2 can be used to estimate the speed of convergence across a group of countries or regions between an initial time 0 and time T, such that

$$\log[y_i(T)] = (1 - \exp^{-\beta T}) \log[y_i^*] + \exp^{-\beta T} \log[y_i(0)], \quad (3)$$

where the added subscript i denotes the country or region. Subtracting the log of initial per capita income, $\log[y_i(0)]$, from both sides of the equation and dividing by the time period, T, to obtain the growth rate of y_i on the left-hand side of the equation, results in;

$$(1/T) \{ \log[y_i(T)] - \log[y_i(0)] \} = (1/T) \{ (1 - \exp^{-\beta T}) \log[y_i^*] + \exp^{-\beta T} \log[y_i(0)] - \log[y_i(0)] \} \quad (4)$$

Using some simple algebra yields,

$$(1/T) \{ \log[y_i(T)] - \log[y_i(0)] \} = [(1 - \exp^{-\beta t})/T] \log[y_i^*] - [(1 - \exp^{-\beta t})/T] \log[y_i(0)] \quad (5)$$

By definition, the left-hand side of the Equation 5 is the growth rate of y_i . Since absolute convergence implies that the steady-state value of income, y_i^* , is the same for all countries or regions, the first term in the right-hand side of the equation is a constant. So, Equation 5 can be written as:

$$(1/T) \{ \log[y_i(T)] - \log[y_i(0)] \} = a - [(1 - \exp^{-\beta t})/T] \log[y_i(0)], \quad (6)$$

where the intercept, $a \equiv [(1 - \exp^{-\beta t})/T] \log[y^*]$ and β is the speed of absolute convergence.

Conditional β -convergence: As the central prediction of neoclassical growth theory that all countries would converge towards the same level of productivity -no matter what their characteristics are- proved to be an illusion, two extensions of neoclassical growth model are proposed, which claim that technology, innovation, R&D, and human capital are not as important in economic growth as emphasized by the new growth theory. They argue that the neoclassical growth model, with exogenous technological progress and diminishing returns to capital, explains most of the cross-country variation in output per person: one by incorporating human capital into the production function, the other by controlling for a number of structural and policy variables. The first one is the augmented Solow growth model by Mankiw et al. (1992), where the usual two factor neoclassical model of Equation 1 is extended to include a measure for human capital such that

$$Y = K^\alpha H^\beta (AL)^{1-\alpha-\beta}, \quad (7)$$

where $\alpha + \beta < 1$. Starting from the production function of Equation 7, Mankiw et al. (1992) argue that they are able to explain 80 percent of the international variation in income per capita empirically. They use the fraction of the working age population that attended secondary school as a measure of the rate of investment in human capital and find evidence for convergence in standards of living with their augmented Solow model holding population growth and capital accumulation constant. However, Nelson and Phelps (1966) stated long ago that the straightforward insertion of some index of educational attainment in the production function might constitute a gross misspecification of the relationship between education and the dynamics of production. Indeed, human capital accumulation fails to enter significantly in the determination of economic growth when Benhabib and Spiegel (1994) run the specification implied by a standard Cobb-Douglas production function, which includes human capital as a factor. Instead, human capital is found to affect the growth of total factor productivity through two mechanisms: first by influencing the rate of domestically produced technological innovation, and second, by affecting the speed of adoption of technology from abroad. Eaton and Tamura (1996) approve the conclusion that human capital contributes to productivity of countries by facilitating the adoption of new technology rather than by serving as a standard factor of production.

The second extension of the neoclassical growth model is the notion of conditional convergence introduced by Barro and Sala-i-Martin (1992) as a result of an empirical analysis. They first check whether there has been an absolute convergence across a wide spectrum of 98 countries from 1960 to 1985, using Equation 6 as the regression equation, where the dependent variable is the growth rate of real per capita GDP and the independent variables are a constant and the log of 1960 per capita GDP. The main finding of the regression is the lack of a close relationship between the growth rate and the log of 1960 per capita GDP. In fact, the convergence coefficient, β , has the wrong sign; i.e. there is a small tendency for the initially rich countries to grow faster than the poor ones between 1960 and 1985. However, once some other variables, such as primary and secondary school enrollment rates in 1960, the average ratio of government consumption expenditure to GDP from 1970 to 1985, proxies for political stability, and a measure of market distortions based on purchasing power parity ratios for investment goods, are held constant, they are able to find a significantly negative partial relationship between the per capita growth rate from 1960 to 1985 and log of 1960 per capita GDP. This finding implies conditional convergence, i.e. a negative relationship between the log of initial per capita GDP and subsequent growth rate as stated by neoclassical growth model, only if the steady-state position and the steady-state growth rate are held constant. These long-run steady-state values, in a sample of 98 countries, likely feature large differences. Therefore, conditional convergence considers that countries may differ in their long run per capita income levels and argues that the greater the gap between a country's initial and long-run per capita income levels is, the more rapidly it grows. Long-run per capita income level of each country is determined by the underlying parameters of technology, preferences, natural resources, and government policies, which are in fact introduced by the new growth literature.

Relaxing the assumption related to the absolute convergence that long-run per capita income levels are the same for all countries, i.e. $y_i^* = y^*$, the conditional convergence notion of Barro and Sala-i-Martin (1995) takes into account the differences in y_i^* , the steady-state per capita income of each country, by adding “other variables” to the regression equation such that the Equation 6 becomes:

$$(1/T) \{ \log[y_i(T)] - \log[y_i(0)] \} = a + \text{“other variables”} - [(1 - \exp^{-\beta t})/T] \log[y_i(0)], \quad (8)$$

The “other variables” help to hold constant cross-sectional differences in the long-run values, such that the assumption $y_i^* = y^*$ holds for a wider spectrum of countries as well. Therefore, the conditional convergence allows for the heterogeneity across economies, especially by dropping the assumption that all economies have the same parameters, and therefore, the same steady-state positions. The main idea is that an economy grows faster in per capita terms, the farther it is from its own steady-state position. This line of thought is compatible with the implications of the new growth theory, especially those of the diffusion of technology models.¹ Indeed, as Romer (2001) states, running a regression conditioned on these variables and finding that countries with lower initial income grow more rapidly can be interpreted differently. Within the neoclassical model

¹See Oz (2016) for details.

with exogenously determined level of technology, which is identical across all countries, this finding can be interpreted as evidence of diminishing returns to physical capital or human capital. But it is also possible to interpret it as such: the technology is lower in the country that starts at a lower level of development and it grows faster as better technology diffuses there. Though Barro and Sala-i-Martin (1995) interpret their results related to absolute convergence across regions of certain economies as consistent with the neoclassical growth model considering that these regions have roughly similar tastes, technologies, and political institutions, they also accept that observed convergence is also consistent with diffusion of technology models of the new growth theory.

3 Data and the Methodology

Per capita income data of the provinces of Turkey are retrieved from the web site of the Turkish Statistical Institute (TUIK). The data, issued in December 12, 2016, cover the years 2004-2014, so the empirical analysis is done for this time period. The data issued in current prices are converted to 2004 prices using the regional price indexes at NUTS2 level (26 regions) for each province.

Considering that regions within a country are more homogeneous in terms of preferences, institutions, and technologies compared to different countries, as detailed in the previous section, the first specification in the regression analysis is based on the absolute convergence of Equation 6. The speed of absolute convergence across Turkish provinces is estimated using non-linear least squares² following Barro and Sala-i-Martin (1995) such that;

$$(1/T) \{ \log[y_i(T)] - \log[y_i(0)] \} = a - [(1 - \exp^{-\beta T})/T] \log[y_i(0)] + u_i(0, T), \quad (9)$$

where the intercept, $a \equiv [(1 - \exp^{-\beta T})/T] \log[y^*]$ and $y_i(0)$ is per capita income in province i at the beginning of the interval. Similarly, $y_i(T)$ is per capita income in province i at the end of the interval, T is the length of the interval, and β is the speed of absolute convergence, i.e. the catch up speed of the relatively poorer provinces to the richer ones in terms of the level of per capita income. $u_i(0, T)$ represents the average of error terms, u_{it} , between date 0 and T and is assumed to have 0 mean, variance σ_u^2 , and be distributed independently of $\log[y_i(0)]$.

The second specification is based on the conditional convergence Equation 8, which takes into account “other variables” besides the initial per capita income level. In general, the cross-country studies on conditional convergence, use the underlying parameters of technology, preferences, natural resources, and government policies as “other variables”. However, firms and households of different regions within a country have access to similar technologies and regions of a country share a common central government and therefore have similar institutional setups and legal systems. These facts leave only one assumption that can be relaxed: they have similar tastes and cultures. In fact, there is evidence that the attitude towards girls’ education between provinces of Turkey differs to a large

²The reason for using non-linear LS is explained in Barro and Sala-i-Martin (1995) Chapter 11.

extent. Tansel and Gungor (2012) state that there is a significant educational gender gap throughout Turkey. The smallest educational gender gap is observed in the developed regions such as Marmara and Aegean while the largest educational gender gap is observed in the region of Southeast and East Anatolia. Similarly, Nissan and Niroomand (2015) find that the female schooling is considerably larger for the developed as compared to the less developed provinces, signifying the effects of social and traditional forces in the treatment of women in different provinces in Turkey. These forces may result in important differences in the schooling choice, thus education level of each province in Turkey, implying that the assumption $y_i^* = y^*$ for all provinces may not hold. Thus, as proposed by Barro and Sala-i-Martin (1995), a variable reflecting human capital³ is used as the “other variables” in the Equation 8, so the Specification 2 is:

$$(1/T) \{ \log[y_i(T)] - \log[y_i(0)] \} = a + \text{“mean - schooling”} - [(1 - \exp^{-\beta t})/T] \log[y_i(0)] + u_i(0, T), \quad (10)$$

where “mean-schooling” is the weighted sum of the years passed at each educational degree such that (5,8,11,15,17,21) years of schooling are assumed for (Primary School, Primary Education, High and Vocational High School, University, Masters, and Doctorate), respectively. The weights are the ratio of population over 15 years of age and over who completed each degree.

A third specification is also used in this paper, where the percentage of population with education level at and above high school is used as the proxy for human capital instead of the “mean-schooling”, such that

$$(1/T) \{ \log[y_i(T)] - \log[y_i(0)] \} = a + \text{“high - and - above”} - [(1 - \exp^{-\beta t})/T] \log[y_i(0)] + u_i(0, T), \quad (11)$$

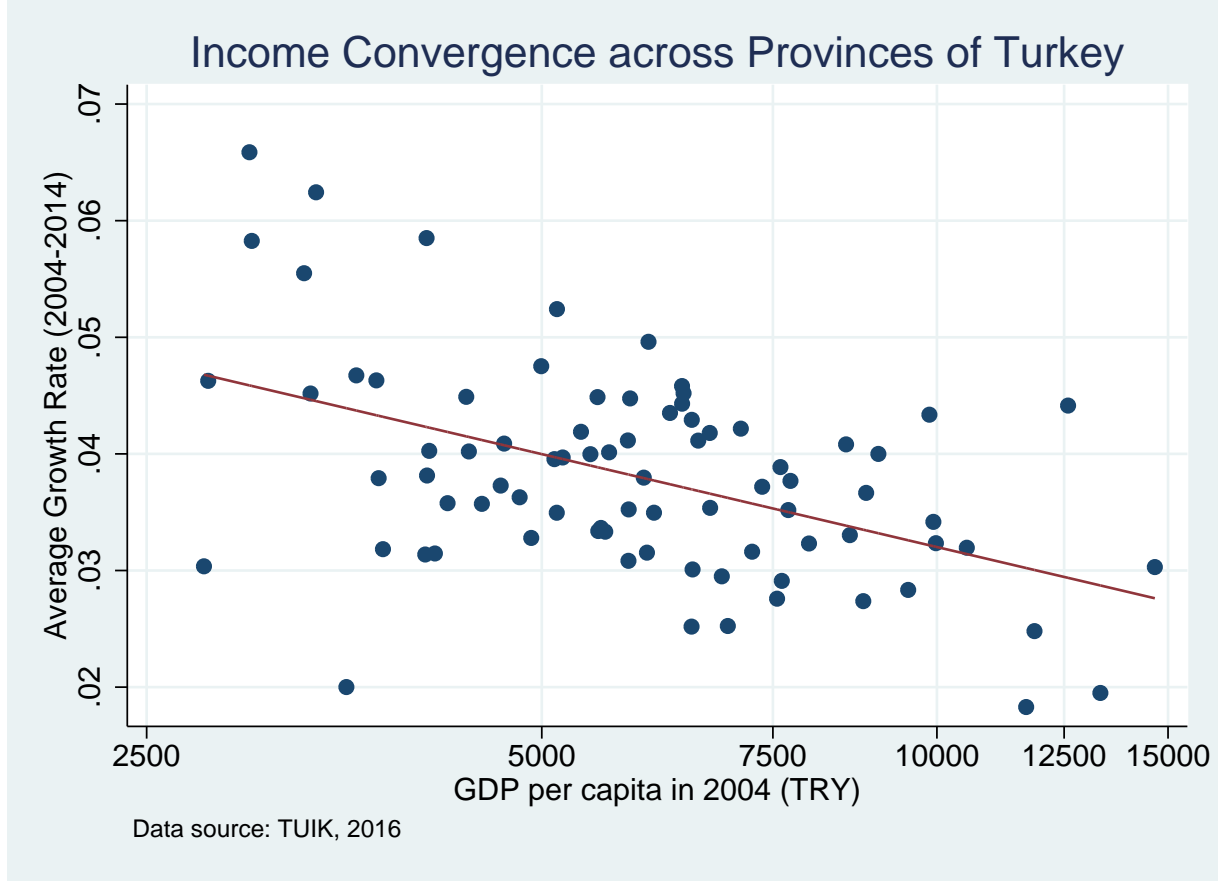
where “high-and-above” refers to the ratio of the population with 15 years of age and over who completed at least junior or vocational high school. The education data used in the specifications 2 and 3 are taken from National Education Statistics Database of TUIK. The oldest available data, which belongs to the year 2009, is used in the regressions, in line with the usual practice of empirical literature on convergence that uses initial values of the “other variables”.

4 Results of the Analysis on Income Convergence across Turkish Provinces

Before reporting the estimation results for the speed of convergence across provinces of Turkey, graphical counterpart of the first specification (Equation 9) is given in the following figure to check whether there exists absolute convergence across provinces. The

³This is in line with the Augmented Solow Model of Mankiw, David Romer and Weil (1992), as well.

Figure 1: Convergence of real GDP per capita across provinces in Turkey during 2004 - 2014

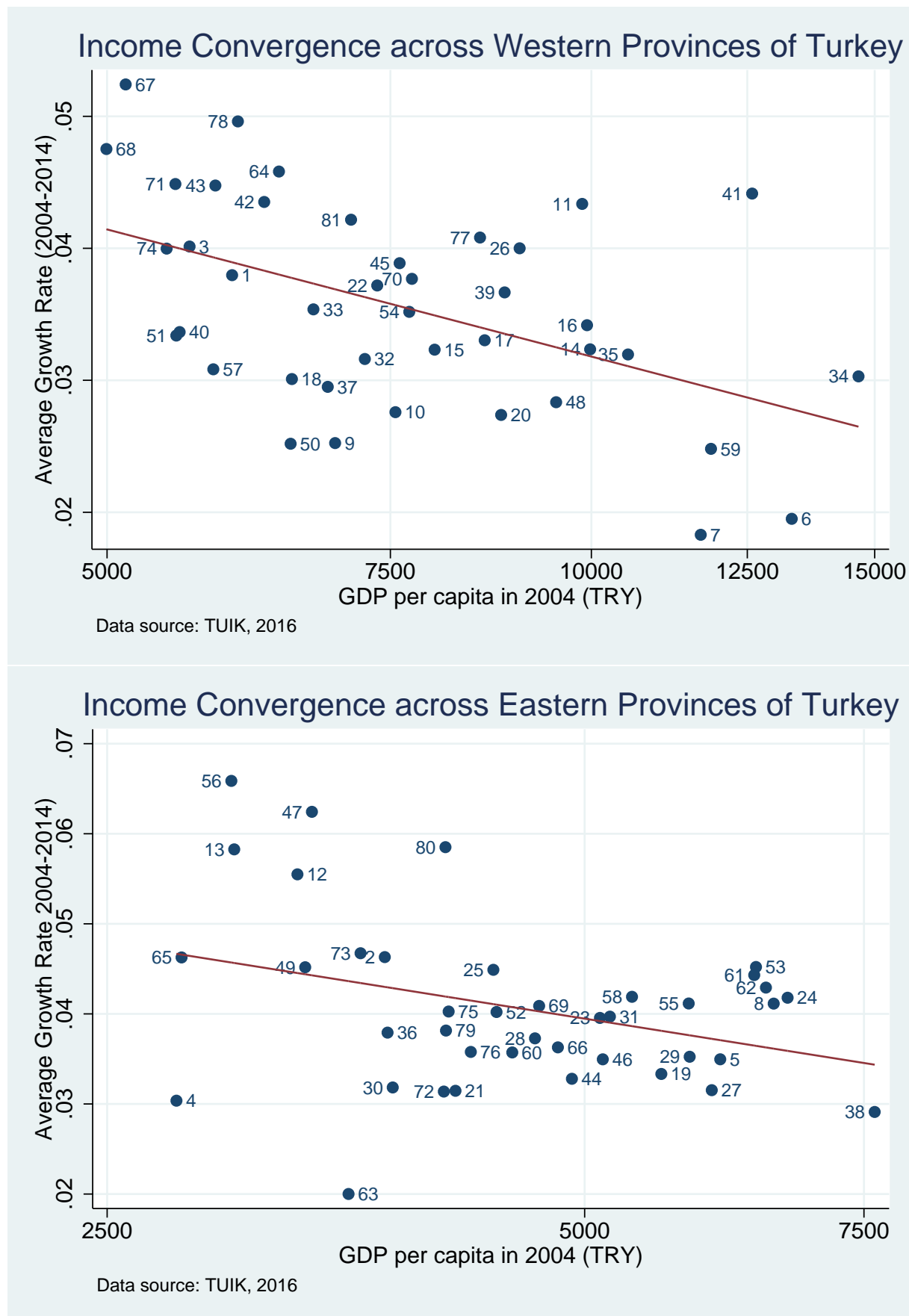


left-hand side of the Equation 9, i.e, the dependent variable, which is the average growth rate of per capita income between 2004 and 2014, is shown on the vertical axis and the independent variable, the log of per capita income in 2004⁴, is shown on the horizontal axis. The Figure 1, which provides a scatter plot for all of the 81 provinces in Turkey, indicates that there is a negative relationship between these two variables, implying that absolute β -convergence exists across Turkish provinces.

As stated earlier, the absolute convergence across economies tends to hold if underlying parameters related to technology, natural resources, government policies, and preferences are similar. However, there is evidence related to differences in preferences between eastern and western parts of Turkey in general, and in the attitude towards girls' education, in particular. The significant educational gender gap found in Tansel and Gungor (2012), such that Marmara and Aegean have small while Southeast and East Anatolia have large educational gender gaps, motivates to check the absolute convergence across provinces in the western and eastern part of Turkey, separately. The following two figures show the absolute convergence in these two parts, which cover 41 western and 40 eastern provinces, respectively. This kind of separation allows to add province codes (listed in the Appendix) as labels without causing overlaps in the figure.

⁴The horizontal axis is in log scale to be able to show 2004 per capita income of provinces in TRY instead of in log terms.

Figure 2: Convergence of real GDP per capita across Western and Eastern Provinces of Turkey



Comparing the two graphs in Figure 2, reveals that the slope, $[(1 - \exp^{-\beta t})/T]$, is higher in absolute terms in the first one compared to the second, implying that the absolute income convergence across western provinces of Turkey is higher than that across eastern provinces, because as β increases, the slope increases as well. This relatively lower absolute convergence in eastern Turkey indicates that β -convergence is likely to be conditional instead of absolute in the East. Note also that there is a considerable difference in per capita incomes of the provinces in western and eastern part of Turkey: The per capita GDP of 41 provinces in western Turkey ranges between 5000 and 15000 Turkish lira in 2004, while this range is between 2500 and 7500 for 40 provinces in eastern Turkey. The details are in the following descriptive statistics table for parameters contained in all three specifications used in the empirical analysis.

Table 1: Descriptive Statistics for Turkish Provinces (2004-2014)

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
All Provinces					
rgdpc14	81	9152.79	3256.92	3745.32	19842.95
rgdpc04	81	6333.42	2502.01	2764.56	14656.48
mean-schooling	81	6.0988	0.8731	3.5270	8.1768
high-and-above	81	0.2479	0.0549	0.1231	0.4279
growth-rate	81	0.0381	0.0090	0.0183	0.0659
Western Provinces					
rgdpc14	41	11245.28	3033.39	7709.44	19842.95
rgdpc04	41	7941.79	2380.26	4995.35	14656.48
mean-schooling	41	6.5192	0.6092	4.6780	8.1768
high-and-above	41	0.2722	0.0487	0.1925	0.4279
growth-rate	41	0.0356	0.0079	0.0183	0.0524
Eastern Provinces					
rgdpc14	40	7007.98	1732.17	3745.32	10196.28
rgdpc04	40	4684.85	1234.19	2764.56	7617.75
mean-schooling	40	5.6679	0.8983	3.5270	7.0886
high-and-above	40	0.2229	0.0498	0.1231	0.3279
growth-rate	40	0.0407	0.0094	0.0200	0.0659

Table 2 shows nonlinear least-squares estimation results for the three specifications in the form of Equations 9, 10, and 11, for Turkish provinces for the time period 2004-2014, the period for which the data exist. The rows of the table correspond to various groupings

of the provinces: basically all provinces as well as western 41 and eastern 40 provinces, separately. Istanbul seems to be an outlier in Figure 1, because it has the highest per capita income and has higher growth probably due to its unique characteristics. So, it is dropped both from the whole sample and the western part of Turkey to check whether it has a bias on the estimation results.

The first column of Table 2 shows the results of the absolute convergence of the Specification 1, where the logarithm of the income per capita at the beginning of the time period is the only explanatory variable. Column two adds mean schooling value of the population with 15 years of age and over as the proxy for human capital, while column three includes the ratio of the population with 15 years of age and over who completed at least junior or vocational high school as an alternative proxy for the human capital. As argued before, the inclusion of these variables allows to estimate conditional β -convergence and would help to assess to what extent is the convergence across provinces in Turkey conditional on their human capital level.

Table 2: Convergence across Turkish Provinces (2004-2014)

	Specification 1	Specification 2		Specification 3	
	β	β	mean-schooling	β	high-and-above
Overall Turkey	0.0122*** (-0.0027)	0.0194*** (-0.004)	0.0036** (-0.0014)	0.0217*** (-0.0045)	0.0705*** (-0.0247)
Overall Turkey (excluding Istanbul)	0.0125*** (-0.0028)	0.0200*** (-0.0042)	0.0037** (-0.0014)	0.0223*** (-0.0046)	0.0714*** (-0.0249)
Western Provinces	0.0150*** (-0.0046)	0.0147*** (-0.0053)	-0.0002 (-0.0021)	0.0196*** (-0.0065)	0.0333 (-0.0305)
Western Provinces (excluding Istanbul)	0.0161*** (-0.0051)	0.0158*** (-0.0058)	-0.0002 (-0.0021)	0.0212*** (-0.0071)	0.0351 (-0.0308)
Eastern Provinces	0.0130** (-0.0062)	0.0362*** (-0.0101)	0.0073*** (-0.0021)	0.0398*** (-0.0115)	0.1400*** (-0.0411)
*** p<0.01, ** p<0.05, * p<0.1					

Table 2 gives the estimated β values, the standard error of this estimate (in parenthesis) as well as the estimated coefficients of the proxies for human capital and their standard errors. Although all three specifications have a constant term, they are not reported in Table 2. The stars report the significance levels such that three stars, two stars, and one star indicate that the coefficients are significantly different from zero at probability levels of 1, 5, and 10 per cents, respectively. The estimated speed of absolute convergence, where only the logarithm of the income per capita at the beginning of the time period is used as explanatory variable, is 1.22 per cent across all provinces of Turkey, and it increases slightly to 1.25 per cent when Istanbul is excluded. Absolute convergence across western provinces of Turkey is estimated somewhat higher, reaching 1.61 per cent when

Istanbul is excluded, compared to that of 1.3 per cent across eastern 40 provinces. All of the estimated β values are significant at 1 per cent level.

The second specification, where mean-schooling is added as explanatory variable, i.e. when average schooling level of each province is controlled for, the speed of convergence reaches 2 per cent for the whole country, excluding Istanbul. The estimated β value reaches 3.62 per cent across the eastern provinces when mean schooling is taken into account, whose coefficient is 0.0073 and significant at 1 per cent level. The coefficient for mean schooling is not significant for western provinces with or without Istanbul, and as it implies the speed of convergence across them does not change to a large extent with the inclusion of mean schooling. However, once the ratio of the population with 15 years of age and over who completed at least junior or vocational high school is used instead of mean schooling in the third specification, the estimated β increases to around 2 per cent from approximately 1.5 per cent for western provinces, though its coefficient is not significant. In fact, the speed of convergence is higher across both eastern provinces and all provinces as well in case of specification 3, implying that the ratio of the population with 15 years of age and over who completed at least junior or vocational high school is a better proxy than mean schooling, at least for Turkey. The estimated β -convergence reaches as high as 4 per cent across eastern provinces in the specification 3 and the coefficient of the proxy for education is 0.14, implying that a 1 percentage point increase in the ratio of the graduates of high school and above results in 0.14 percentage point increase in the growth rate.

The estimated β -convergence values for Turkey are similar to the findings of Barro and Sala-i-Martin (1995) that the US states, Japan prefectures, and regions within the EU tend to converge at a speed of around 2-3 per cent per year, only if a proxy for human capital is included in the regression equation as an explanatory variable together with the initial level of their per capita income. Therefore, main conclusion is that only conditional convergence of 2 per cent or higher seems to exist across Turkish provinces. In other words, incomes of poor provinces in Turkey tend to catch up those of rich ones in per capita terms at a pace similar to that of poorer regions of other countries conditioned on the human capital level they possess.

As stated earlier, the ratio of the population with 15 years of age and over who completed at least junior or vocational high school seems to be a better proxy for human capital than mean schooling value of the population with 15 years of age, especially for western provinces. This is approved by Nelson and Phelps (1966), which states that the progressiveness of technology has implications for the optimal capital structure, particularly, the more dynamic the technology is, the more human capital relative to tangible capital the society has to build. The idea is supported by the model developed in Keller (1996), in which the long-run benefit from technology diffusion depends on whether the rate of human capital formation is increased relative to the increase in the amount of spillovers. The reason is that further accumulation of human capital is necessary to implement new technologies. If a country fails to increase the rate of human capital formation in accordance with the rate of knowledge spillovers, the new technology cannot be fully absorbed, and the relative lack of human capital forces the growth rate of the economy back to its former level. Barro (1996) finds significantly negative estimated coefficient for the inter-

action term between male schooling and logarithm of GDP, implying that more years of school raise sensitivity of growth to the starting level of GDP. He admits that this finding supports theories that stress the positive effect of education on an economy's ability to absorb new technologies.

5 Summary and Conclusion

Whether there is a per capita income convergence or divergence across countries has been a major area of dispute in economics. There is evidence of a considerable convergence across wealthier countries (e.g. across 20 original OECD members), especially during the postwar period. However, income divergence, or at best, non-convergence, appears to characterize the behavior of most cross-country income differentials when a wider spectrum of countries are covered in the analysis. Barro and Sala-i-Martin (1995) introduce the notion of conditional convergence after they are able to find a significantly negative partial relationship between the per capita growth rate and the log of initial per capita GDP for wider spectrum of countries as well, once they take into account the underlying parameters of technology, preferences, natural resources, and government policies, which are in fact introduced by the new growth literature. They also demonstrate that absolute convergence holds not only across OECD members, but also across U.S. states, Japan prefectures, and regions within the EU, an expected result since regions within an economy are even more homogenous relative to OECD members. Indeed, firms and households of different regions within an economy tend to have access to similar technologies, share a common central government, therefore have similar institutional setups and legal systems, and they can be assumed to have roughly similar tastes and cultures.

In this paper, the convergence of per capita incomes across Turkish provinces during 2004-2014 period is examined following the availability of per capita incomes of Turkish provinces for this period as of December 2016. The results of the nonlinear least squares regression show that the absolute convergence across Turkish provinces, which is estimated as 1.2 per cent, is lower than those estimated for the US states, Japan prefectures, and the members of the EU. However, once the assumption that Turkish provinces have similar tastes and cultures is relaxed following the evidence that the attitude towards girls' education between provinces of Turkey differs to a large extent and accordingly, a proxy for human capital is included -besides the initial level of per capita income- as a second explanatory variable in the regression equation, the speed of convergence increases to 2.2 per cent per year. This implies that once the differences in educational attainment across Turkish provinces are held constant, there exists conditional income convergence of similar magnitude found in studies on convergence across regions of other economies. Furthermore, the ratio of the population with 15 years of age and over who completed at least junior or vocational high school seems to be a better proxy for human capital than mean schooling, at least for Turkey.

Taking into consideration the evidence that the attitude towards girls' education differs to a large extent between eastern and western regions of Turkey, the same regressions are repeated for two groups obtained by dividing the original sample into two, such that the first one covers 41 western and the second 40 eastern provinces of Turkey. The results show

that the estimated β -convergence reaches as high as 4 per cent across eastern provinces, while it is around 2 per cent across western provinces when the ratio of the population with 15 years of age and over who completed at least junior or vocational high school is used as the proxy for human capital. This result implies that an effort to change attitude towards education in eastern Turkey is critical in increasing the speed of convergence across provinces. In general, public policy to increase human capital in eastern Turkey is likely to have higher returns in terms of reducing income inequality across provinces in Turkey.

To sum up, once the differences in educational attainment across Turkish provinces are held constant, there exists income convergence of similar magnitude found across regions of other economies. Furthermore, the inclusion of a proxy for the human capital matters more for eastern provinces, such that the speed of convergence increases from 1.3 to almost 4 per cent per year across them. However, like most of the cross sectional empirical studies on economic growth, this paper ignores quality issues, implicitly assuming that any variation in quality of human capital is likely to be small relative to the importance and variation in pure quantity of human capital (Hanushek and Kimko, 2000). So, a further step can be incorporating human capital quality, say by using average university entrance exam results of provinces together with the ratio of the population with 15 years of age and over who completed at least junior or vocational high school while estimating the conditional convergence across Turkish provinces.

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Table 3: License Plate Codes for Turkish Provinces

Code	Province	Code	Province	Code	Province
1	Adana	28	Giresun	55	Samsun
2	Adıyaman	29	Gümüşhane	56	Siirt
3	Afyonkarahisar	30	Hakkari	57	Sinop
4	Ağrı	31	Hatay	58	Sivas
5	Amasya	32	Isparta	59	Tekirdağ
6	Ankara	33	Mersin	60	Tokat
7	Antalya	34	İstanbul	61	Trabzon
8	Artvin	35	İzmir	62	Tunceli
9	Aydın	36	Kars	63	Şanlıurfa
10	Balıkesir	37	Kastamonu	64	Uşak
11	Bilecik	38	Kayseri	65	Van
12	Bingöl	39	Kırklareli	66	Yozgat
13	Bitlis	40	Kırşehir	67	Zonguldak
14	Bolu	41	Kocaeli	68	Aksaray
15	Burdur	42	Konya	69	Bayburt
16	Bursa	43	Kütahya	70	Karaman
17	Çanakkale	44	Malatya	71	Kırıkkale
18	Çankırı	45	Manisa	72	Batman
19	Çorum	46	Kahramanmaraş	73	Şırnak
20	Denizli	47	Mardin	74	Bartın
21	Diyarbakır	48	Muğla	75	Ardahan
22	Edirne	49	Muş	76	Iğdır
23	Elazığ	50	Nevşehir	77	Yalova
24	Erzincan	51	Niğde	78	Karabük
25	Erzurum	52	Ordu	79	Kilis
26	Eskişehir	53	Rize	80	Osmaniye
27	Gaziantep	54	Sakarya	81	Düzce