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CONVERGENCE OR DIVERGENCE? AN EMPIRICAL ANALYSIS FOR THE REGIONS OF TURKEY

Hakki Kutay Bolkol
Istanbul 29 Mayis University, Turkey
Email: hkbolkol@29mayis.edu.tr

Abstract

This study aims to investigate the convergence issue for the NUTS2 level regions of Turkey based on the neoclassical perspective in order to test the empirical power of neoclassical models. The difference and one of the contributions of this study is that it uses per-capita gross value added instead of per-capita income because of not only data limitations but also some advantages it has. For example, it is purer and it shows real production activities that is why using it is not a handicap rather it is better indicator for growth studies. The investigation period of this study is the years between 2005 and 2011 due to the lack of data. In empirical part, β convergence (both conditional and unconditional), σ convergence, and coefficient of variation method are tested in order to capture whether there exists convergence or not. Empirical results show that there is convergence between regions of Turkey. However, by investigating the descriptive statistics in the light of empirical results, it can be easily seen that the reason of convergence is the crisis (2008 crisis). Since our investigation period is too short, the empirical result is highly affected by the crisis so that it is impossible to infer that there is convergence. The reason of finding convergence in crisis is that 2008 crisis is related with financial sector and it affects rich regions more. Therefore, this type of convergence is deceptive. In other words, it does not show the real trend. Consequently, according to this work, we cannot infer that there is convergence, to say that we need reinvestigation with larger time period.

Keywords: Economic Growth, Regional Convergence, β Convergence, σ Convergence, Coefficient of Variation

JEL Codes: O18, O47, R11, R58

1. Introduction

We can call neoclassical growth theory formulated by Solow (1956) as a milestone for convergence literature. It states that all economies will converge to balanced growth paths with constant capital per labor, regardless of their initial conditions. The reason behind the convergence is based on the decreasing return to scale to capital. What I mean is that regions with low capital stocks and per capita income have a higher return to capital based on neoclassical growth theory.

After that, with the seminal works of Baumol (1986) and Barro and Sala-i Martin (1991) convergence across countries and regions become very popular issue in empirical economics.

When it comes to Turkey, reducing gaps in income and standard of living between rich West and poor East is an important issue in politics and economic policy making (Aldan and Gaygisiz, 2006). Regional policies have a significant place in Development plans of Turkey. In 3th Development Plan (1973-77), the definition of "Priority Provinces for Development" (PPD) which gives the priority of directing investments towards them in order to reduce interregional disparities in long-run (Gezici and Hewings, 2004) is used. However, in time, the amount of provinces to which the priority is given increased very rapidly that is why it is hard to say that the strategy of PPD has become successful. Moreover, after 1980s, with the export base development policy, investments have mostly directed towards metropolitan cities.

This paper aims to investigate more recent times by using neoclassical model in order to test the empirical success of it. However, because of data limitations, it takes the helping hand of some descriptive statistics as well.

It will be very beneficial to state at the very beginning that in the literature, studies related with economic growth show that the countries which cannot cope with the problem of regional income differences, also cannot reach a permanent growth (Dogruel and Dogruel, 2003).

The rest of the paper is organized as follows; section 2 gives a review on literature, section 3 provides methods and data, section 4 presents empirical results, section 5 gives descriptive statistics and section 6 concludes.

2. Literature Review
2.1 Pioneer Empirical Studies

Baumol (1986) examines productivity growth, convergence, and welfare by using Maddison's 1870-1976 data (long-run data for 16 countries: Australia, United Kingdom, Switzerland, Belgium, Netherlands, Canada, United States, Denmark, Italy, Austria, Germany, Norway, France, Finland, Sweden, Japan). He states that there is remarkable convergence of output per labor hour among industrialized nations. Almost all of the leading free enterprise economies have moved closer to the leader. On the other side, paper states that only less developed countries cannot show such a trend (by looking the data from Summer-Heston which provides data for more countries). He constructs a regression, and it is found that there is negative relationship between growth rate of GDP per work hour in 110 years since 1870 (1870-1979) (dependent variable) and absolute level of GDP per work hour in 1870 (independent variable) which means that the higher a country's productivity level, the more slowly that level grow in the future. After stating this, paper touches on the spillover and public good effect. Therefore, laggards have more to learn from the leaders, and that is why the process creates convergence. The explanation of the poor performance of less developed countries is that they cannot benefit much from the public good properties of the innovations and investments of developed nations, for example, a less developed country that produces no cars cannot benefit from the innovation and adaptation of a better car-producing robot in Japan. Within this context the problems that less developed countries are faced related with lack of education and associated skills. Furthermore, by analyzing the different source of data, he states that there is more than one convergence club. Industrial countries appear to belong to one convergence club, middle-income countries belong to other, and low income countries diverge over time. At the end due to the convergence hypothesis paper gives alarm for U.S.; it is stated that there is a slowdown in U.S. productivity growth and its lag behind other industrial countries.

De Long (1988) criticizes Baumol's results because of the existence of sample selection bias. He states that Baumol's regression uses an ex-post sample of countries that are now rich and successfully developed. Besides, it is stated that by using Maddison's data Baumol's results do not provide strong conclusion about convergence because in that dataset nations that have not converged are excluded from the sample. He proposes that there is a need of adding new countries which have not converged yet but likely to converge (ex-ante sample) that's why he adds seven more countries including Argentina, Chile, E. Germany, Ireland, New Zealand, Portugal, Spain to Baumol's sample. Also in regression part, De Long uses different specification than Baumol by using log differences in per-capita income between 1870 and 1979

on a constant and the log of per-capita income in 1870. He states that using logarithmic income specification has two advantages. First one is the measurement of slope, and the second one is the ease of adding new countries to the sample. Besides he states that simple regression cannot be used to test the convergence. By using more comprehensive estimation techniques and adding seven countries which are likely to converge to Baumol's sample, he finds little sign of convergence of productivity and per-capita income. However, he accepts the force of convergence but according to his point of view, it depends on the nation's capability of adaptation of technology which is a public good.

Barro and Sala-i Martin (1991) find that there is significant negative relationship between initial per-capita incomes and growth rates of economies which indicates convergence. They use panel data regression techniques and they use the method of β-convergence. As it is mentioned β-convergence is related with the investigation between growth rates of per capita incomes and income levels belong to starting period. β-convergence assumes that low income region grows faster than high income region and eventually catches up the high income region. Positive β value ($\beta > 0$) represents convergence or vice versa (negative value represents divergence). β-convergence can be also named as absolute convergence. β-convergence can be divided into two as unconditional convergence and conditional convergence. Unconditional convergence assumes that economies have same level of technology, saving rates etc. while conditional convergence adds new variables to the model that can capture the differences related with technology, saving rates etc. There is another concept called σ-convergence. It is based on the hypothesis which states that standard deviation of the logarithmic value of per capita income will decrease in time. Decrease in standard deviation represents convergence or vice versa (divergence in the case of increase in standard deviation). β-convergence is necessary but not sufficient condition for σ-convergence (Sala-i Martin, 1996). In other words, there may be β-convergence while there is no σ-convergence but the inverse is impossible.

2.2 Empirical Studies on Turkey

In that part, the first aim is to capture how different methods or techniques are used in convergence literature for Turkey by mentioning various studies on Turkey. The second aim is to find whether there is consensus on convergence or divergence in literature.

Filiztekin (1999) investigates convergence across Turkish provinces with sectoral dynamics. He puts the emphasis on the "sectoral dynamics" because, according to his point of view, the effect of sectoral structure on regional inequality becomes more interesting for Turkey case since starting from mid-1960s Turkey prepares Five-Year-Development Plans in which the main focus is given to sectoral development. However, it is stated that almost in every plan includes regional planning, but none of them makes a good connection between sectoral development and regional development. This paper uses annual domestic product per adult population for the years between 1975 and 1995. Study applies to method of coefficient of variation (this method divides standard deviation to the mean) to specify the degree of dispersion and according to result, it is stated that the dispersion increased dramatically in the last twenty years. Also, it is stated that while rich provinces are converging towards each other, poor provinces become more dispersed. To test the convergence, paper first uses the method of β-convergence, and it is found that there is no absolute convergence across Turkish provinces. In other words, it is stated that holding steady states constant across provinces the results indicate divergence from the mean. Paper uses regional dummies to control for differences in steady states. After that, the sign of β turns out to be positive which indicates convergence in one sub-periods but not in other sub-periods. Furthermore, paper also includes the share of agricultural output in the initial year to the estimated equation in order to control structural differences between provinces. After that, β coefficient indicates that the provinces are converging at the speed of 1.7% per year. Consequently, convergence across Turkish provinces is conditional. When it comes to the sectoral part, study analyzes agriculture, industry, construction and services sectors. It also investigates sectoral productivities during the investigation periods by analyzing the output per employee. Again β-convergence is used to test convergence across sectors, and not surprisingly it is found that there is no convergence at

the aggregate level. However, convergence rates vary across sectors significantly. It is found that only in agricultural sector there is no convergence, while in all other sectors there is convergence ranging from 2.6 percent in services and 18.9 percent in construction. Moreover, paper also uses the method of σ-convergence at aggregate and sectoral levels. And it is found that the only sector in which the dispersion of productivities has declined through very little is construction. What is more, in the paper there is part which compares Turkey with Southern Europe (Italy and Spain) and again the method of coefficient of variation is used to compare the dispersion between these three countries. It is found that Turkish experience is significantly different than Southern European countries because while in Turkey re-allocation of labor from low productive sectors to high productive sectors seems to be major source of growth, the driving force in Italian and Spanish economies is improvement of productivity within sectors rather than re-allocation of labor across sectors. To sum up, it is stated that although provinces in Turkey converging conditionally, they display a diverging pattern.

Tansel and Gungor (1999) examine the convergence issue for provinces of Turkey for the 5-year sub-periods between 1975 and 1995. The main aim of this study is to investigate whether the less developed provinces of Turkey are converging in labor productivity levels and productivity growth rates to richer provinces of Turkey and whether this convergence is conditional on human capital. Empirically, convergence is tested by regressing the growth rates with initial or starting level of income. A negative and significant association between initial income level and growth rate refers absolute convergence. Paper uses three different methodologies in order to estimate the convergence parameter. It begins with using the discrete time regression equation from Barro and Sala-i Martin (1992). At this point, it is better to mention that the technological parameter is assumed to be the same across economies which can be seen as a short-coming of basic neoclassical literature. Secondly, study mentions Mankiw *et al.* (1992) which is also based on neoclassical model, however, they take into account differences in the saving rate and labor force growth rate across different country samples. More importantly, the most important contribution of Mankiw *et al.* (1992) is that the inclusion of human capital which is measured as the secondary level enrollment rate that makes convergence conditional upon human capital. Lastly, study mentions the methodology from Islam (1995) since although Mankiw *et al.* (1992) is better than Barro and Sala-i Martin (1992) (especially when the data of saving rates and human capital is available), it may omit other steady state factors because initial level of technological process assumed to be constant across the cross-sectional units. Islam (1995) examines dynamic panel framework that takes these differences into account. Moreover, it should be also noted that this study uses mean years of schooling as a measurement of human capital. And it uses GPP (Gross Provincial Product) instead of using per-capita incomes in order to investigate labor productivity. To sum up, this study finds that there is absolute convergence in labor productivities across provinces of Turkey and inclusion of human capital is found to increase the convergence rate among Turkey's provinces. Lastly, another important finding of this study is that faster convergence rates are found for relatively poorer and relatively richer countries than the total set of provinces.

Gezici and Hewings (2002) make a spatial analysis for the regional inequalities in Turkey. The main contribution of this paper is that it investigates not only inter-provincial inequalities but also within provincial inequalities by the help of spatial data analysis. Study creates three alternative partitions in order to analyze inequality from different levels and perspectives. These are: geographical regions (7 regions), functional regions (top 16 provinces that have biggest share in GDP) and coastal-interior regions (2 sets). Paper uses Theil Index since it accounts both for inter-regional and intra-regional inequalities. According to results of Theil Index, it is stated that interregional inequalities are increasing while intra-regional inequalities are declining for all partitions for the years between 1980 and 1997. Moreover, it is also found that although there is some evidence that there is spread effect from most developed provinces to their neighbors, they increase overall inequality.

Dogruel and Dogruel (2003) examine regional income differences and growth for Turkey for the period between 1987 and 1999. The main aim of this study is to understand the regional growth process and investigate the direction of income differences across regions, especially in the period of rapid international expansion after 1980s, because with the

globalization, regional differences become open to external factors. Moreover, international institutions like WTO (World Trade Organization), IMF (International Monetary Fund) and World Bank have started to intervene especially developing countries because developed countries such as US and EU countries can shape these interventions according to their good while developing countries have no power to do that. In other words, in developing countries, government's elbow room is restricted with the improvement in human capital due to the global interventions and because of the free movement of labor across regions, it not possible to state that the improvement in human capital can reduce the regional differences. Furthermore, paper also mentions internal limitations which prevents the transfer of funds from rich to poor regions and the trade-off between economic effectiveness and regional development. What is more, other important emphasis of this paper is the negative relationship between public enterprise and economic growth. Moreover, study also puts the emphasis on the polarization to unique provinces in regions. In the empirical part, study uses 3 different methods to test the convergence. First two are called $\beta-\text{convergence}$ and σ-convergence. Third and alternative method to σ-convergence is the method of investigating coefficient of variation. Study takes the model of Barro and Sala-i Martin (1995) which is discrete time model and based on initial and end periods, as a base, however, because of the frequent fluctuations in Turkey, as Lall and Yilmaz (2001) did, study uses the modified version of this model and uses two successive years. Moreover, study includes another modification which is separating the regions as below average (East) and above average (West) according to per-capita income levels in order to capture the structural differences between provinces. Furthermore, study also mentions second way for capturing structural differences which is adding new variables that reflect the structural features of provinces in to the model. Dogruel and Dogruel (2003) use panel data approach in this work. Provinces are used as a defining unit of regions. In empirical results, it is found that there is $\beta-\text{convergence}$ for every model. However, in the next step it is found that there is weak $\sigma-\text{convergence}$ and it is valid only for high income provinces. Moreover, based on the empirical result, in low income and total provinces levels, there is no σ-convergence. Lastly, study gives the result of coefficient of variation in order to diminish the effects of large fluctuations. The results of coefficient of variation more certainly reveal the convergence that is valid only in high income regions. By analyzing the empirical results, Dogruel and Dogruel (2003) deduce that during the periods in which crisis and natural disasters (like; earthquake) happen, there is a tendency to convergence while during the general growth periods, there is a tendency to divergence. Consequently, it can be stated that according to empirical results, although there is a tendency for convergence according to β-convergence, it not sufficient because according to both σ-convergence and coefficient of variation results, there is convergence only in high income provinces, it is not valid in overall country and in low income provinces that is why it can be concluded that the gap between rich and poor regions widens.

Karaca (2004) examines the income differences between the regions of Turkey to test whether there is convergence. Paper states that there is a high difference between "West" and "East" for the benefit of "West". This situation causes migration (East to West) problems related with irregular urbanization, and public order. Therefore, government implies some policies to cope with the problem of income differences across regions. The main aim of this paper is to investigate whether these policies reduce the income differences or not. Study uses provincial level data for the period between 1975 and 2000. In empirical part, paper uses the method of β and σ convergence, and coefficient of variation separately. In order to investigate conditional convergence, study uses two methods. Firstly, it adds the dummy variables that can capture the structural differences across provinces. These dummy variables are set according to location of the provinces (East or West). Secondly, it uses the share of agricultural sector in gross value added to capture the structural differences across provinces. In overall, according to empirical results, study finds that there is no convergence rather there is divergence across regions of Turkey. This result paves the way for author to propose rethinking on the policies that are implemented in order to decrease the differences across regions. Consequently, he states that the failure happens because policies that give helping hand to provinces include large number of provinces which decrease or vanish the effectiveness of the policies.

Gezici and Hewings (2004) investigate regional convergence and core-periphery relation in Turkey. They examine the performance of GDP per-capita over the period between 1980 and 1997. Study applies the methods of β and σ convergence (by testing both unconditional and conditional convergence by adding new variables that can capture structural differences to the model), and according to results of these methods, it is found that there is no evidence for convergence across both provinces and the functional regions in Turkey. Furthermore, study also uses spatial analysis, and it is found that there is high level of spatial dependency. Thus, the level of regional per-capita GDP growth is highly related with neighbors and still there are significant disparities between east and west regions for the benefit of west. Moreover, it is also stated that the policy of PPD (Priority Provinces in Development) could not reach a complete success since PPDs do not grow faster than core-developed provinces.

Aldan and Gaygisiz (2006) investigate convergence across provinces of Turkey with a spatial analysis. The reason why they prefer spatial analysis is that apart from analyzing regional disparities which is the main aim of this study, they also want to analyze the spatial spillovers in the growth process of the provinces. The investigation period of this study is the year between 1987 and 2001. Study uses provincial GDP as a variable. Two different methodologies are used in the analyses. First one is the methodology of β-convergence. Also the effects of spatial dependence are analyzed by using spatial econometric techniques. Second one is the Markov chain analysis and spatial dependence is integrated using spatial Markov chains. According to empirical results, study find that there is no convergence and existence of spatial spillover in the growth process of provinces.

There are some studies which test convergence by using unit root tests like Aslan and Kula (2011). They evaluate regional stochastic convergence by using data on per capita income among 67 provinces in Turkey over the period 1975-2001. They put the emphasis on structural breaks caused by supply shocks such as earthquake in İzmir-Gölcük 1999 and significant policy changes such as transportation technology and tax benefit for some area. Therefore, they use unit root test procedure (in this method, rejection of null hypothesis, meaning that there is no unit root, indicates convergence, conversely, acceptance of null hypothesis, meaning that there is unit root, indicates divergence) with structural breaks in order to test convergence across provinces. Hence, they use LM (Lagrange Multiplier) unit root test since it allows structural breaks and it is not subject to spurious rejections which can occur in ADF (Augmented Dickey Fuller) type tests in the presence of unit root with breaks. In empirical result, they first find that in the case of without any structural breaks the null hypothesis rejected for 38 provinces, however, for remaining 28 provinces, the null hypothesis could not be rejected that can be interpreted as lack of convergence. After that they apply the panel version of the LM test to group 67 provinces in the sample. What is more, they also do this for 28 provinces that indicate no convergence according to unit root test. And it is found that both for panel with 67 provinces and 28 provinces null hypothesis is rejected which means that there is no unit root and there is a convergence. Furthermore, they also try to do the analysis with 2 structural breaks to avoid the lack of ability to reject the null hypothesis. And it is found that null hypothesis is rejected for all 64 provinces expect Bitlis, Erzurum, and Hakkari. After that they again investigate with panel case and they find that null hypothesis is rejected again which means that there is convergence. The reason they use panel data is lack of sufficient number of data in hand. Therefore, investigate this issue with panel version of LM test looks meaningful. However, in my opinion, defining break date differently for each provinces and using 2 rather than 1 break just for finding stationarity, call into question in readers mind. To sum up, the study finds strong evidence for convergence except for the provinces of Bitlis and Erzurum when 2 structural breaks are taken into account that is why they recommend that government should provide tax benefit for these two provinces to catch up with other provinces in Turkey.

As it can be understood from the literature, there is no consensus about convergence issue. The reason for this may be the differences in techniques that are used in studies or the differences in the time periods that the studies have.

3. Methods and Data

This paper aims to test the convergence across regions of Turkey by using the model which reflects neoclassical perspective in order to test the empirical success of neoclassical models which indicates convergence. Neoclassical perspective predicts that relatively poor countries or regions grow faster than relatively rich countries or regions until they converge each other. This is called as convergence hypothesis in literature. There are some ways to test this like the methods of β-convergence, σ-convergence, and coefficient of variation. This study uses both of these three methods to test the convergence between regions of Turkey.

Firstly, as it was explained in literature review, β-convergence is related with the investigation between growth rates of per capita incomes and income levels belong to starting period. β-convergence assumes that low income region grows faster than high income region and eventually catches up the high income region. Positive β value ($\beta > 0$) represents convergence or vice versa (negative value represents divergence). β-convergence can be also named as absolute convergence. β-convergence can be divided into two as unconditional convergence and conditional convergence. Unconditional convergence assumes that economies have same level of technology, saving rates etc. while conditional convergence adds new variables to the model that can capture the differences related with technology, saving rates etc.

Secondly, there is another concept called σ-convergence. It helps to capture the direction of change in regional differences. It is based on the hypothesis which states that standard deviation of the logarithmic value of per capita income will decrease in time. Decrease in standard deviation represents convergence or vice versa (divergence in the case of increase in standard deviation). β-convergence is necessary but not sufficient condition for σ-convergence (Sala-i Martin, 1996). In other words, there may be β-convergence while there is no σ-convergence but the inverse is impossible. Because it is not an econometric analysis, we can classify the regions as west and east without considering the reduction in sample size and the number observations. What I mean is that we cannot do this for β-convergence analysis because of the concern of inadequate number of observations to make an econometric analysis since our time period is too short because of data limitations. Because σ-convergence is available for us to classify the regions as west and east, by using this method we can investigate the convergence issue by comparing the west and east regions. In order to make this kind of classification, as Karaca (2004) did, Istanbul, West Marmara, Aegean, East Marmara, West Anatolia and Mediterranean are considered as "West", and Middle Anatolia, West Black Sea, East Black Sea, Northeast Anatolia, Middle East Anatolia, and Southeast Anatolia are considered as "East"(Detailed information is provided in the tables in Appendix B).

Thirdly, alternative method to σ-convergence is the method of investigating coefficient of variation which divides the standard deviation to the mean. In this method, if coefficient of variation will reduce in time, this represents convergence across regions or vice versa. This method is also available for making east-west classification with our limited data. But it has one more advantage that it can eliminate the fluctuations (by dividing the standard deviation to the mean) due to the rapid changes in growth rates year by year that can be observed in σ-convergence method.

The difference and one of the contributions of this study is that it uses per-capita gross value added instead of per-capita income because of not only data limitations but also some advantages it has. For example, it is purer and it shows real production activities that is why using it is not a handicap rather it is better indicator for growth studies.

Other contribution of this study is the time period it includes (2005-2011) because studies in literature generally use provincial level per-capita income to test convergence within a country. However, for Turkey, provincial level per-capita income data has not been announced since 2001 (this was the case by the time this paper was finished but TURKSTAT newly announced it, however, in the literature to test the conditional convergence, the main trend is to use the share of related sectors in gross value added. And the new data related with gross value added in provincial level has not been announced yet. So, this study still preserves its novelty) that is why studies in literature have an end period of 2001.

This research uses NUTS2 level regions (26 regions) because only it provides the available data related with gross value added. The data is taken from TURKSTAT. The investigation period is limited by the year between 2005 and 2011 due to the lack of available data. Actually, per-capita gross value added data starts from 2004, however, since we need to convert it into real terms, we need to use the price index (CPI [NUTS2 level CPI data starts from 2005 in TURKSTAT. Besides, since it is available only monthly, I take average to convert it yearly) with the base year of 2003 is used] in NUTS2 level. And the available data for that starts from 2005. On the other side, available per capita gross value added data has an end period of 2011. So automatically, time period of this empirical work becomes the years between 2005 and 2011.

This paper follows Barro and Sala-i Martin (1992) by using their regression given below in order to calculate β-convergence because it is typical neoclassical model and as it is stated before this paper aims to test the empirical power of neoclassical models.

$$\frac{1}{T}\log\left(\frac{y_{i,t}}{y_{i,t-T}}\right) = a - \left[\frac{1-e^{-\beta T}}{T}\right]\log(y_{i,t-T}) + u_{i,t} \tag{1}$$

In this equation, T represents the time interval, $y_{i,t-T}$ represents gross value added per-capita in the beginning year, $y_{i,t}$ represents gross value added per capita for region i in year t (end year). β is the coefficient that shows the speed of convergence. As it was stated, positive sign of β shows convergence, and negative sign of β indicates divergence. Of course, before making these comments the coefficient must be statistically significant.

In equation (1) the coefficient of β can be obtained by two ways. First way is solving the equation by using linear ordinary least square method and finding β from $b = \left[\frac{1-e^{-\beta T}}{T}\right]$. The second way is solving the equation by using non-linear ordinary least square method and this gives the value of β directly. Generally studies in literature use the second way, however, as it can be understood from the equation, only values of beginning and end periods are used in this type of model. This paper uses panel data, that is why this automatically reduces our sample size (since we have 26 regions, we only have 26 observations in this case) and misses the changes in the period between beginning and end. In other words, β becomes dependent to the conditions of beginning and end periods (To see the things better, mathematical formulation is made in the Appendix A). To capture the changes in between periods, this study follows Lall and Yılmaz (2001) and Dogruel and Dogruel (2003) and converts the model into two successive years. Following linear equation is used.

$$\log(y_{i,t}) = \alpha + b\log(y_{i,t-1}) + cT_t \tag{2}$$

In this equation T is also added to the model as a variable to capture the trend effect in the economy. And beta becomes; $\beta = -\ln(b)$. Again we need positive β to find convergence (the transformation process is shown in Appendix A).

Finally, this equation is used to test unconditional convergence, however, since it does not capture structural differences between regions, for conditional convergence some additional variables are added in order to control the differences between regions. Like Karaca (2004), this paper adds the share of agricultural sector in gross value added, however, as a distinct from Karaca (2004), the share of services sector in gross value added is also added. Because of the type of our model, these variables are added to the model with a one year lag. These variables are added in current prices contrast to per-capita gross value added because they represent share and when you make it real, conflict between real and relative values appears. There is a need to state that the first aim was to add the share of construction sector to the equation but because of data limitations, the share of services sector in gross value added is added to the equation. The final equation to test conditional convergence becomes like;

$$\log(y_{i,t}) = \alpha + b\log(y_{i,t-1}) + cT_t + eA_{i,t-1} + fS_{i,t-1} \tag{3}$$

In this equation $A_{i,t-1}$ represents the share of agricultural sector in gross value added; $S_{i,t-1}$ represents the share of services sector in gross value added.

After testing β convergence (both conditional and unconditional), as it was mentioned before, the method of σ-convergence and coefficient of variation is used.

4. Empirical Results

As it is stated before we are dealing with panel data analysis so that by taking the helping hand of Hausman test, we construct fixed-effect model. After testing diagnostic tests (Cross Sectional Dependency, Heteroscedasticity and Serial Correlation) because there exist cross-sectional dependency, heteroscedasticity and serial correlation, and also the number of cross-sections are greater than the number of time series, by using Driscoll-Kraay F.E. Estimation (see Tatoglu, 2013) we construct a fixed-effects regression for unconditional convergence (All tests mentioned are given in Appendix C). The results are presented in Table 1 below. According to results, we can say that there is convergence because of positive β value. Besides, the probability values are significant.

Table 1. Driscoll-Kraay F.E. Estimation for Unconditional Convergence

Regression with Driscoll-Kraay standard errors for Unconditional Convergence Method: Fixed-effects regression Dependent Variable: $\log(y_{i,t})$	
Independent Variables	**Coefficient**
$\log(y_{i,t-1})$	0.3775*** (3.31)
T_t	0.0042* (1.85)
Cons	2.3397*** (5.49)
Prob > F = 0.0025 **within R-squared =** 0.3349	
Calculated β value: 0.9742 **Result:** Convergence	

Notes: t statistics are reported in parentheses.
*, ** and *** represent 10%, 5% and 1% significance level respectively.

After testing for unconditional convergence, we apply the same steps for conditional convergence, and Hausman test again suggests us to use fixed-effect model and because there exist cross-sectional dependency, heteroscedasticity and serial correlation, by using Driscoll-Kraay F.E. Estimation, we construct a fixed-effects regression for conditional convergence (All tests mentioned are given in Appendix C). The results are presented in Table 2. According to results, there is convergence thanks to the positive β value. However, in that table below, the share of agricultural sector in gross value added is insignificant. This is not surprising because agricultural sector is not a kind of sector that can create convergence. Apart from the share of agricultural sector in gross value added, all other variables are significant for convergence. And as it is expected, in conditional convergence, R-squared and β value increased because of adding other related variables that can capture the structural differences between regions. This increased positive β value shows that there is convergence with higher rate in conditional part compared to unconditional part.

Table 2. Driscoll-Kraay F.E. Estimation for Conditional Convergence

Regression with Driscoll-Kraay standard errors for Conditional Convergence Method: Fixed-effects regression Dependent Variable: $\log(y_{i,t})$	
Independent Variables	**Coefficient**
$\log(y_{i,t-1})$	0.3436*** (2.95)
T_t	0.0068** (2.43)
$A_{i,t-1}$	-0.0001 (-0.12)
$S_{i,t-1}$	-0.0038*** (-2.82)
Cons	2.6857*** (5.74)
Prob > F = 0.0000 **within R-squared =** 0.3919	
Calculated β value: 1.0680 **Result:** Convergence	

Notes: t statistics are reported in parentheses.
 *, ** and *** represent 10%, 5% and 1% significance level respectively.

Finally, the results indicate that there is β convergence both for conditional and unconditional case. But in order to understand the direction of change in regional differences we need to take the helping hand of sigma convergence. In sigma convergence, as it was mentioned before, we can also classify the regions as west and east. Table 3 and Figure 1 show the results of sigma convergence. By investigating the results, we can easily capture that the factor that makes the trend decreasing is the crisis of 2008 because when we look the standard deviation (all), the decrease only happens between 2008 and 2010. In other words, if the crisis years are subtracted from the sample, there will be divergence according to sigma convergence analysis. However, with this crisis years in our sample, when we look the beginning and end year, we capture a decrease meaning that there is convergence. But it is deceptive due to the effects of 2008 crisis. In other words, since our investigation period is too short, 2008 crisis dominates our sample and creates a convergence. And as it can be seen from the table and the figure, after the effects of crisis are eliminated (after 2010) the ratio increases again.

Table 3. σ-Convergence

	Standard Deviation (all)	Standard deviation (west)	Standard deviation (east)
2005	0.1712	0.1173	0.1259
2006	0.1733	0.1210	0.1258
2007	0.1751	0.1174	0.1269
2008	0.1762	0.1113	0.1274
2009	0.1627	0.1066	0.1140
2010	0.1534	0.1071	0.1016
2011	0.1621	0.1114	0.1110

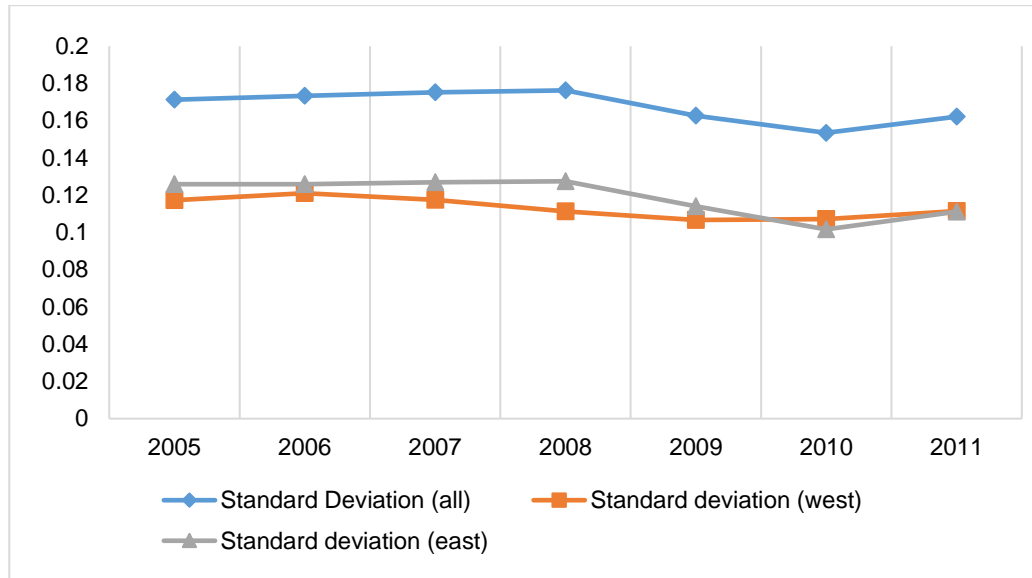**Source:** Author's own calculation.

Figure 1. σ-Convergence

Furthermore, by looking Figure 1, we can also capture that east regions converge more radically in crisis. And in crisis years the trend of standard deviation of east regions goes down to the trend of standard deviation of west regions. The convergence in west regions is less radical but also for west regions we can say that the reason of convergence is the crisis because it again happens only in crisis years. Besides, it is not surprising to find less convergence in west regions because the crisis of 2008 is financial crisis and west regions are more sensitive to crisis in a body that is why there is less convergence in west regions during the crisis. On the other hand, in east regions there are some regions that the share of financial sector is very little and insignificant so that the convergence in east regions during the crisis is much more radical. In other words, there are some regions that are affected by the crisis while also there are some regions that are totally independent from financial crisis in east. But one thing is for sure that there is convergence for both east and west in crisis.

In order to eliminate the fluctuations (by dividing the standard deviation to the mean) due to the rapid changes in growth rates year by year that can be observed in σ-convergence method, the results of coefficient of variation method is given in Table 4 and Figure 2 below.

Table 4. Coefficient of Variation

	Coefficient of Variation (all)	Coefficient of variation (west)	Coefficient of variation (east)
2005	0.0456	0.0303	0.0346
2006	0.0459	0.0310	0.0344
2007	0.0463	0.0300	0.0347
2008	0.0465	0.0284	0.0348
2009	0.0431	0.0274	0.0312
2010	0.0405	0.0274	0.0276
2011	0.0425	0.0283	0.0300

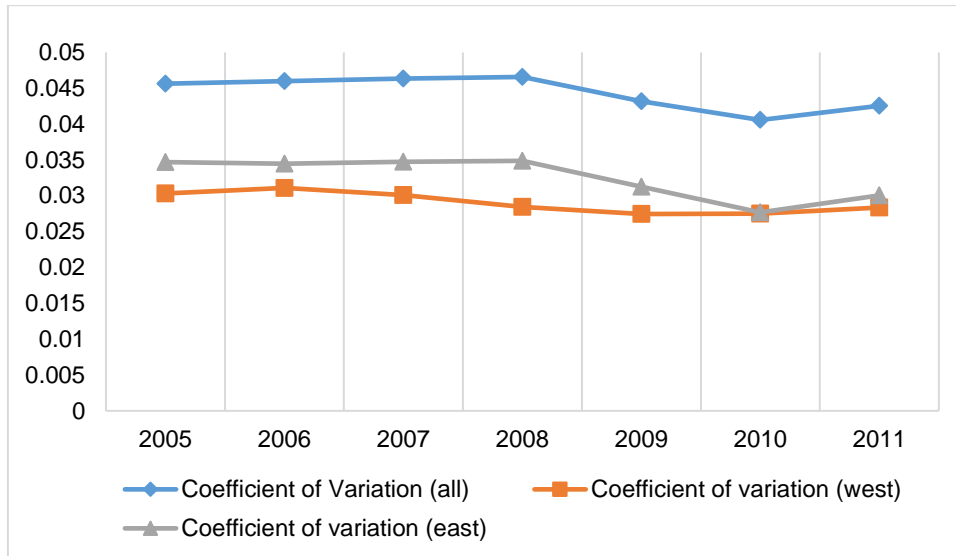**Source:** Author's own calculation.

Figure 2. Coefficient of Variation

The results obtained from the method of coefficient of variation are not different from the results of sigma convergence. In general, we can say that the reason of convergence is the crisis since when we look the coefficient of variation (all) in Table 4, there is a decrease/convergence only in crisis years. However, both in sigma convergence and coefficient of variation method, the effect of crisis is so strong and our time period is too short that in total, the convergence happens (when we compare the beginning and the end period, there is a decrease meaning that there is convergence). But again as it can be seen from the table and the figure, like what happens in the result of sigma convergence, after the effects of crisis are eliminated (after 2010) the ratio increases again meaning that the gap between east and west continue to rise.

5. Descriptive Statistics

The results obtained from sigma convergence and coefficient of variation methods, encourage us to investigate some descriptive statistics in order to analyze the crisis issue in convergence. In that scope, firstly, we decided to analyze average growth of per-capita gross value added for east and west separately to compare them. Table 5 and Figure 3 below show this.

Table 5. Average Growth of Per-capita Gross Value Added

	Average Growth of Per-capita Gross Value Added (west)	Average Growth of Per-capita Gross Value Added (east)
2005	-	-
2006	0.0518	0.0434
2007	0.0243	0.0088
2008	0.0201	0.0047
2009	-0.0654	-0.0271
2010	0.0234	0.0494
2011	0.0871	0.0626

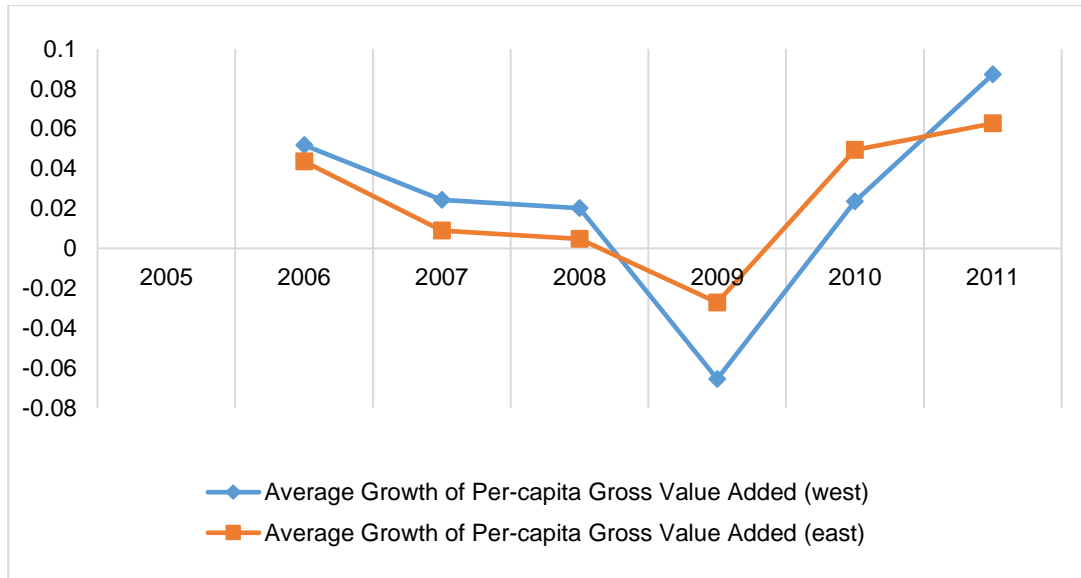**Source:** Author's own calculation.

Figure 3. Average Growth of Per-capita Gross Value Added

By investigating the results, we see that the growth of per-capita gross value added of west is above the growth of per-capita gross value added of east (meaning that the gap widens) except the crisis years. In crisis, the growth of west goes down to growth of east (meaning that the gap shrinks or convergence appears). But after the crisis, it exceeds the growth of east again. In crisis years, both have negative growth but the fall in west is much bigger than the east. Consequently, it can be stated that convergence appears in the crises, however, it happens in negative rates of growth so that it is not desirable and sustainable. And as it can be seen from the table and the figure, as the effects of crisis are eliminated (after 2010) west again exceeds the east. So the gap between east and west reduces in crisis but after the crisis, it widens again. Shortly, this result shows that the reason of convergence is nothing but the crisis. And we can say that because our time period is too short (2005-2011), crisis becomes dominant and we find convergence in β convergence (both for conditional and unconditional) analysis.

Secondly, we try to handle the issue by investigating richest/poorest ratio for east and west separately. Table 6 and Figure 4 illustrates that, again, in crisis years this ratio falls. But here, there is one more thing that we have to mention which is that this ratio begins to decrease after 2006 but the decrease gains acceleration with the effects of 2008 crisis. So we can say that there were some economic problems before 2008 crisis. Crisis hit Turkey while already there were some other economic problems. After the effects of 2008 crisis disappears (after 2010), we can easily see that the ratio starts to increase both in west and east. Consequently, this statistics also prove that crisis creates a convergence.

Table 6. Richest/Poorest Ratio

	Richest/Poorest (EAST)	Richest/Poorest (WEST)
2005	2.7766	2.4267
2006	2.9731	2.5169
2007	2.7223	2.4729
2008	2.5332	2.3328
2009	2.3445	2.3177
2010	2.2237	2.2676
2011	2.5333	2.3134

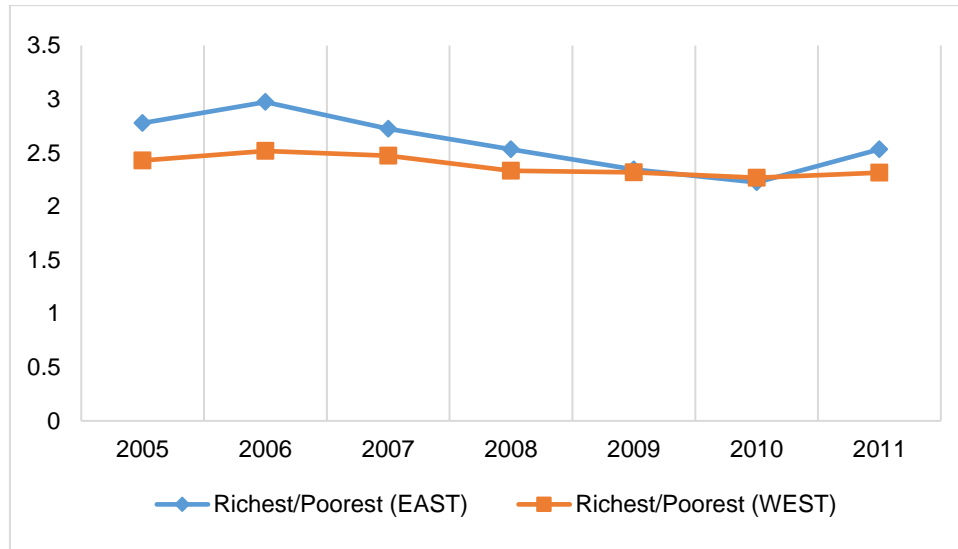**Source:** Author's own calculation.

Figure 4. Richest/Poorest Ratio

6. Conclusion

We analyze the convergence issue for the regions of Turkey by using neoclassical model in order to test the empirical success of neoclassical models. However, we have limited data for Turkey that is why, in order to reach an accurate conclusion, we use some descriptive statistics as well. According to results, neoclassical type β-convergence method (both unconditional and conditional) indicates convergence for the regions of Turkey but when we investigate the issue deeply by taking the helping hand of the method of sigma convergence and coefficient of variation, and descriptive statistics like; average growth of per-capita gross value added and richest/poorest ratio for east and west separately, we find that the reason of such a convergence is the crisis of 2008. In literature, our results are consistent with Dogruel and Dogruel (2003) since they also find that in crisis period's convergence appears. However, we proved that this kind of convergence is deceptive for our analysis because our time period is too short, 2008 crisis dominates our sample. Consequently, we cannot infer that there is convergence, to say that we need reinvestigation with larger time period.

References

Aldan, A. and Gaygisiz, E., 2006. Convergence across provinces of Turkey: A spatial analysis. *The Central Bank of the Republic of Turkey Research and Monetary Policy Department Working Paper,* No: 06/09.

Aslan, A. and Kula, F., 2011. Is there really divergence across Turkish provinces? Evidence from the Lagrange Multiplier Unit Root Tests. *European Planning Studies,* 19(3), pp. 539-549. https://doi.org/10.1080/09654313.2011.548359

Barro R. J. and Sala-i Martin, X., 1991. Convergence across states and regions. *Brooking Papers on Economic Activity,* 22(1), pp. 107-182. https://doi.org/10.2307/2534639

Barro, R. and Sala-i Martin, X., 1992. Convergence. *Journal of Political Economy,* 100(2), pp. 223-251. https://doi.org/10.1086/261816

Barro, R. J. and Sala-i Martin, X. 1995. *Economic growth.* New York: McGraw-Hill.

Baumol, W. J., 1986. Productivity growth, convergence and welfare: What the long-run data show. *American Economic Review* 76(5), pp. 1072-1085.

De Long, J. B., 1988. Productivity growth, convergence, and welfare: Comment. *The American Economic Review,* 78(5), pp. 1138-1154.

Dogruel, F. and Dogruel, A. S., 2003. Turkiye'de bolgesel gelir farkliliklari ve buyume [Regional income differences in Turkey and growth]. In: A. H. Kose, F. Senses and E.Yeldan, eds. 2003. *Iktisat uzerine yazilar I: Kuresel duzen, birikim, devlet ve siniflar, Korkut Boratav'a armagan*. Istanbul: Iletisim Yayinlari. pp. 287-318.

Filiztekin, A., 1999. Convergence across Turkish provinces and sectoral dynamics. *Background paper for Turkey: Economic Reforms, Living Standards and Social Welfare Study, World Bank Report, Poverty Reduction and Economic Management Unit.*

Gezici, F. and Hewings, J. D., 2002. Spatial analysis of regional inequalities in Turkey. *REAL Working Paper,* No. 02-T-11

Gezici, F. and Hewings, J. D., 2004. Regional convergence and economic performance of peripheral areas in Turkey. *Review of Urban and Regional Development Studies,* 16(2), pp. 113-132. https://doi.org/10.1111/j.1467-940X.2004.00082.x

Islam, N., 1995. Growth empirics: A panel data approach. *Quarterly Journal of Economics*, 110(4), pp. 1127-1170. https://doi.org/10.2307/2946651

Karaca, O., 2004.Turkiye'de bolgelerarasi gelir farkliliklari: Yakinsama var mi? [Interregional income differences in Turkey: Is there convergence?] *Turkish Economic Association,* Discussion paper, No. 2004/7.

Lall, S. and Yilmaz, K., 2001. Regional economic convergence: Do policy instruments make a difference? *The Annals of Regional Science*, 35, pp. 153-166. https://doi.org/10.1007/s001680000035

Mankiw, N. G., Romer, D. and Weil, D. N., 1992. A contribution to empirics of economic growth. *Quarterly Journal of Economics*, 107(2), pp. 407-437. https://doi.org/10.2307/2118477

Sala-i Martin, X., 1996. The classical approach to convergence analysis. *The Economic Journal*, 106(437), pp. 1019-1036. https://doi.org/10.2307/2235375

Solow, R. M., 1956. A contribution to the theory of economic growth. *Quarterly Journal of Economics*, 70(1), pp. 65-94. https://doi.org/10.2307/1884513

Tansel, A. and Gungor, N. D., 1999. Economic growth and convergence an application to the provinces of Turkey, 1975-1995. *Economic Research Forum for the Arab Countries, Iran and Turkey.*

Tatoglu, F. Y., 2013. *Panel veri ekonometrisi: Stata uygulamali [Econometric analysis of panel data].* Istanbul: Beta Yayinlari.

Turkish Statistical Institute (TURKSTAT), 2016. *Istatistiklerle Turkiye 2015 [Turkey in Statistics 2015]*. Ankara: Turkish Statistical Institute, Printing Division.

Appendix A

(A1)
$$\frac{1}{T}\log\left(\frac{y_{i,t}}{y_{i,t-T}}\right) = a - \left[\frac{1-e^{-\beta T}}{T}\right]\log(y_{i,t-T}) + u_{i,t}$$

When the time interval is between 2005 and 2011, the left-hand side of the equation shows that;

For 2006 → $\frac{1}{1}\log\left(\frac{y_{i,2006}}{y_{i,2005}}\right)$ For 2007 → $\frac{1}{2}\log\left(\frac{y_{i,2007}}{y_{i,2005}}\right)$

For 2008 → $\frac{1}{3}\log\left(\frac{y_{i,2008}}{y_{i,2005}}\right)$ For 2009 → $\frac{1}{4}\log\left(\frac{y_{i,2009}}{y_{i,2005}}\right)$

For 2010 → $\frac{1}{5}\log\left(\frac{y_{i,2010}}{y_{i,2005}}\right)$ For 2011 → $\frac{1}{6}\log\left(\frac{y_{i,2011}}{y_{i,2005}}\right)$

As it can be seen, as the end period becomes larger, this prevents us to capture the changes in between periods. And since I use panel data, this reduces my observations (26 regions × 1 periods = 26 observations). However, when we apply the equation below, we can use our whole sample except the year of 2005 which means we have (26 × 6 = 156) 156 observations.

(A2)
$$\log(y_{i,t}) = \alpha + b\log(y_{i,t-1}) + cT_t$$

It is better to give some quick information about this transformation. Call $\left[\frac{1-e^{-\beta T}}{T}\right]$ as "b", because there is minus sign in front of it, it is "$-b$". Then take the natural logarithm of it. It becomes $-\ln b = -\ln e^{-\beta T}$. Then rewriting it; $-\ln b = \beta$. And we add "T" into the equation as a new variable that shows the trend effect.

Appendix B

Table 7. NUTS1 Level

TR1-Istanbul	İstanbul
TR2-West Marmara	Tekirdağ, Edirne, Kırklareli, Balıkesir, Balıkesir, Çanakkale
TR3-Aegean	İzmir, Aydın, Denizli, Muğla, Manisa, Afyon, Kütahya, Uşak
TR4-East Marmara	Bursa, Eskişehir, Bilecik, Kocaeli, Sakarya, Düzce, Bolu, Yalova
TR5-West Anatolia	Ankara, Konya, Karaman
TR6-Mediterranean	Antalya, Isparta, Burdur, Adana, Mersin, Hatay, K.Maraş, Osmaniye
TR7-Middle Anatolia	Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir, Kayseri, Sivas, Yozgat
TR8-West Black Sea	Zonguldak, Karabük, Bartın, Kastamonu, Çankırı, Sinop, Samsun, Tokat, Çorum, Amasya
TR9-East Black Sea	Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane
TR10-Northeast Anatolia	Erzurum, Erzincan, Bayburt, Ağrı, Kars, Iğdır, Ardahan
TR11-Middle East Anatolia	Malatya, Elazığ, Bingöl, Tunceli, Van, Muş, Bitlis, Hakkari
TR12- Southeast Anatolia	Gaziantep, Adıyaman, Kilis, Şanlıurfa, Diyarbakır, Mardin, Batman, Şırnak, Siirt

Source: TURKSTAT (2016)

Table 8. NUTS2 Level Regions and Separation of them into West and East

West	East
Adana, Mersin-TR62 Ankara-TRS1 Antalya, Isparta, Burdur-TR61 Aydın, Denizli, Muğla-TR32 Balıkesir, Çanakkale-TR22 Bursa, Eskişehir, Bilecik-TR41 Hatay, K.Maraş, Osmaniye-TR63 Kocaeli, Sakarya, Düzce, Bolu, Yalova-TR42 Konya, Karaman-TRS2 Manisa, Afyonkarahisar, Kütahya, Uşak-TR33 Tekirdağ, Edirne, Kırklareli-TR21 İstanbul-TR10 İzmir-TR31	Ağrı, Kars, Iğdır, Ardahan-TRA2 Erzurum, Erzincan, Bayburt-TRA1 Gaziantep, Adıyaman, Kilis-TRC1 Kastamonu, Çankırı, Sinop-TR82 Kayseri, Sivas, Yozgat-TR72 Kırıkkale, Aksaray, Niğde,Nevşehir,Kırşehir-TR71 Malatya, Elazığ, Bingöl, Tunceli-TRB1 Mardin, Batman, Şırnak, Siirt-TRC3 Samsun, Tokat, Çorum, Amasya-TR83 Trabzon, Ordu, Giresun, Artvin, Gümüşhane-TR90 Van, Muş, Bitlis, Hakkari- TRB2 Zonguldak, Karabük, Bartın-TR81 Şanlıurfa, Diyarbakır-TRC2

Source: TURKSTAT (2016)

Appendix C

Table 9. Hausman Test for Unconditional Convergence

Hausman Test
Ho: difference in coefficients not systematic Prob>chi2 = 0.0000

Table 10. Diagnostic Tests for Unconditional Convergence

Diagnostic Tests		
Cross-Sectional Dependency	**Breush-Pegan LM**	Pr.: 0.0000
	Peseran	Pr.: 0.0000
	Frees	Cross Sectional Independence: 3.633 Critical Values: alpha 0.10: 0.4127 Critical Values: alpha 0.05: 0.5676 Critical Values: alpha 0.01: 0.9027
	Friedman	Pr.: 0.0014
Heteroscedasticity	**Modified Wald test for groupwise heteroskedasticity in fixed effect regression model** Pr.: 0.0000	
Serial Correlation	**Wooldridge test for autocorrelation in panel data** **H0: no first order autocorrelation** Pr.: 0.0000	

Table 11. Hausman Test for Conditional Convergence

Hausman Test
Ho: difference in coefficients not systematic Prob>chi2 = 0.0000

Table 12. Diagnostic Tests for Conditional Convergence

Diagnostic Tests		
Cross-Sectional Dependency	**Breush-Pegan LM**	Pr.: 0.0000
	Peseran	Pr.: 0.0000
	Frees	Cross Sectional Independence: 2.075
		Critical Values: alpha 0.10: 0.4127
		Critical Values: alpha 0.05: 0.5676
		Critical Values: alpha 0.01: 0.9027
	Friedman	Pr.: 0.0750
Heteroscedasticity	**Modified Wald test for groupwise heteroskedasticity in fixed effect regression model**	
	Pr.: 0.0000	
Serial Correlation	**Wooldridge test for autocorrelation in panel data**	
	H0: no first order autocorrelation	
	Pr.: 0.0000	