Analysis of Regional Income Convergence in Turkey¹

Hakkı Kutay Bolkol

Istanbul 29 Mayıs University, Department of Economics, Istanbul.

ORCID ID: 0000-0002-8979-4462

Abstract

This work investigates convergence among regions of Turkey with neoclassical exogenous growth perspective. According to results, it can be stated that there is a tendency of convergence among the regions of Turkey. However, there is an important crisis (2008 crisis) in the investigation period of this study in which the tendency of convergence increases. Besides, descriptive statistics show that during the crisis, the speed of convergence increases, however, apart from crisis and post-crisis, excess capacity periods it is impossible to state that there is convergence among regions of Turkey. On the other side, descriptive statistics show that periods without economic crisis also do not indicate divergence. Therefore, it cannot be stated that there is divergence or convergence among regions of Turkey for the investigation period of this study but the main conclusion is that crisis has a positive impact with respect to closing income differences among regions.

Key words: *Economic Growth, Regional Convergence, Turkey*

JEL classification: *O47, O50, R11, R15*

Submitted: 04.03.2019- Accepted: 21.03.2019

Introduction

On theoretical ground, the pioneer study for convergence belongs to Solow (1956). In his theory of neoclassical growth, there will be convergence among all economies towards balanced growth paths because of the assumption of decreasing return to scale to capital. More simply, according to neoclassical theory, relatively low income and capital stock regions obtain higher returns from additional unit of capital.

Neoclassical models starting with Solow (1956) can be called exogenous technology growth models since they treat technology as an exogenous factor. Technology finds itself in Total Factor Productivity (TFP), in other words, Solow residual in neoclassical models. TFP is the unexplained part of the economic growth which is not related with capital or labor. Technological advancement is accepted as an explanation for TFP. In other words, what is left after subtracting the share of capital and labor from output is TFP.

¹ This paper is a part of Hakkı Kutay Bolkol's PhD thesis at Marmara University.

When it comes to empirical ground for convergence literature, first Baumol (1986) then Barro and Sala-i Martin (1991) pave the way for other researchers by making a great contribution for the popularity of convergence among countries and regions in the field of empirical economics.

This study is about regional income convergence in Turkey. The main reason for investigating this issue is that if a country suffer from significant income differences among its regions, it is almost impossible to obtain permanent growth for this country (Doğruel and Doğruel, 2003).

The rest of the paper is organized as follows; section 2 presents a review on literature, section 3 explains how the data is converted into real term, information about methods and data is given in section 4, section 5 provides empirical results, and lastly section 6 concludes.

Literature Review

This part is divided into two as Pioneer Studies and Empirical studies on Turkey because this study works on Turkey case and the models that empirical studies use are taken from these pioneer studies.

Pioneering Studies

Baumol (1986) investigates convergence issue by touching on productivity growth. Maddison's long-run data which includes data 16 countries² is used in this work. This study indicates the existence of noteworthy convergence among developed countries. On the other hand, by investigating Summer-Heston's data that includes more countries, it is stated that only underdeveloped countries are not in a trend of convergence. By constructing a regression, inverse relationship between growth rate of GDP per work hour and absolute level of GDP per work hour is found. Therefore, paper indicates that as country's productivity level increases, its growth rate decreases. Furthermore, study also mentions the public good characteristics of knowledge and its spillover effect. In this respect, by following the leaders' footsteps, laggards can take the benefit from the public good characteristic of knowledge with spillover effect. This situation may create convergence. On the other side, less developed countries cannot benefit much from public good characteristics of knowledge owing to having insufficient human capital. This is the main reason of the poor performance of underdeveloped economies. Study indicates that the main problem of less developed countries is education. Moreover, study denies the single convergence club. In this respect, it is stated that there is one for developed countries one for middle-income countries and underdeveloped economies diverge over time.

De Long (1988) criticizes Baumol (1986) due to the problem of sample selection bias in his empirical work. According to this work, Baumol uses ex-post sample which means that sample is consist of only already rich and successfully developed countries. Moreover, Maddison also excluded some countries that have not converged from the sample. Therefore, Baumol's results do not sufficient to indicate convergence. According to De Long (1988), other countries that have a tendency to converge but haven't converged yet (ex-ante sample) need to be included into the sample. In this respect, this study adds seven³ more countries. In empirical part, different than Baumol (1986), logarithmic income specification is used because it has two additional advantages. It eases the measurement of slope and adding new countries to the existing sample. Moreover, it is stated that simple regression is not sufficient for analyzing convergence. More sophisticated estimation techniques are applied for the modified sample and study finds weak convergence. On the other side, depending on the capability of adaptation of technology, paper does not deny the force of convergence.

Beta convergence terminology is widely used in growth studies. This terminology gain popularity mainly after Barro and Sala-i Martin (1990, 1991, 1992). It investigates the relationship between growth rate of per capita income and income level in the starting period. There is beta convergence if the partial correlation between growth of income and its initial level is negative (Barro and Sala-i Martin, 1995). It assumes that sooner or later low income regions catch up the high income regions by growing faster than high income regions. In this respect, it reflects the dynamics of neoclassical growth theory in which factors of production are subject

² *Australia, Austria, Belgium, Canada , Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Sweden, Switzerland, United Kingdom, United States.*

³ *Argentina, Chile, East Germany, Ireland, New Zealand, Portugal and Spain.*

to diminishing returns. By constructing a unique model that widely used by other growth studies, Barro and Sala-i Martin (1990, 1991, 1992) make a beta convergence analysis by using panel data regression techniques. They mainly focus on the regions of United States. According to results of beta convergence analyses, Barro and Sala-i Martin (1990, 1991, 1992) find an evidence for convergence. Barro and Sala-i Martin (1990, 1991, 1992, 1995) pave the way for other studies on convergence issue with their uniquely constructed beta convergence model. A few examples (other than Turkey case), by using their model Bergström (1998) and Kangasharju (1998) find an evidence for convergence for the regions of Sweden and Finland respectively. On the other side, despite of using their model, there are also some studies that could not find an evidence for convergence like Siriopulos and Asteriou (1998) that investigates the convergence issue for the regions of Greece and Dobson and Ramlogan (2002) that examines the convergence issue for Latin America.

Empirical Studies on Turkey

Filiztekin (1999) analyzes convergence issue among Turkish provinces for 1975-1995 period. Study applies coefficient of variation method in order to investigate the degree of dispersion. According to result, the dispersion increased sharply in the investigation period. Furthermore, it is found that there is convergence only among rich provinces. In order to make a convergence analysis, paper uses beta convergence. According to results there is no unconditional convergence across Turkish provinces. Besides, paper also adds the share of agricultural sector to the equation in order to investigate the convergence issue for conditional case by control structural differences among provinces. Distinct from unconditional convergence result, it is found that there is an existence of conditional convergence across Turkish provinces.

Tansel and Güngör (1999) investigates the validity of convergence among Turkish provinces between 1975 and 1995. While examining convergence issue, dependency of convergence on human capital is also investigated in this study. Study does not use single methodology as for empirical technique. Firstly, it uses the model of Barro and Sala-i Martin (1992) in order to investigate beta convergence. Secondly, for the purpose of adding human capital in to the analysis, paper uses the methodology of Mankiw et al. (1992). Lastly, paper uses the methodology of Islam (1995) and investigate convergence issue with a dynamic model. Consequently, it is found that there is absolute convergence and adding human capital to the analysis increases the speed of convergence.

Doğruel and Doğruel (2003) examine convergence issue for Turkey for the period between 1987 and 1999. In the empirical part, in order to test the convergence, study uses beta convergence methodology from Barro and Sala-i Martin (1995). Apart from that, study also uses sigma convergence and as an alternative to sigma convergence coefficient of variation method. Beta convergence indicates the validity of convergence while sigma convergence refers weak convergence which occurs only in high income provinces. Other than high income provinces, there it is found that there is no sigma convergence. In order to eliminate the potential biased results that can be obtained from sigma convergence analysis because of large fluctuations, coefficient of variation method is used and the results prove the validity of convergence which only occurs in high income regions. Consequently, according to results, while crises and natural disasters create a convergence among provinces of Turkey, during general periods the picture is more close to indicate divergence.

Karaca (2004) also examines the convergence issue for Turkey by touching on the problem of high income differences between rich west and poor east which brings about migration problems with respect to irregular urbanization, and public order. Therefore, policies are implemented by government in order to overcome the problem of income differences among regions. This study aims to examine the success of these policies on declining the differences with respect to income. Provincial level analysis is made. The investigation period is the years between 1975 and 2000. As for empirical technique, study uses beta convergence by applying the model of Barro and Sala-i Martin (1992). In order to make more comprehensive analysis, sigma convergence and coefficient of variation methods are also used. Beta convergence is investigated with both conditional and unconditional case. For conditional case east-west dummy and the share of agricultural sector is added to the model. According to results, no evidence for convergence is found. Conversely, it is found that there is divergence among provinces of Turkey. Therefore, study concludes that there is a

requirement of reconsideration on policies implemented for decreasing the income differences across regions.

Gezici and Hewings (2004) examines convergence in Turkey between 1980 and 1997. Study implements beta convergence model for both conditional and unconditional case. Besides, sigma convergence and the method of coefficient of variation are also applied in order to make a more comprehensive analysis. According to results, no convergence is found among Turkish provinces. Moreover, there is also no evidence for convergence across functional regions of Turkey.

Research and Methodology

Converting Data into Real Term

Regional level data is available in TURKSTAT (Turkish Statistical Institute) with nominal values. Therefore, it is better to mention how the data is converted from nominal to real term. In that scope, the first way is to use the CPI data. However, on regional level, CPI data is only valid for NUTS2 level regions of Turkey. Second way is using GDP deflator. GDP deflator can be obtained by dividing nominal GDP to real GDP, however real GDP is only valid for NUTS0 level so it becomes the deflator of Turkey.

Furthermore, the price of all goods produced are taken into account in GDP deflator, while the CPI reflects only consumer side. To illustrate this point, when there is a change in the price of a good that is bought by government or firms will appear in GDP deflator, it will not be shown up in CPI. Therefore, using GDP deflator can be more beneficial. Of course, using Turkey's deflator for every regions can also cause some problems. In that respect, it is better to analyze CPI for the NUTS2 level (it is only available for NUTS2 level in TURKSTAT). If there is no much differences among regions, using GDP Deflator can be better option.

Figure 1 shows the trend of average CPI for the period between 2005 and 2017 (regional level data only valid for 2004-2017 and regional level CPI data starts with 2005). According to Figure 1, it can be stated that there is no much differences among regions so that using GDP deflator can be better way for converting the data into real term.

However, it is not sufficient to give a decision by only investigating average CPI. Therefore, standard deviation (2005-2017) and average growth rate (2006-2017) of CPI are also investigated (see Figure 2, Figure 3) and it is found that there is no much differences among regions. Consequently, it is decided to use GDP Deflator while converting the data into real term.

Note: See Appendix B, Table B.1 for the provinces included in regions specified by codes.

Source: Author's own calculations.

Figure 1: Average CPI (NUTS2)

Note: See Appendix B, Table B.1 for the provinces included in regions specified by codes.

Source: Author's own calculations.

Figure 2: Standard Deviation of CPI (NUTS2) (2005-2017)

Note: See Appendix B, Table B.1 for the provinces included in regions specified by codes.

Source: Author's own calculations.

Figure 3: Average Growth Rates of CPI (NUTS2) (%) (2006-2017)

Moreover, the comparison of beta convergence model (both for conditional and unconditional), sigma convergence and coefficient of variation with real values by using CPI and GDP deflator for NUTS2 level regions of Turkey is given in Appendix A since CPI on regional level is only valid for NUTS2. It can be observed that the results are almost the same so that using GDP Deflator is not a handicap under these conditions rather due to the reasons that are mentioned, it is relatively better than using CPI.

Methods and Data

There is beta convergence if partial correlation between growth of income and its initial level is negative (Barro and Sala-i Martin, 1995). Beta convergence indicates that poor regions grow faster than rich regions and this catching up process creates a convergence. This reflects the characteristics of neoclassical growth

theory formulated by Solow (1956) that the main assumption is that factors of production are subject to diminishing returns. In this work, beta (both conditional and unconditional) convergence analysis is made by using widely used neoclassical convergence model from Barro and Sala-i Martin (1992). The equation of the model is given below.

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

In above equation, T represents the time interval, $y_{i,t-T}$ represents per capita income in the beginning year, $y_{i,t}$ represents per capita income for region i in year t (end year). Parameter β is the measure of beta convergence. In this model, positive β refers convergence while negative β implies divergence.

There are two different ways of obtaining the β . First way is to apply linear regression and finding β from $b = \left[\frac{1-e^{-\beta T}}{T} \right]$. The second way is to construct non-linear regression that gives the value of β directly. However, in this model only beginning and end values are used. In other saying, there is a dependency of initial and end conditions. This may cause some problems if the economy faces different economic conditions like crisis in between period. Therefore, in order to use all available time periods, Lall and Yilmaz (2001) and Doğruel and Doğruel (2003) are followed and the model is converted into two successive years. The final equation for unconditional convergence is given in equation [2].

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

In this equation beta becomes “ $-\ln b$ ” by calling $\left[\frac{1-e^{-\beta T}}{T} \right]$ as “ b ” and taking the natural logarithm: $-\ln b = -\ln e^{-\beta T}$. This form can be rewritten as: $-\ln b = \beta$. The term “ T ” helps to control for the trend effect. Again positive β is required in order to indicate that there is convergence.

Moreover, in order to test the model for conditional convergence case, new variables that can represent the structural differences among regions/provinces need to be added to the equation. Within this scope, percentage share of agricultural and services sector in GDP are added to the model. Unlike per-capita income, these variables are added in current prices since they represent share, converting them into real values brings about conflict between relative and real values. Moreover, due to the nature of the model, one period lag of these variables are added to the model. Equation used to analyze conditional convergence given below.

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

In this equation $A_{i,t-1}$ and $S_{i,t-1}$ represent the percentage share of agricultural and services sector in GDP, respectively.

Furthermore, current income (GDP) data for regional level is only valid for the period between 2004 and 2017. Therefore, the investigation period for that part is the years between 2004 and 2017. The data is obtained from TURKSTAT.

Also, the analysis is made for NUTS1, NUTS2, and NUTS3 level regions of Turkey in order to make a comparison between different levels of regions.

According to Baltagi (2008) serial correlation and cross-sectional dependence are problems belong to macro panels that have long time series (over 20-30 years). Since the investigation period of this study is much shorter than this threshold, robustness check of the regressions is only made for heteroskedasticity and in the case of the validity of heteroskedasticity, robust standard errors are used. Furthermore, due to the short time period (small T), unit root tests are not applied.

Neoclassical model which investigates beta convergence from Barro and Sala-i Martin (1992) that is used in this work, usually indicates convergence because of the nature of this model. This model is about investigation between income and income with one lag. As it is mentioned, beta equals to minus natural logarithm of the coefficient of one period lagged value of income. Therefore, there is very low possibility to find negative value of beta. Consequently, there is a need to investigate some other descriptive statistics like

sigma convergence, coefficient of variation, richest poorest ratio, first second ratio and first third ratio and decrease in these ratios indicates convergence while increase implies divergence. Like in original model, in descriptive statistics, log form of income is used. Besides, descriptive statistics contains east-west comparisons in order to reach more accurate and comprehensive results. By following the general procedure east-west classification is made and it is illustrated in Appendix B. NUTS1, NUTS2 and NUTS3 level classifications are also given in Appendix B.

Apart from beta convergence, sigma convergence is also used in order to analyze the direction of change in regional differences because it investigates the standard deviation of the logarithm of per capita income. For convergence, standard deviation of income should have a decreasing trend. If it has an increasing trend, this represents divergence. Beta convergence is necessary but not sufficient condition for sigma convergence (Sala-i Martin, 1996). More simply, without sigma convergence, there may be beta convergence but if there is no beta convergence it is unnecessary to apply sigma convergence. As an alternative to sigma convergence, coefficient of variation method is also used. In this method standard deviation is divided by the mean so that potential biased results due to the potential effects of large fluctuations (because of rapid changes in growth rates) obtained from sigma convergence can be eliminated with the method of coefficient of variation. As in the sigma convergence if coefficient of variation will have a declining trend, this is a sign for convergence while increasing trend represents divergence.

Empirical Results

According to results given in Table 2 and Table 3, it can be stated that there is beta convergence for both conditional and unconditional case. Fixed-effects regression method is used as Hausman test consistently suggests as the analysis is made for the regions of Turkey and all the parts are used so that what need to be focused on is the within variation. Besides, conditional convergence results indicate higher speed of convergence because in conditional convergence structural differences among regions are controlled by using share variables of services and agricultural sector.

Apart from beta convergence analysis (both for conditional and unconditional case), other analyses like: sigma convergence, coefficient of variation, richest/poorest, first/second, first/third (The ranking is given in Appendix C) are also made.

The results obtained from sigma convergence analysis do not indicate something certain about convergence issue because while there is a decrease in trend for NUTS2 and NUTS3 level regions, for NUTS1 there is decrease in trend of east region but increase in west region. Furthermore there is no certain trend but one thing is for certain that the main decrease belongs to crisis (2008 crisis) period. Therefore, crisis creates some degree of convergence.

According to coefficient of variation results, for both levels of regions the trend is decreasing which indicates convergence. However, it is impossible to conclude something certain because again the source of the main decrease is the crisis. This situation is also valid for richest poorest analysis. Consequently, in spite of stating something certain due to the effect of crisis, coefficient of variation and richest poorest results are close to indicate that there is convergence among regions of Turkey.

On the other side, according to results of first second and first third ratio analyses, it is impossible to state something certain. At NUTS1 region there is a fluctuating trend in first second ratio analysis but comparing the beginning and end values, an increase is captured which brings about the conclusion of convergence. On the other side, at NUTS2 level there is a dominance of increasing trend. However, at NUTS3 level there is a dominance of decreasing trend. Consequently, the results of first second ratio analysis do not indicate something certain related with convergence issue among the regions of Turkey. Similarly, according to analysis of first third ratio, at NUTS1 and NUTS2 level although the trend is fluctuating, comparing beginning and end values, there is a decrease which implies convergence. On the other side, at NUTS3 level while there is a decreasing trend for east, for west there is a dominance of increasing trend.

Table 1: Beta Convergence (Unconditional)

Beta Convergence (Unconditional)					
NUTS1 (12 regions)		NUTS2 (26 regions)		NUTS3 (81 provinces)	
Heteroskedasticity Test		Heteroskedasticity Test		Heteroskedasticity Test	
Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ Pr.: 0.9969		Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ Pr.: 0.0094		Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ Pr.: 0.0000	
$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t$		$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t$		$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t$	
Fixed-effects regression Dependent Variable: $\log(y_{i,t})$		Fixed-effects regression Dependent Variable: $\log(y_{i,t})$		Fixed-effects regression Dependent Variable: $\log(y_{i,t})$	
Independent Variables	Coefficient	Independent Variables	Coefficient	Independent Variables	Coefficient
$\log(y_{i,t-1})$	0.6146*** (9.32) [0.0659]	$\log(y_{i,t-1})$	0.6752*** (16.61) [0.0407]	$\log(y_{i,t-1})$	0.6399*** (22.13) [0.0277]
T_t	0.0066*** (5.63) [0.0012]	T_t	0.0057*** (6.76) [0.0008]	T_t	0.0065*** (11.81) [0.0005]
Cons	1.5486*** (5.91) [0.2619]	Cons	1.2977*** (8.14) [0.1595]	Cons	1.4242*** (13.20) [0.1079]
Prob > F = 0.0000 R-squared (within) = 0.9449 Calculated β value: 0.4868 Result: Convergence		Prob > F = 0.0000 R-squared (within) = 0.9398 Calculated β value: 0.3927 Result: Convergence		Prob > F = 0.0000 R-squared (within) = 0.9294 Calculated β value: 0.4465 Result: Convergence	
t statistics in (), standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.		t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.		t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.	

Table 2: Beta Convergence (Conditional)

Beta Convergence (Conditional)					
NUTS1 (12 regions)		NUTS2 (26 regions)		NUTS3 (81 provinces)	
Heteroskedasticity Test		Heteroskedasticity Test		Heteroskedasticity Test	
Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ Pr.: 0.9512		Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ Pr.: 0.0018		Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ Pr.: 0.0000	
$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t + eA_{i,t-1} + fS_{i,t-1}$		$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t + eA_{i,t-1} + fS_{i,t-1}$		$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t + eA_{i,t-1} + fS_{i,t-1}$	
Fixed-effects regression Dependent Variable: $\log(y_{i,t})$		Fixed-effects regression Dependent Variable: $\log(y_{i,t})$		Fixed-effects regression Dependent Variable: $\log(y_{i,t})$	
Independent Variables	Coefficient	Independent Variables	Coefficient	Independent Variables	Coefficient
$\log(y_{i,t-1})$	0.5357*** (6.55) [0.0818]	$\log(y_{i,t-1})$	0.6227*** (9.33) [0.0667]	$\log(y_{i,t-1})$	0.5926*** (14.22) [0.0417]
T_t	0.0080*** (6.36) [0.0013]	T_t	0.0070*** (6.00) [0.0012]	T_t	0.0074*** (10.76) [0.0007]
$A_{i,t-1}$	0.0010 (0.55) [0.0016]	$A_{i,t-1}$	0.0014 (1.39) [0.0010]	$A_{i,t-1}$	0.0002 (0.29) [0.0006]
$S_{i,t-1}$	-0.0024** (-2.00) [0.0012]	$S_{i,t-1}$	-0.0016 (-1.47) [0.0011]	$S_{i,t-1}$	-0.0009 (-1.63) [0.0006]
Cons	1.9794*** (5.23) [0.3781]	Cons	1.5629*** (4.99) [0.3132]	Cons	1.6526*** (8.57) [0.1928]
Prob > F = 0.0000 R-squared (within)= 0.9488 Calculated β value: 0.6242 Result: Convergence		Prob > F = 0.0000 R-squared (within)= 0.9437 Calculated β value: 0.4736 Result: Convergence		Prob > F = 0.0000 R-squared (within)= 0.9301 Calculated β value: 0.5233 Result: Convergence	
t statistics in (), standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.		t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.		t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.	

Sigma Convergence of log(y)														
NUTS1 (12 regions)					NUTS2 (26 regions)					NUTS3 (81 provinces)				
year	All	West	East		year	All	West	East		year	All	West	East	
2004	0.1768	0.0996	0.0765		2004	0.1766	0.1300	0.1016		2004	0.1627	0.1257	0.1142	
2005	0.1760	0.0993	0.0803		2005	0.1760	0.1273	0.1026		2005	0.1617	0.1250	0.1132	
2006	0.1786	0.1015	0.0817		2006	0.1787	0.1327	0.1011		2006	0.1643	0.1299	0.1135	
2007	0.1797	0.1034	0.0808		2007	0.1791	0.1330	0.1026		2007	0.1636	0.1282	0.1133	
2008	0.1789	0.1033	0.0841		2008	0.1781	0.1294	0.1058		2008	0.1636	0.1230	0.1171	
2009	0.1710	0.1017	0.0782		2009	0.1698	0.1243	0.1011		2009	0.1546	0.1171	0.1120	
2010	0.1603	0.0929	0.0740		2010	0.1592	0.1189	0.0928		2010	0.1440	0.1106	0.1051	
2011	0.1627	0.0947	0.0765		2011	0.1614	0.1190	0.0981		2011	0.1483	0.1128	0.1099	
2012	0.1576	0.0954	0.0721		2012	0.1553	0.1167	0.0909		2012	0.1430	0.1114	0.1039	
2013	0.1593	0.0993	0.0717		2013	0.1569	0.1180	0.0941		2013	0.1436	0.1134	0.1034	
2014	0.1594	0.0974	0.0737		2014	0.1578	0.1148	0.0979		2014	0.1453	0.1105	0.1053	
2015	0.1572	0.1008	0.0776		2015	0.1554	0.1148	0.0996		2015	0.1417	0.1100	0.1054	
2016	0.1569	0.1025	0.0705		2016	0.1532	0.1133	0.0958		2016	0.1398	0.1066	0.1029	
2017	0.1593	0.1037	0.0707		2017	0.1547	0.1135	0.0957		2017	0.1418	0.1073	0.1054	

Sigma Convergence

Standard Deviation (all)
Standard deviation (west)
Standard deviation (east)

Sigma Convergence

Standard Deviation (all)
Standard deviation (west)
Standard deviation (east)

Sigma convergence

Standard Deviation (all)
Standard deviation (west)
Standard deviation (east)

Coefficient of Variation of log(y)												
NUTS1 (12 regions)				NUTS2 (26 regions)				NUTS3 (81 provinces)				
year	All	West	East	year	All	West	East	year	All	West	East	
2004	0.0442	0.0240	0.0199	2004	0.0444	0.0316	0.0264	2004	0.0413	0.0309	0.0297	
2005	0.0436	0.0237	0.0207	2005	0.0439	0.0307	0.0265	2005	0.0407	0.0305	0.0292	
2006	0.0440	0.0241	0.0209	2006	0.0443	0.0319	0.0260	2006	0.0412	0.0315	0.0291	
2007	0.0441	0.0245	0.0206	2007	0.0443	0.0318	0.0262	2007	0.0408	0.0310	0.0290	
2008	0.0439	0.0245	0.0215	2008	0.0440	0.0310	0.0270	2008	0.0408	0.0297	0.0299	
2009	0.0422	0.0242	0.0200	2009	0.0422	0.0299	0.0259	2009	0.0387	0.0284	0.0287	
2010	0.0392	0.0220	0.0187	2010	0.0392	0.0285	0.0235	2010	0.0357	0.0267	0.0266	
2011	0.0395	0.0222	0.0192	2011	0.0394	0.0282	0.0247	2011	0.0365	0.0270	0.0276	
2012	0.0381	0.0223	0.0180	2012	0.0377	0.0276	0.0227	2012	0.0350	0.0265	0.0259	
2013	0.0382	0.0231	0.0178	2013	0.0379	0.0277	0.0234	2013	0.0349	0.0268	0.0257	
2014	0.0381	0.0226	0.0182	2014	0.0379	0.0268	0.0242	2014	0.0352	0.0260	0.0260	
2015	0.0374	0.0233	0.0190	2015	0.0372	0.0268	0.0245	2015	0.0342	0.0258	0.0259	
2016	0.0373	0.0236	0.0173	2016	0.0366	0.0264	0.0235	2016	0.0336	0.0250	0.0252	
2017	0.0376	0.0238	0.0172	2017	0.0368	0.0263	0.0234	2017	0.0340	0.0250	0.0257	

Coefficient of Variation

—●— Coefficient of Variation (all)
 —●— Coefficient of variation (west)
 —●— Coefficient of variation (east)

Coefficient of Variation

—●— Coefficient of Variation (all)
 —●— Coefficient of variation (west)
 —●— Coefficient of variation (east)

Coefficient of Variation

—●— Coefficient of Variation (all)
 —●— Coefficient of variation (west)
 —●— Coefficient of variation (east)

Richest/Poorest ratio of log(y)												
NUTS1 (12 regions)				NUTS2 (26 regions)				NUTS3 (81 provinces)				
year	All	West	East	year	All	West	East	year	All	West	East	
2004	1.1547	1.0800	1.0520	2004	1.1861	1.1210	1.0894	2004	1.2007	1.1468	1.1220	
2005	1.1476	1.0786	1.0482	2005	1.1801	1.1172	1.0837	2005	1.1990	1.1415	1.1248	
2006	1.1507	1.0795	1.0492	2006	1.1811	1.1228	1.0840	2006	1.2095	1.1442	1.1344	
2007	1.1483	1.0790	1.0472	2007	1.1787	1.1200	1.0817	2007	1.2108	1.1381	1.1346	
2008	1.1481	1.0796	1.0471	2008	1.1782	1.1180	1.0811	2008	1.2166	1.1329	1.1375	
2009	1.1456	1.0784	1.0475	2009	1.1741	1.1168	1.0787	2009	1.2058	1.1319	1.1248	
2010	1.1368	1.0718	1.0461	2010	1.1653	1.1056	1.0761	2010	1.1785	1.1086	1.1071	
2011	1.1361	1.0733	1.0478	2011	1.1639	1.1052	1.0773	2011	1.1901	1.1100	1.1174	
2012	1.1342	1.0750	1.0451	2012	1.1531	1.1079	1.0678	2012	1.1835	1.1132	1.1185	
2013	1.1315	1.0766	1.0430	2013	1.1550	1.1074	1.0706	2013	1.1862	1.1123	1.1161	
2014	1.1324	1.0752	1.0451	2014	1.1557	1.1058	1.0714	2014	1.1883	1.1093	1.1153	
2015	1.1339	1.0765	1.0462	2015	1.1616	1.1062	1.0751	2015	1.1874	1.1123	1.1110	
2016	1.1315	1.0788	1.0435	2016	1.1571	1.1046	1.0718	2016	1.1812	1.1102	1.1072	
2017	1.1347	1.0796	1.0461	2017	1.1613	1.1028	1.0743	2017	1.1844	1.1103	1.1106	

Richest/Poorest

—●— Richest/Poorest all
—●— Richest/Poorest west
—●— Richest/Poorest east

Richest/Poorest

—●— Richest/Poorest (all)
—●— Richest/Poorest (west)
—●— Richest/Poorest (east)

Richest/Poorest

—●— Richest/Poorest (all)
—●— Richest/Poorest (west)
—●— Richest/Poorest (east)

1st/2 nd ratio of log(y)												
NUTS1 (12 regions)				NUTS2 (26 regions)				NUTS3 (81 provinces)				
year	All	West	East	year	All	West	East	year	All	West	East	
2004	1.0297	1.0297	1.0076	2004	1.0097	1.0097	1.0028	2004	1.0097	1.0097	1.0114	
2005	1.0281	1.0281	1.0045	2005	1.0085	1.0085	1.0047	2005	1.0085	1.0085	1.0163	
2006	1.0282	1.0282	1.0018	2006	1.0083	1.0083	1.0081	2006	1.0078	1.0078	1.0096	
2007	1.0259	1.0259	1.0029	2007	1.0060	1.0060	1.0060	2007	1.0060	1.0060	1.0078	
2008	1.0266	1.0266	1.0018	2008	1.0071	1.0071	1.0043	2008	1.0068	1.0068	1.0009	
2009	1.0247	1.0247	1.0034	2009	1.0061	1.0061	1.0024	2009	1.0061	1.0061	1.0001	
2010	1.0275	1.0275	1.0051	2010	1.0090	1.0090	1.0033	2010	1.0088	1.0088	1.0006	
2011	1.0299	1.0299	1.0092	2011	1.0128	1.0128	1.0044	2011	1.0027	1.0027	1.0020	
2012	1.0326	1.0326	1.0057	2012	1.0163	1.0163	1.0049	2012	1.0039	1.0039	1.0080	
2013	1.0315	1.0315	1.0072	2013	1.0162	1.0162	1.0084	2013	1.0007	1.0007	1.0022	
2014	1.0308	1.0308	1.0061	2014	1.0171	1.0171	1.0084	2014	1.0003	1.0003	1.0008	
2015	1.0321	1.0321	1.0008	2015	1.0198	1.0198	1.0040	2015	1.0019	1.0019	1.0021	
2016	1.0331	1.0331	1.0066	2016	1.0190	1.0190	1.0083	2016	1.0030	1.0030	1.0015	
2017	1.0325	1.0325	1.0084	2017	1.0218	1.0218	1.0071	2017	1.0006	1.0006	1.0025	

1st/2nd

1st/2nd (all) 1st/2nd (west) 1st/2nd (east)

1st/2nd

1st/2nd (all) 1st/2nd (west) 1st/2nd (east)

1st/2nd

1st/2nd (all) 1st/2nd (west) 1st/2nd (east)

Table 7: First Third Ratio

1st/3rd ratio of log(y)												
NUTS1 (12 regions)				NUTS2 (26 regions)				NUTS3 (81 provinces)				
year	All	West	East	year	All	West	East	year	All	West	East	
2004	1.0406	1.0406	1.0101	2004	1.0342	1.0342	1.0168	2004	1.0155	1.0155	1.0138	
2005	1.0376	1.0376	1.0095	2005	1.0342	1.0342	1.0101	2005	1.0121	1.0121	1.0175	
2006	1.0352	1.0352	1.0084	2006	1.0317	1.0317	1.0084	2006	1.0083	1.0083	1.0155	
2007	1.0353	1.0353	1.0088	2007	1.0318	1.0318	1.0092	2007	1.0072	1.0072	1.0148	
2008	1.0356	1.0356	1.0052	2008	1.0312	1.0312	1.0078	2008	1.0071	1.0071	1.0098	
2009	1.0392	1.0392	1.0062	2009	1.0358	1.0358	1.0082	2009	1.0138	1.0138	1.0004	
2010	1.0371	1.0371	1.0080	2010	1.0317	1.0317	1.0087	2010	1.0090	1.0090	1.0029	
2011	1.0339	1.0339	1.0099	2011	1.0270	1.0270	1.0097	2011	1.0128	1.0128	1.0050	
2012	1.0339	1.0339	1.0078	2012	1.0272	1.0272	1.0107	2012	1.0163	1.0163	1.0097	
2013	1.0320	1.0320	1.0084	2013	1.0249	1.0249	1.0110	2013	1.0162	1.0162	1.0075	
2014	1.0314	1.0314	1.0087	2014	1.0234	1.0234	1.0092	2014	1.0171	1.0171	1.0036	
2015	1.0336	1.0336	1.0081	2015	1.0242	1.0242	1.0085	2015	1.0198	1.0198	1.0023	
2016	1.0331	1.0331	1.0078	2016	1.0256	1.0256	1.0093	2016	1.0190	1.0190	1.0040	
2017	1.0353	1.0353	1.0099	2017	1.0243	1.0243	1.0091	2017	1.0218	1.0218	1.0042	

1st/3rd

1st/3rd (all) 1st/3rd (west) 1st/3rd (east)

1st/3rd

1st/3rd (all) 1st/3rd (west) 1st/3rd (east)

1st/3rd

1st/3rd (all) 1st/3rd (west) 1st/3rd (east)

Table 8 given below summarizes the general result obtained from different models and techniques.

Table 8: General Result

Method	General Result
Beta Convergence (Unconditional)	Convergence
Beta Convergence (Conditional)	Convergence
Sigma Convergence	Uncertain (close to convergence in Nust2 and Nuts3; close to convergence in east, close to divergence in west for Nuts1)
Coefficient of Variation	Close to convergence
Richest/Poorest	Close to convergence
1st/2nd	Uncertain (close to divergence in Nuts1; divergence in Nuts2; convergence in Nuts3)
1st/3rd	Uncertain (Close to convergence for Nuts1 and Nuts2; divergence in west, convergence in east for Nuts3)

Investigating the issue from general perspective, there is higher possibility to find convergence because there is global crisis (2008 crisis) in the short investigation period of this study. This is because crises (especially crises related with financial sector) hit riches more than the poor. Therefore, probability of finding convergence gets higher during this type of crises. What's more, neoclassical model from Barro and Sala-i Martin (1992) is a convergence-sided model. Because beta is equal to minus natural logarithm of the coefficient of one period lagged value of income, there is very low possibility to find beta with negative value since when the coefficient of income with one period lag is between zero and one, calculated beta becomes positive. Not surprisingly, in this study it is also found that there is convergence in beta convergence analysis.

Consequently, according to the results obtained from neoclassical beta convergence analysis and other statistical analysis and descriptive statistics, it can be stated that the results are close to state that there is convergence among Turkish regions. The reason for using the word "close" is that the results obtained from descriptive statistics like sigma convergence, coefficient of variation, Richest-poorest ratio, first-second ratio, first-third ratio, do not give a clear picture and there is an important crisis (2008 crisis) in the investigation period in which the tendency of convergence increases. Maybe if there was no crisis in the investigation period of this study, the results would be different however due to the lack of regional data for Turkey it is impossible to extend to time dimension. Moreover, in order to handle the convergence issue in a more general framework, it is better to investigate per-capita income and its growth for poor east and rich west separately during the investigation period. In order to make such an aggregate east-west classification in per-capita terms, there is a need to use mid-year region population estimation because per-capita GDP represents aggregate GDP divided by the mid-year region population estimation. Per-capita income and aggregate income is available in TURKSTAT so that mid-year population estimation can be found by dividing aggregate income to per-capita income. Thereafter, for east and west regions real GDP and mid-year population estimation for every unit are added, according to whether they belong west or east, for every year and by dividing total real GDP to mid-year population estimation, real GDP per-capita and real GDP per-capita growth for east and west is found. (It is not reported but after that, for robustness check, by summing east and west total GDP and mid-year population estimation, per-capita GDP and per-capita GDP growth for Turkey is found and comparing with the original data the same results are found).

According to Table 9 and Figure 1, as it is known west region is much wealthier than east region. And apart from the crisis period the gap does not seem to be closed.

Table 9: West-East Real GDP Per-capita

year	(WEST) Real GDP Per-capita	(EAST) Real GDP Per-capita
2004	15343.3221	7137.4532
2005	16485.7305	7711.7600
2006	17465.1251	8059.9938
2007	18126.0308	8296.5681
2008	18011.5170	8302.5362
2009	16824.3078	7978.8483
2010	17796.1933	8819.3394
2011	19494.4316	9580.4002
2012	20107.0902	10012.3148
2013	21526.7532	10694.1502
2014	22302.0967	11099.6096
2015	23258.2885	11731.7364
2016	23683.9728	11883.8094
2017	25164.7197	12469.6595
Average	19684.9700	9555.5842

Figure 4: West-East Real GDP Per-capita

Per-capita growth rates are given in Table 10 and Figure 5. According to table and figure, it can be stated that east region grows more than west region. However, as it can be seen, if crisis period subtracted from the sample the difference in growth rates becomes smaller because as it can be predicted, crisis hits rich regions more than poor regions. What's more, if after crisis excess capacity period (2010-2011) is also subtracted from the sample as well as crisis period (2008-2009), the growth of west becomes more than the growth of east (for 2005-2007 and 2012-2017 Growth of West: 4.8162; Growth of East (%): 4.7253). Therefore, it is impossible to state that there is convergence. At the same time it is also impossible to state that there is divergence. However, empirical results and descriptive statistics closer to indicate that there is convergence probably due to the effect of crisis.

Table 10: West-East Real GDP Per-capita Growth (%)

Year	(WEST) Real GDP Per-capita Growth (%)	(EAST) Real GDP Per-capita Growth (%)
2005	7.4456	8.0464
2006	5.9409	4.5156
2007	3.7841	2.9352
2008	-0.6318	0.0719
2009	-6.5914	-3.8987
2010	5.7767	10.5340
2011	9.5427	8.6295
2012	3.1427	4.5083
2013	7.0605	6.8100
2014	3.6018	3.7914
2015	4.2875	5.6950
2016	1.8302	1.2963
2017	6.2521	4.9298
Average	3.9571	4.4511

Figure 5: West-East Real GDP Per-capita Growth (%)

Conclusion

In this work, convergence issue for the regions of Turkey is investigated with neoclassical exogenous growth perspective. According to results it can be stated that there is a tendency of convergence for the regions of Turkey. However, one should keep in mind that there is an important crisis (2008 crisis) in the investigation period of this study in which the tendency of convergence increases. Besides, descriptive statistics show that during the crisis, the speed of convergence increases, however, generally it cannot be captured that there is convergence among regions of Turkey in periods other than crisis and post-crisis, excess capacity periods. On the other side, descriptive statistics show that periods without economic crisis do not indicate divergence also. Therefore, it cannot be stated that there is convergence or divergence among regions of Turkey for the investigation period of this study but the main conclusion is that crisis has a positive impact with respect to closing income differences among regions.

References

- Baltagi, B.H. (2008). *Econometric Analysis of Panel Data*, Wiley.
- Barro, R. J. and Sala-i-Martin, X. (1990). Economic growth and convergence across the United States (No. w3419). *National Bureau of Economic Research*.
- Barro R.J. and Sala-i Martin, X. (1991). Convergence across States and Regions. *Brooking Papers on Economic Activity*, 1, pp. 107-182.
- Barro, R. and Sala-i Martin, X. (1992). Convergence. *Journal of Political Economy*, 100(2), April, pp. 223-251.
- 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, pp. 1072-1085.
- Bergstrom, F. (1998). Regional policy and convergence of real per capita income among Swedish counties. Stockholm School of Economics..
- De Long, J.B. (1988). Productivity Growth, Convergence, and Welfare: Comment. *The American Economic Review*, Vol. 78, Issue 5, December, pp. 1138-1154.

- Dobson, S., & Ramlogan, C. (2002). Convergence and divergence in Latin America, 1970-1998. *Applied Economics*, 34(4), 465-470.
- Doğruel, F. and Doğruel, A.S. (2003). Türkiye'de bölgesel gelir farklılıkları ve büyüme. In: A. H. Kose, F. Senses and E.Yeldan, eds. 2003. *İktisat Üzerine Yazılar I: Küresel Düzen, Birikim, Devlet ve Sınıflar, Korkut Boratav'a Armagan*, pp. 287-318.
- Filiztekin, A. (1999). Convergence across Turkish Provinces and Sectoral Dynamics. *background paper for World Bank*.
- 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.
- Islam, N. (1995). Growth Empirics: A Panel Data Approach. *Quarterly Journal of Economics*, CX, pp. 1127-1170.
- Kangasharju, A. (1998). Beta convergence in Finland: regional differences in speed of convergence. *Applied Economics*, 30(5), 679-687.
- Karaca, O. (2004). Türkiye'de Bölgeler Arası Gelir Farklılıkları: Yakınsama Var mı?. *Turkish Economic Association, Discussion paper*, 2004/7.
- Lall, S. and Yılmaz, K. (2001). Regional Economic Convergence: Do Policy Instruments Make a Difference?. *Springer-Verlag*, 35, pp. 153-166.
- Mankiw, N. G., Romer, D. and Weil, D.N. (1992). A Contribution to Empirics of Economic Growth. *Quarterly Journal of Economics*, CVII, pp. 407-437.
- Sala-i Martin, X. (1996). The classical approach to convergence analysis. *The Economic Journal*, 106(437) July, pp. 1019-1036.
- Siriopoulos, C., & Asteriou, D. (1998). Testing for convergence across the Greek regions. *Regional Studies*, 32(6), 537-546.
- Solow, R.M. (1956). A Contribution to the Theory of Economic Growth. *Quarterly Journal of Economics*, 70, pp. 65-94.
- Tansel, A. and Güngör, 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*.

Appendix A

Table A.1: Comparison between GDP Deflator and CPI (2005-2017) (1)

Beta Convergence (Unconditional) NUTS2			
GDP DEFLATOR		CPI	
Heteroskedasticity Test		Heteroskedasticity Test	
Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ for all i Pr.: 0.0001		Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ for all i Pr.: 0.0000	
$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t$		$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t$	
Unconditional Convergence Results Fixed-effects regression Dependent Variable: $\log(y_{i,t})$		Unconditional Convergence Results Fixed-effects regression Dependent Variable: $\log(y_{i,t})$	
Independent Variables	Coefficient	Independent Variables	Coefficient
$\log(y_{i,t-1})$	0.6720*** (1685.29) [0.0399]	$\log(y_{i,t-1})$	0.6360*** (17.50) [0.0363]
T_t	0.0064*** (7.32) [0.0009]	T_t	0.0068*** (8.59) [0.0007]
Cons	1.3103*** (8.36) [0.1568]	Cons	1.3767*** (10.15) [0.1356]
Prob > F = 0.0000 Calculated β value: 0.3975		Prob > F = 0.0000 Calculated β value: 0.4525	
R-squared (within) = 0.9367 Result: Convergence		R-squared (within) = 0.9133 Result: Convergence	
t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.		t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.	

Table A.2: Comparison between GDP Deflator and CPI (2005-2017) (2)

Beta Convergence (Conditional) NUTS2			
GDP DEFLATOR		CPI	
Heteroskedasticity Test		Heteroskedasticity Test	
Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ for all i Pr.: 0.0000		Modified Wald test H0: $\sigma(i)^2 = \sigma^2$ for all i Pr.: 0.0000	
$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t + eA_{i,t-1} + fS_{i,t-1}$		$\log(y_{i,t}) = \alpha + b \log(y_{i,t-1}) + cT_t + eA_{i,t-1} + fS_{i,t-1}$	
Conditional Convergence Results Fixed-effects regression Dependent Variable: $\log(y_{i,t})$		Conditional Convergence Results Fixed-effects regression Dependent Variable: $\log(y_{i,t})$	
Independent Variables	Coefficient	Independent Variables	Coefficient
$\log(y_{i,t-1})$	0.6436*** (11.05) [0.0582]	$\log(y_{i,t-1})$	0.6051*** (9.57) [0.0632]
T_t	0.0074*** (6.85) [0.0011]	T_t	0.0072*** (7.65) [0.0009]
$A_{i,t-1}$	0.0024** (2.30) [0.0009]	$A_{i,t-1}$	0.0024** (2.36) [0.0010]
$S_{i,t-1}$	-0.0009 (-1.01) [0.0009]	$S_{i,t-1}$	-0.0010 (-1.00) [0.0010]
Cons	1.4391*** (5.34) [0.2697]	Cons	1.5090*** (5.25) [0.2875]
Prob > F = 0.0000 R-squared (within)= 0.9408 Calculated β value: 0.4407 Result: Convergence		Prob > F = 0.0000 R-squared (within)= 0.9205 Calculated β value: 0.5024 Result: Convergence	
t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.		t statistics in (), robust standard errors in [], ***/**/* indicate significance at 1%, 5% and 10% respectively.	

Table A.3: Comparison between GDP Deflator and CPI (2005-2017) (3)

Sigma Convergence of log(y) NUTS2													
GDP DEFLATOR						CPI							
year	Standard (all)	Deviation	Standard (west)	deviation	Standard (east)	deviation	year	Standard (all)	Deviation	Standard (west)	deviation	Standard (east)	deviation
2005	0.1760		0.1273		0.0991		2005	0.1692		0.1243		0.0978	
2006	0.1787		0.1327		0.0975		2006	0.1695		0.1266		0.0948	
2007	0.1791		0.1330		0.0990		2007	0.1712		0.1281		0.0963	
2008	0.1781		0.1294		0.1021		2008	0.1722		0.1242		0.1005	
2009	0.1698		0.1243		0.0975		2009	0.1658		0.1196		0.0980	
2010	0.1592		0.1189		0.0897		2010	0.1562		0.1160		0.0904	
2011	0.1614		0.1190		0.0948		2011	0.1603		0.1177		0.0964	
2012	0.1553		0.1167		0.0876		2012	0.1546		0.1158		0.0888	
2013	0.1569		0.1180		0.0908		2013	0.1560		0.1163		0.0921	
2014	0.1578		0.1148		0.0944		2014	0.1563		0.1119		0.0951	
2015	0.1554		0.1148		0.0961		2015	0.1528		0.1117		0.0962	
2016	0.1532		0.1133		0.0924		2016	0.1503		0.1103		0.0925	
2017	0.1547		0.1135		0.0925		2017	0.1530		0.1119		0.0924	

Sigma Convergence

Standard Deviation (all) Standard deviation (west) Standard deviation (east)

Sigma convergence

Standard Deviation (all) Standard deviation (west) Standard deviation (east)

Table A.4: Comparison between GDP Deflator and CPI (2005-2017) (4)

Coefficient of Variation of log(y) NUTS2							
GDP DEFLATOR				CPI			
year	Coefficient of Variation (all)	Coefficient of variation (west)	Coefficient of variation (east)	year	Coefficient of Variation (all)	Coefficient of variation (west)	Coefficient of variation (east)
2005	0.0439	0.0307	0.0256	2005	0.0445	0.0316	0.0266
2006	0.0443	0.0319	0.0250	2006	0.0443	0.0320	0.0256
2007	0.0443	0.0318	0.0253	2007	0.0447	0.0324	0.0260
2008	0.0440	0.0310	0.0261	2008	0.0449	0.0314	0.0271
2009	0.0422	0.0299	0.0250	2009	0.0435	0.0304	0.0266
2010	0.0392	0.0285	0.0227	2010	0.0407	0.0293	0.0243
2011	0.0394	0.0282	0.0238	2011	0.0413	0.0294	0.0256
2012	0.0377	0.0276	0.0219	2012	0.0397	0.0289	0.0235
2013	0.0379	0.0277	0.0225	2013	0.0399	0.0289	0.0242
2014	0.0379	0.0268	0.0234	2014	0.0398	0.0277	0.0250
2015	0.0372	0.0268	0.0236	2015	0.0387	0.0276	0.0251
2016	0.0366	0.0264	0.0227	2016	0.0380	0.0272	0.0240
2017	0.0368	0.0263	0.0226	2017	0.0385	0.0274	0.0239

Coefficient of Variation

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

—●— Coefficient of Variation (all) - - -●- - Coefficient of variation (west)

...●... Coefficient of variation (east)

Coefficient of Variation

2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

—●— Coefficient of Variation (all) - - -●- - Coefficient of variation (west)

...●... Coefficient of variation (east)

Appendix B

Figure B.1: East-West Classification

Table B.1: NUTS1-NUTS2-NUTS3

NUTS 1		NUTS 2		NUTS 3		NUTS 1		NUTS 2		NUTS 3			
TR Turkey													
TR1	Istanbul	TR10	İstanbul	TR100	İstanbul	TR8	West Black Sea	TR81	(Zonguldak, Karabük, Bartın)	TR811	Zonguldak		
TR2	West Marmara	TR21	(Tekirdağ, Edirne, Kırklareli)	TR211	Tekirdağ				TR82	(Kastamonu, Çankırı, Sinop)	TR812	Karabük	
			TR22	(Balıkesir, Çanakkale)	TR212					Edirne	TR813	Bartın	
					TR213					Kırklareli	TR821	Kastamonu	
		TR3	Aegean	TR31	(İzmir, Aydın, Denizli, Muğla)			TR221	Balıkesir	TR83	(Samsun, Tokat, Çorum, Amasya)	TR222	Çankırı
TR32	(Manisa, Afyonkarahisar, Kütahya, Uşak)				TR222			Çanakkale	TR823		Sinop		
					TR310			İzmir	TR831		Samsun		
TR33	(Bursa, Eskişehir, Bilecik)			TR321	Aydın			TR832	Tokat				
				TR322	Denizli			TR833	Çorum				
				TR323	Muğla			TR834	Amasya				
				TR331	Manisa	TR901	Trabzon						
TR4	East Marmara			TR41	(Kocaeli, Sakarya, Düzce, Bolu, Yalova)	TR332	Afyonkarahisar	TR9	East Black Sea	TR90	(Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane)	TR902	Ordu
						TR333	Kütahya				TR903	Giresun	
		TR334	Uşak			TR904	Rize						
		TR411	Bursa			TR905	Artvin						
		TR412	Eskişehir			TR906	Gümüşhane						
TR5	West Anatolia	TR42	(Ankara)	TR413	Bilecik	TRA	North East Anatolia	TRA1	(Erzurum, Erzincan, Bayburt)	TRA11	Erzurum		
				TR421	Kocaeli				TRA12	Erzincan			
				TR422	Sakarya				TRA13	Bayburt			
				TR423	Düzce				TRA21	Ağrı			
				TR424	Bolu			TRA22	Kars				
TR6	Mediterranean	TR51	(Konya, Karaman)	TR425	Yalova	TRB	Central East Anatolia	TRA2	(Ağrı, Kars, Iğdır, Ardahan)	TRA23	Iğdır		
				TR510	Ankara				TRA24	Ardahan			
				TR521	Konya				TRB1	(Malatya, Elazığ, Bingöl, Tunceli)	TRB11	Malatya	
				TR522	Karaman				TRB12	Elazığ			
				TR7	Central Anatolia			TR61	(Antalya, Isparta, Burdur)	TR611	Antalya	TRC	South East Anatolia
TR612	Isparta	TRB14	Tunceli										
TR613	Burdur	TRB21	Van										
TR621	Adana	TRB22	Muş										
TR622	Mersin	TRB23	Bitlis										
TR8	Black Sea	TR63	(Hatay, Kahramanmaraş, Osmaniye)	TR623	Mersin	TRC1	(Gaziantep, Adıyaman, Kilis)	TRB24	Hakkari				
				TR631	Hatay		TRC11	Gaziantep					
				TR632	Kahramanmaraş		TRC12	Adıyaman					
				TR633	Osmaniye		TRC13	Kilis					
				TR71	(Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir)		TRC2	(Şanlıurfa, Diyarbakır)	TRC21	Şanlıurfa			
TR9	East Black Sea	TR71	(Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir)	TR711	Kırıkkale	TRC2	(Mardin, Batman, Şırnak, Siirt)	TRC22	Diyarbakır				
				TR712	Aksaray		TRC31	Mardin					
				TR713	Niğde		TRC32	Batman					
				TR714	Nevşehir		TRC33	Şırnak					
				TR715	Kırşehir		TRC34	Siirt					
TR10	Central Anatolia	TR72	(Kayseri, Sivas, Yozgat)	TR721	Kayseri	TRC3	South East Anatolia	TRC3	Şırnak, Siirt)	TR722	Sivas		
				TR723	Yozgat					TR721	Kayseri		
				TR722	Sivas					TR722	Sivas		
				TR723	Yozgat					TR723	Yozgat		
				TR724						TR724			

Source: TURKSTAT

Appendix C

Table C.1: Ranking (all)

RANKING (2004-2017) all								
NUTS1 (12 regions)				NUTS2 (26 regions)			NUTS3 (81 regions)	
2004, 2006-2008, 2010-2011, 2013,2016	2005	2009, 2012	2014-2015, 2017	2004-2005	2006-2017 (except 2013)	2013	2004-2005, 2007, 2009	2006, 2008, 2010-2017
1. Istanbul 2. West Anatolia 3. East Marmara 12. Central East Anatolia	1. Istanbul 2. West Anatolia 3. East Marmara 12. North East Anatolia	1. Istanbul 2. West Anatolia 3. East Marmara 12. South East Anatolia	1. Istanbul 2. East Marmara 3. West Anatolia 12. Central East Anatolia	1. Istanbul 2. Ankara 3. Izmir 26. Van, Muş, Bitlis, Hakkari	1. Istanbul 2. Ankara 3. Kocaeli, Sakarya, Düzce, Bolu, Yalova 26. Van, Muş, Bitlis, Hakkari	1. Istanbul 2. Ankara 3. Kocaeli, Sakarya, Düzce, Bolu, Yalova 26. Ağrı, Kars, Iğdır, Ardahan	1. Istanbul 2. Ankara 3. Kocaeli 81. Ağrı	1. Istanbul 2. Kocaeli 3. Ankara 81. Ağrı

RANKING (2004-2017) west						
NUTS1 (12 regions)		NUTS2 (26 regions)		NUTS3 (81 regions)		
2004-2013, 2016	2014-2015, 2017	2004-2005	2006-2017	2004-2005, 2007, 2009	2006, 2008, 2010, 2012- 2013, 2015	2011, 2014, 2016-2017
1. Istanbul 2. West Anatolia 3. East Marmara 6. Mediterranean	1. Istanbul 2. East Marmara 3. West Anatolia 6. Mediterranean	1. Istanbul 2. Ankara 3. Izmir 13. Hatay, Kahramanmaraş, Osmaniye	1. Istanbul 2. Ankara 3. Kocaeli, Sakarya, Düzce, Bolu, Yalova 13. Hatay, Kahramanmaraş, Osmaniye	1. Istanbul 2. Ankara 3. Kocaeli 33. Osmaniye	1. Istanbul 2. Kocaeli 3. Ankara 33. Osmaniye	1. Istanbul 2. Kocaeli 3. Ankara 33. Kahramanmaraş

RANKING (2004-2017) east										
NUTS1 (12 regions)		NUTS2 (26 regions)					NUTS3 (81 regions)			
2004	2005	2004	2005-2010, 2012	2011	2013	2014, 2016	2004	2005-2007	2008	2009
1. Central Anatolia 2. West Black Sea 3. East Black sea 6. Central East Anatolia	1. Central Anatolia 2. East Black Sea 3. West Black Sea 6. Northeast Anatolia	1. Kastamonu, Çankırı, Sinop 2. Kayseri, Sivas, Yozgat 3. Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir 13. Van, Muş, Bitlis, Hakkari	1. Kayseri, Sivas, Yozgat 2. Kastamonu, Çankırı, Sinop 3. Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane 13. Van, Muş, Bitlis, Hakkari	1. Kayseri, Sivas, Yozgat 2. Kastamonu, Çankırı, Sinop 3. Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir 13. Van, Muş, Bitlis, Hakkari	1. Kayseri, Sivas, Yozgat 2. Kastamonu, Çankırı, Sinop 3. Zonguldak, Karabük, Bartın 13. Ağrı, Kars, Iğdır, Ardahan	1. Kayseri, Sivas, Yozgat 2. Kastamonu, Çankırı, Sinop 3. Zonguldak, Karabük, Bartın 13. Van, Muş, Bitlis, Hakkari	1. Kayseri 2. Kastamonu 3. Erzincan 48. Ağrı	1. Kayseri 2. Artvin 3. Trabzon 48. Ağrı	1. Kayseri 2. Artvin 3. Erzincan 48. Ağrı	1. Erzincan 2. Artvin 3. Kayseri 48. Ağrı
2006-2008, 2009-2011, 2013-2017	2009, 2012						2010 1. Artvin 2. Tunceli 3. Erzincan 48. Ağrı	2011-12 1. Erzincan 2. Kayseri 3. Artvin 48. Ağrı	2013 1. Erzincan 2. Kayseri 3. Tunceli 48. Ağrı	
1. Central Anatolia 2. East Black Sea 3. West Black Sea 6. Central East Anatolia	1. Central Anatolia 2. East Black Sea 3. West Black Sea 6. Southeast Anatolia	2015 1. Kayseri, Sivas, Yozgat 2. Trabzon, Ordu, Giresun, Rize, Artvin, Gümüşhane 3. Kastamonu, Çankırı, Sinop 13. Van, Muş, Bitlis, Hakkari	2017 1. Kayseri, Sivas, Yozgat 2. Zonguldak, Karabük, Bartın 3. Kırıkkale, Aksaray, Niğde, Nevşehir, Kırşehir 13. Van, Muş, Bitlis, Hakkari				2014 1. Kayseri 2. Erzincan 3. Rize 48. Ağrı	2015 1. Kayseri 2. Rize 3. Trabzon 48. Ağrı	2016 1. Tunceli 2. Kayseri 3. Rize 48. Ağrı	2017 1. Tunceli 2. Kayseri 3. Artvin 48. Ağrı