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INCOME CONVERGENCE AMONG TURKISH PROVINCES: AN INCOME INEQUALITY APPROACH

Türkiye İlleri Arasında Gelir Yakınsaması: Bir Gelir Eşitsizliği Yaklaşımı

R. Can AKKAY*

Keywords:
Income Convergence, Income Distribution, Unit Root Tests with Structural Breaks, OLS, Variance.

JEL Codes:
C32, D31, R10, R12.

Abstract

This study examines the income convergence among the 81 provinces of Turkey from the perspective of the income distribution. Unit root tests with a structural break, OLS time-series regression, variance, and coefficient of variation analysis are employed to investigate the beta and sigma income convergences over the 1992-2019 period. The empirical results indicate strong convergence to the average for the relatively high-income provinces and strong divergence from the average for the relatively low-income provinces. In addition, a closing income gap among provinces is observed in the economic slowdown periods 1993-1994, 2001-2002, 2008-2009 while the income distribution gets worse in the high-growth periods. In the Turkish economy, income differences between provinces have been decreasing in parallel with the slowing economic growth since 2013. This study differs from other studies in the literature on three points. First, the combined use of beta and sigma income convergence approaches has created an alternative tool to analyze the income inequality concept. Secondly, approximately doubling the number of observations in the newly used data set contributed positively to the accuracy of the results of the empirical study. Third, the inclusion of events that may cause structural breaks in the economy over the period 1992-2019, increased the reliability of the outputs of the study.

Anahtar Kelimeler:
Gelir Yakınsaması, Gelir Dağılımı, Yapısal Kırılmalı Birim Kök Testleri, EKK, Varyans.

JEL Kodları:
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Öz

Bu çalışma, Türkiye'nin 81 ili arasındaki gelir yakınsamasını, gelir dağılımı perspektifinden incelemektedir. 1992-2019 döneminde, beta ve sigma gelir yakınsamalarını araştırmak için yapısal kırılmalı birim kök testleri, OLS zaman serisi regresyonu, varyans ve varyasyon katsayısı araçları kullanılmıştır. Ampirik sonuçlar, nispeten yüksek gelirli iller için ülkenin ortalama kişi başı gelirine doğru güçlü bir yakınsamayı ve nispeten düşük gelirli iller için ortalama kişi başı gelirden güçlü bir ıraksamayı göstermektedir. Buna ek olarak; 1993-1994, 2001-2002, 2008-2009 ekonomik yavaşlama dönemlerinde iller arasındaki gelir açığının kapandığı; yüksek büyüme dönemlerinde ise iller arasındaki gelir dağılımının bozulduğu gözlemlenmiştir. Türkiye ekonomisinde, 2013 yılından itibaren görülen yavaşlamaya paralel olarak, iller arasındaki gelir farklılıklarında görülen azalma devam etmektedir. Bu çalışma literatürdeki diğer çalışmalardan üç noktada ayrışmaktadır. Birincisi, beta ve sigma gelir yakınsaması yaklaşımlarının beraber kullanılması, gelir eşitsizliği kavramı ile ilgili analiz yapmayı sağlayan alternatif bir araç yaratmıştır. İkincisi, yeni kullanılan veri setindeki gözlem sayısının yaklaşık iki katına çıkması, ampirik çalışmanın sonuçlarının doğruluğu açısından olumlu katkı sağlamıştır. Üçüncüsü, 1992-2019 döneminde ekonomide yapısal kırılmalara neden olabilecek olayların analize dahil edilmesi, çalışmanın çıktılarının güvenirliliğini artırmıştır.

*Assist. Prof. Dr., İstanbul University, Faculty of Economics, Turkey. canakkay@istanbul.edu.tr, ORCID: 0000-0002-1005-5828

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1. Introduction

The neoclassical growth model developed by Solow (1956) and Swan (1956), suggested theoretically that the per capita income differences between high-income and low-income countries will disappear in time. The underlying idea here is the diminishing returns to capital. Accordingly, the economic growth rate of a country will be decreasing as the country approaches the steady-state level of capital per unit of effective labor (Dowrick and Rogers, 2002: 369). In this context, economies with a lower capital per unit of effective labor will have higher rates of return which leads to higher economic growth rates for these countries. In other words, ceteris paribus, the economic growth rates of the poor countries are expected to be higher than the growth rates of the rich countries according to the neoclassical approach. In this sense, theoretically, a closing income gap between poor and rich countries would be not surprising. Unfortunately, the developments in the real world didn't satisfy the theoretical expectation of the neoclassical growth theory. Contrary to the expectation, it has been observed that the income gap between poor and rich countries continues to widen.

This inconsistency between the theory and practice has been encouraging many researchers to investigate the topic from different perspectives, theoretically and empirically. The criticism of Romer (1986) and Lucas (1988), two pioneers of the endogenous growth literature, have been the starting point of the alternative explanation of the increasing income gap between countries. They criticized the neoclassical growth theory for its assumption of diminishing returns to capital. They suggested that the increase in human capital and knowledge are the main drivers of economic growth and both can reverse the diminishing return character of the capital in the opposite direction. According to their view, the technological change exists endogenously contrary to the assumption of the neoclassical approach so that each economy converges to its steady-state which may differ from country to country since each has different technological progress (Islam, 2003: 314). Mankiw et al. (1992), however, explained the international differences in income per capita by employing an augmented Solow growth model. Mankiw et al. concluded that differences in savings, education level and population growth explain most of the international income variations among countries. In addition, differences in tax policies and political stability can be counted among other important determinants of income differences across countries. Acemoglu et al. (2005) approached the widening income gap between countries from another perspective. The authors evaluated the mentioned list of variables like innovation, education, economies of scale, capital accumulation, etc. as the proximate causes of economic growth and suggested that the fundamental explanation of the economic growth differences among countries is related to the institutional condition differences of these countries, based on the study of North and Thomas (1973). These conditions were defined by North (1990) as "the rules of the game in a society, or more formally, as the humanly devised constraints that shape human interaction" (Acemoglu et al., 2005).

While the underlying reasons for the income differences among countries have been discussed; some other studies focused on the empirical ways to measure whether there is convergence or divergence in the income levels within and between countries at the domestic and international levels, respectively. These studies are classified by Erlat (2012) under four alternative methodologies. The first one is Baumol's (1986) cross-section technique which was employed also by Barro and Sala-i-Martin (1992) and Mankiw et al. (1992); the second one is Quah's (1993) distribution approach; the third one is Islam's (1995) panel data approach, and the last one is the time series approach of Carlino and Mills (1993) and Bernard and Durlauf (1995).

As additional information; the cross-section, panel, and time-series methodologies are used to detect the absolute and conditional beta convergences while the distribution methodology is used to determine the sigma convergence.[1]

Despite the "income differences among countries" seems the primary interest of the literature; the income differences among regions and provinces became another popular research topic since the findings are directly related to individual welfare and happiness. (Graham and Felton, 2006: 108-109) The influential studies of Barro and Sala-i Martin (1992), Sala-i Martin (1996b), and Rey and Montouri (1999) can be shown as the building blocks for this branch of the literature.

This study belongs to the last-mentioned branch of the literature which investigates the income convergence concept at the provincial level for Turkey. In this context, the following three questions are tried to be answered to establish a relationship between "income convergence" and "income inequality". The questions are as follows: (i) Which provinces are converging to the average per capita income of Turkey and which provinces are diverging from this average according to the beta convergence? (ii) Is there a sigma convergence among the Turkish provinces at the aggregate level? (iii) What do these two income convergences expose for the income inequality among the provinces in Turkey?

The answers to these questions are investigated via unit root, OLS regression, and variance procedures over the period 1992 to 2019. As a contribution, the income inequality among Turkish provinces is investigated with the tools of the income convergence concept. In this context, the study differs from other studies by suggesting the beta and sigma convergence analysis as an alternative way to investigate the income inequality within a country.

The remainder of the study is as follows. The important studies of the literature including the empirical studies about Turkey are reviewed in the next section. The data and some descriptive statistics are introduced in the third section. The fourth section describes the empirical methodology. Empirical results are given in the fifth section. Section six concludes.

2. Literature Survey

As was mentioned in the introduction part, the inconsistency between the theory and practice has led many researchers to dig deeper and investigate the background of this inconsistency. In this context, the study of Baumol (1986) can be seen as the starting point of the income convergence literature which examined the existence of unconditional (absolute) convergence for the 16 OECD countries. The findings of the study supported scientifically the existence of a strong convergence among these countries. Conversely, the same empirical procedure provided different results as the sample size is expanded to 72 countries. Based on these findings, Baumol (1986) concluded that there is no convergence in the larger sample as a whole but income convergence can be observed as the countries were divided into groups. This study has been followed by two other important studies by Barro and Sala-i Martin (1992) and Mankiw et al. (1992) respectively which can be evaluated as the other milestones of the literature

[1] The beta convergence is defined as a negative relation between the initial levels of relative GDP and relative growth rates while the degree of dispersion of per capita income level across a group of economies is called a sigma convergence.

due to their contributions. Barro and Sala-i Martin (1992) used the optimal savings version of the neoclassical growth model of Cass-Koopmans and explored the income convergence for the U.S.'s states at the regional level. The empirical findings support unconditional convergence by about 2% while the investigation at the country level shows that there is conditional convergence among 98 countries. In this context, the school enrollment rate and the government consumption over GDP ratio have been identified as the two variables which are held responsible for the uncovered income gaps between countries. Besides, this study has been the first one that explored income convergence at the regional level. Mankiw et al. (1992), on the other hand, modified the neoclassical growth model by allowing the rate of investment and population growth to differ from country to country while other growth determinants are assumed as constants. In addition, they employed human capital as another variable to explore the income differences among countries. The findings of the study supported the approach of the augmented Solow model which asserts that differences in saving, education, and population growth can explain the cross-country differences in per capita income level. The two important contributions of these studies are defined by Islam (2003) as; (i) the transformation of the informal specification of the convergence regression into a more formal and model-based research procedure, and (ii) the usage of the "conditional convergence" concept for the first time in addition to the "unconditional convergence" approach. Simultaneously with these developments, Quah (1993) brought a new perspective by adding the "sigma convergence" approach to the literature as an alternative to the "beta convergence". This approach is based on the usage of the standard deviation of the cross-sectional distribution of income level or growth rate. Instead of measuring convergence indirectly through the sign of beta, the theory of Quah contends that convergence should be judged directly by examining the dynamics of income level and/or growth rate dispersions among economies. In addition, the sigma convergence may provide some information about the distribution of income within a country when the concept is applied at the regional level. While these theoretical developments were taking place in the literature, some authors started to make alternative analyses to cross-section-data analysis on the empirical side. The study of Islam (1995) has been one of the pioneering studies which employed the panel data approach for the first time to examine the income convergence among countries. The empirical results have shown a very strong positive correlation between human capital and technology, resource endowments, climate, and institutions (Islam, 1995: 1133). From the chronological point of view, the study of Carlino and Mills (1993) has been the first one in which the time-series approach was employed for the empirical investigation. The analysis of the eight geographic regions of the U.S. provided some evidence for the conditional convergence across regions. As another preliminary study of the time series approach, Bernard and Durlauf (1995) investigated the income convergence among 15 OECD countries. Their empirical research has shown no convergence among the sample countries but strong evidence for common trends was identified.

The above-mentioned study of Carlino and Mills (1993), as one of the building blocks of the income convergence literature, has inspired a group of studies, including this study, about the "regional/provincial convergence" concept. In this context, many researchers applied this methodology to explore the beta and sigma convergences for regions/provinces in different countries. Sala-i-Martin (1996b), one of the pioneering studies in this field, investigated the regional income convergence for the UK, France, Italy, Spain, and Canada and detected unconditional convergence in all countries. The studies of Coulombe and Lee (1995), Terassi (1999), Rey and Montouri (1999), and Yudong and Weeks (2000) are other influential

contributions that were cited by many researchers. Coulombe and Lee (1995) and Terrasi (1999) found conditional convergence at the regional level for Canada and Italy respectively while Weeks and Yudong (2000) conclude that there is no income convergence for the Chinese provinces. Rey and Montouri (1999) provided new insight into the literature by employing the spatial econometric technique to explore the income convergence at the regional level. Their findings confirm a convergence in relative incomes among the U.S. states but not independently, which means that the provinces display movements similar to regional neighbors.

Since it is not possible to mention all high-quality studies on "regional/provincial income convergence" due to space constraints, only the prominent ones have been mentioned above. On the other hand, since the focus of this study is Turkey, a detailed review of the studies about Turkey seems a necessity to make the analysis complete. In this context, it has been tried to examine from the first study to the most recent one on "regional income convergence in Turkey".[2] The studies were classified into three categories according to their empirical findings which show (i) convergence among provinces, (ii) no convergence/divergence among provinces, and (iii) both convergence and divergence among provinces.

As far as it is known the first regional study about the income convergence in Turkey was made by Filiztekin (1998) and the findings show a 1.9 percent yearly conditional convergence rate for the Turkish provinces which is very near to the two percent rate which has been stated by Barro and Sala-i Martin (1992) for the U.S. case. Tansel and Gungor (1999) determined conditional but also unconditional income convergences at the provincial level over the period 1980-1995. The authors conclude that (i) higher savings and human capital affect the speed of the convergence positively, and (ii) eastern and western provinces show different sigma convergences over the analysis period 1980-1995. Sagbaş (2002) found an absolute beta convergence across provinces while Ersungur and Polat (2006) reached the same conclusion at the NUTS-1 level.[3] Another important finding of the study has been the positive impact of the 1994, 1998, and 2001 economic crises on income convergence. Kılıcaslan and Ozyatagan (2007) used a modified version of beta convergence. According to the empirical findings based on the panel data, both aggregate income and per capita income indicate converging patterns. The authors underlined the population change as a source of regional income convergence. Yıldırım (2009) investigated not only the regional convergence dynamics but also regional income inequality in Turkey. The empirical investigation provides some evidence for unconditional and conditional beta convergence across provinces while the speed of convergence differs considerably. Accordingly, eastern and southern provinces show higher speeds of convergence. Besides, it is observed that regional income inequality tends to increase in periods of economic expansion and decrease in periods of recession. Onder et al. (2010) found that public capital has a positive and considerable effect on regional convergence at the NUTS-2 level. Zeren and Yılancı (2011) observed absolute

[2] The summary findings of the studies about Turkey can be seen in the Appendix part. The studies have been chosen according to their citation performances and to the scientific quality of the journals in which they were published.

[3] The NUTS is an acronym used to describe the Nomenclature of territorial units for statistics. The main idea is to divide the economic territory of the EU for the purpose of the collection, development and harmonisation of European regional statistics. Three level of NUTS are used. (i) NUTS-1 for the major socio-economic regions, (ii) NUTS-2 for the basic regions for the application of regional policies and, NUTS-3 for the small regions for specific diagnoses. In the Turkish case there are 12 regions at NUTS-1 level, 26 regions at NUTS-2 level and 81 regions at NUTS-3 level.
https://ec.europa.eu/eurostat/web/nuts/background

convergence in 17 regions and conditional convergence in 25 regions out of 26 regions at the NUTS-2 level. Aslan and Kula (2011) employed a unit root tests procedure that allows them to detect structural breaks and found strong evidence for convergence after taking the structural breaks into account. Karaalp and Erdal (2012) determined some evidence for unconditional and conditional convergence across provinces. They also found that the concentration of industry in certain provinces with different factors equipment, human resources, climate, and geographical structure caused a slowdown in convergence. The authors suggested that the income differences between provinces in Turkey will decrease in the long run, but the concentration of industrialization in certain provinces is expected to slow down this process. Ozgul and Karadag (2015) concluded that there is sigma convergence across the regions. They found also some evidence for unconditional beta convergence and stated that socio-economic indicators do not affect regional growth. Gomleksiz et al. (2017) found empirical evidence that supports the convergence at the NUTS-1 region's level. Besides the findings indicated that the government's participation in resolving regional economic disparities will likely be decisive. Soyyigit (2018) employed panel data methodology to explore the income convergence and found supportive evidence for the unconditional convergence with a convergence rate of 1.22 percent. Besides, the author determined an acceleration in the speed of convergence (1.4 percent) after the global financial crisis in 2008. Ozturk and Gultekin (2021) found some evidence for the beta and sigma convergences over the 2004-2017 period. The authors related this result with the relatively more negative effect of the 2008 crisis on the provinces with higher incomes. Besides, they observed that the public investments and government subsidies do not affect the speed of convergence.

While the above-mentioned studies supported the existence of the regional income convergence among Turkish provinces or regions, the following studies conclude that there is no convergence. Even some of them found evidence of income divergence among the Turkish provinces. Erk et al. (2000) examined the convergence concept for seven geographical regions and the provinces in the South-Eastern Anatolian Project. The empirical findings verified the existence of divergence as a whole. Likewise, Berber et al. (2000) investigated the convergence for seven geographical regions and found no evidence for sigma and beta convergences. Altinbas et al. (2002) employed the sigma convergence approach to explore the impact of government support on the cities. The empirical findings indicated a decreasing disparity among the western cities with no government supports. On the other hand, the disparity has increased among the government-supported cities in the eastern, south-eastern, and black sea regions of Turkey. In sum, the overall result for Turkey has been “divergence among provinces”. Gezici and Hewings (2004) investigated the income convergence not only for the provinces but also for the regions. The authors didn’t find clear evidence at the regions and provinces level for beta convergences, either unconditional or conditional, and sigma convergences. In addition, a high level of spatial dependence was revealed. The empirical findings of Karaca (2004) showed beta and sigma divergences for the Turkish provinces as a whole. The author determined that the divergence disappears if the structural characteristics of the provinces are taken into account but there is still no sign of convergence. Abdioglu and Uysal (2013) employed panel unit root tests to examine the convergence at the NUTS-1 region level. Only two of the six-unit root tests argue that the series is stationary while four of them are not stationary. In the light of the empirical findings, the authors concluded that there is no interregional income convergence. Karaca (2018) determined no convergence at the NUTS-2 region's level based on the longest per capita income data among the studies about Turkey which covers the period 1960 to 2014. As a contribution, the author also

provided a detailed explanation of the alternative datasets which were employed by other studies. Aksoy et al. (2019) divided the research period into two. Their investigation indicated five convergence clubs over the 1987-2001 period and six convergence clubs over the period 2004 to 2017. On the contrary, they detected no convergence, neither absolute nor conditional. Their empirical findings suggested that the initial per capita income, human capital, and total credits played important roles in the existence of the convergence clubs.

The last category consists of studies that obtained mixed results about the income convergence among the Turkish provinces. Yamanoglu (2008) stated that Turkey's provinces converged at a rate of 0.7 percent per year between 1990 and 2001 according to the results of the unconditional convergence analysis. Nevertheless, the author didn't determine income convergence between the provinces over the subperiod 1990-1995, but a yearly convergence of 1.8 percent was identified in the 1995-2001 period. Kirdar and Saracoglu (2008) detected unconditional divergence across Turkish provinces at a rate close to 0.48 percent. On the other hand, they found evidence of convergence when geographical differences are taken into consideration. While the rate of conditional convergence is at 1.1 percent per year with fixed effects for the 12 geographical regions, the rate of convergence increases to 6.4 percent with fixed effects for all provinces. The authors added that migration has a significant impact on both regional development rates and convergence speed in Turkey. Erlat (2012) examined the convergence among the provinces and geographical regions by employing the panel unit root approach. The empirical findings indicated mixed results. Although most of the provinces were not converging, some of them indicate signs of convergence. Akinci (2017) explored the existence of the income convergence at the NUTS-1 region level over the period 1980 to 2014 and concluded that the income inequality between the rich and poor classes is increasing in each region. The findings of the analysis revealed the existence of a convergence relationship between the poor class with the lowest income level. The analysis showed that the divergence relations arise with the increasing income level. The author stated that the rich converge to the rich and the poor converge to the poor. Gerni et al. (2015) examined whether the investment policies carried out in Turkey have achieved the regional development-based targets or not. The empirical investigation showed that there is an unconditional convergence in the regional incomes at the NUTS-2 regional level. On the contrary, the analysis based on provinces showed no unconditional convergence among the provinces. The authors state that the regulations over the period 2009-2012 led to a convergence between the provinces and helped in eliminating the development gap among provinces.

In the light of the existing literature, one can conclude that the empirical results about income convergence may differ according to the choices of the empirical tools and datasets employed in the analysis. Besides, there has been more or less a consensus about the negative relationship between the economic slowdown and the income convergence among Turkish provinces (Ersungur and Polat, 2006; Yıldırım, 2009; Akıncı, 2017; Soyyigit, 2018; Ozturk and Gultekin, 2021). In this context, this study can be compared with the studies mentioned in parentheses in terms of the method it uses, the way it handles the subject, and its place in the literature.

3. Data and Descriptive Statistics

This section provides information about the data set which is employed in the empirical investigation part of the study. Besides the Turkish provinces are ranked according to their growth performances and per capita income levels to present the welfare differences at the provincial level.

3.1. Data

At the provincial level, there are different per capita income series available for the Turkish economy (Karaca, 2018). Turkish Statistical Institute (TURKSTAT thereafter) as the official institution provides two datasets; one is from 1987 to 2001, which has been the only source until 2016. The second one covers the 2004-2014 period and it was updated two times in 2019 and 2020 so that the recent dataset contains information about the per capita income levels between 2004-2019. The per capita income levels for the years 1987 to 2001 were calculated using the constant price approach, with 1987 as the base year. For the 2004-2019 series, TURKSTAT modified the calculation methodology and adopted the chain-volume approach, with 2009 as the base year. Besides, it seems impossible to combine the two data series due to two reasons. The first one is the difference in the methodology which has been employed in both series. The second point is the missing years 2002 and 2003.

These technical problems arise the need for a new dataset that is expected to remove the mentioned shortcomings. Dusundere (2020) introduced an alternative dataset for the 1992-2018 period on behalf of the Economic Policy Research Foundation of Turkey (thereafter EPRFT).[4] The author has employed a new methodology based on the work of Henderson et al. (2009), which suggests "satellite data on lights at night" as an easily available proxy for GDP growth for cities and subnational regions. The concept of Henderson et al. has been used in the World Bank reports and many empirical studies where data on real GDP growth at the provincial and regional levels is lacking.[5] Moreover, this methodology was first employed by Basibos (2016), another EPRFT researcher, to forecast the per capita real GDP level of the Turkish economy at the country and provincial levels over the period 1992 to 2013. As a result, real GDP forecast of Basibos based on the satellite method indicates high consistency with the real GDP series published by TURKSTAT which increases the reliability of the GDP per capita data forecast at the provincial level.[6] Dusundere, on the other hand, took the real GDP statistics for the 2004-2018 period directly from the TURKSTAT and employed the "satellite approach" to forecast the real GDP level for the period 1992-2003 and 2019 both at the national and provincial level.[7] The change in the methodology of Dusundere depends on two facts. First, in 2016, TURKSTAT updated the real GDP computation method, using the chain-volume approach instead of the base-year-fixed-price methodology, which improves the aggregate reliability of the data. Second, the high consistency

[4] EPRFT (TEPAV) is a non-partisan, non-profit think tank based in Ankara. The foundation became operational on December 2004 with the goal of enriching the content of information/data in ideological discussions and arguments.

[5] See Gibson et al. (2020) for a detailed literature survey about the usage of the "night lights" in economics.

[6] The author detected an inconsistency between the sum of the total amount of each provinces' GDP and the total GDP of Turkey in 2001 by about 34,64%. (Basibos, 2016, p.8)

[7] The 2019 data was not taken from the TURKSTAT's data since TURKSTAT published the latest dataset after Dusundere published the updated version of her dataset over the period 1992-2019.

of the new data (chain-volume approach) of the TURKSTAT and the data (Başıboş-2016-satellite method) of EPRFT eliminates the necessity to compute real GDP using the satellite approach once again. In this context, it would not be wrong to say that Dusundere has expanded the 2004-2018 dataset of TURKSTAT over the period 1992-2019 with the help of the "satellite approach" at the provincial level on behalf of EPRFT.

3.2. Descriptive Statistics

As noted above the datasets of TURKSTAT (2004-2019) and EPRFT (1992-2019) are two current available datasets provided by institutions that can be employed in the empirical studies. In this study, the dataset of EPRFT (1992-2019) is employed due to its advantage of expanding the research period to 38 years compared to the dataset of TURKSTAT for only 16 years. Besides, the consistency of the two datasets[8] and the employment of the satellite method as a widely accepted scientific research method in calculations of GDP by organizations such as the World Bank, are other underlying reasons for the choice.

In this sub-section, the per capita income growth performances of the Turkish provinces will be discussed. In the first column of Table 1, the provinces are classified according to their contributions to Turkey's GDP in 2019. As expected, the highest contribution was done by Istanbul with 235.6 billion U.S. dollars which count for approximately one-third of Turkey's GDP in 2019. The lowest contribution came from Bayburt with 0.46 billion U.S. dollars.

Table 1. GDP, GDP Per Capita, and Growth Performances of the Turkish Provinces (1992-2019)

GDP ($) billion 2019		GDP ($) growth		GDP($) p. c. 2019		GDP($) p. c. growth	
İstanbul	235,6	Kocaeli	9,72%	Kocaeli	15643	Ardahan	8,12%
Ankara	64,84	Yalova	9,21%	İstanbul	15183	Tunceli	7,91%
İzmir	47,66	Gaziantep	8,68%	Ankara	11498	Zonguldak	7,62%
Bursa	31,56	Osmaniye	8,47%	Tekirdağ	11278	Kilis	7,56%
Kocaeli	30,55	İstanbul	8,41%	İzmir	10914	Artvin	7,35%
Antalya	23,11	Tekirdağ	8,39%	Bursa	10328	Bayburt	7,24%
Konya	15,51	Şırnak	8,21%	Bilecik	10253	Kırıkkale	7,14%
Adana	14,49	Mardin	8,20%	Yalova	10177	Osmaniye	7,14%
Gaziantep	14,20	Kilis	8,12%	Eskişehir	9415	Erzincan	7,09%
Manisa	13,37	Hatay	7,90%	Manisa	9282	Bingöl	7,07%
Mersin	13,34	Şanlıurfa	7,71%	Kırklareli	9249	Ordu	6,92%
Tekirdağ	11,90	İzmir	7,70%	Antalya	9201	Kocaeli	6,89%
Hatay	10,25	Muğla	7,70%	Çanakkale	9133	Mardin	6,84%
Kayseri	10,19	Bursa	7,65%	Bolu	9104	Erzurum	6,80%
Balıkesir	9,25	Sakarya	7,65%	Muğla	8677	Giresun	6,73%
Denizli	8,96	Bingöl	7,59%	Denizli	8634	Sivas	6,72%
Sakarya	8,74	Siirt	7,46%	Sakarya	8491	Kars	6,72%
Muğla	8,53	Antalya	7,39%	Artvin	8033	Bitlis	6,69%
Eskişehir	8,36	Hakkâri	7,38%	Karaman	7839	Manisa	6,60%
Samsun	8,29	Manisa	7,36%	Erzincan	7710	Karabük	6,58%
Aydın	7,13	Van	7,35%	Tunceli	7660	Rize	6,52%
Diyarbakır	6,99	Uşak	7,34%	Rize	7655	Hatay	6,51%
Şanlıurfa	6,68	Batman	7,32%	Düzce	7538	Muş	6,50%
K.Maraş	6,26	Zonguldak	7,27%	Uşak	7535	Uşak	6,49%
Trabzon	5,85	Iğdır	7,21%	Balıkesir	7529	Yalova	6,42%

[8] The dataset of TURKSTAT which covers 2004-2018 period is embedded into the dataset provided by EPRFT for the period 1992-2019.

Table 1. Continued

Çanakkale	4,95	Çanakkale	7,11%	Karabük	7482	Siirt	6,34%
Afyon	4,55	Diyarbakır	7,08%	Kırıkkale	7470	Kütahya	6,32%
Erzurum	4,15	Düzce	7,05%	Edirne	7338	Edirne	6,28%
Zonguldak	4,05	Kayseri	7,03%	Mersin	7248	Afyon	6,25%
Ordu	4,02	K. Maraş	6,97%	Kayseri	7243	Çanakkale	6,24%
Malatya	4,01	Denizli	6,94%	Trabzon	7235	Trabzon	6,22%
Sivas	3,95	Bitlis	6,94%	Burdur	7190	Samsun	6,15%
Kütahya	3,83	Adana	6,87%	Isparta	7010	Adıyaman	6,15%
Mardin	3,81	Karabük	6,84%	Konya	6950	Yozgat	6,13%
Van	3,65	Adıyaman	6,82%	Gaziantep	6864	Çankırı	6,11%
Kırklareli	3,35	Mersin	6,79%	Zonguldak	6794	Iğdır	6,09%
Osmaniye	3,26	Muş	6,77%	Kastamonu	6664	Sakarya	6,09%
Elazığ	3,25	Eskişehir	6,71%	Kütahya	6605	Bartın	6,09%
Isparta	3,12	Artvin	6,71%	Adana	6474	Gümüşhane	6,07%
Çorum	3,09	Ordu	6,70%	Aydın	6419	İzmir	6,03%
Edirne	3,04	Samsun	6,69%	Amasya	6328	Ağrı	6,00%
Düzce	2,96	Ağrı	6,64%	Hatay	6293	Gaziantep	5,99%
Bolu	2,88	Bayburt	6,62%	Afyon	6240	K.Maraş	5,98%
Tokat	2,80	Konya	6,60%	Sivas	6176	Tokat	5,93%
Adıyaman	2,80	Rize	6,59%	Samsun	6144	Bilecik	5,89%
Uşak	2,79	Bilecik	6,55%	Osmaniye	6052	Nevşehir	5,87%
Yalova	2,76	Ankara	6,54%	Çankırı	6051	Malatya	5,84%
Rize	2,63	Erzincan	6,52%	Aksaray	6024	Kırşehir	5,82%
Kastamonu	2,53	Tunceli	6,51%	Kırşehir	5944	Kırklareli	5,79%
Aksaray	2,51	Aksaray	6,49%	Nevşehir	5862	Denizli	5,78%
Batman	2,44	Giresun	6,47%	Niğde	5852	Karaman	5,77%
Şırnak	2,28	Kırıkkale	6,45%	Çorum	5827	İstanbul	5,77%
Giresun	2,26	Balıkesir	6,44%	Bartın	5644	Şırnak	5,72%
Bilecik	2,25	Karaman	6,43%	Ardahan	5570	Düzce	5,72%
Yozgat	2,19	Erzurum	6,40%	Gümüşhane	5535	Çorum	5,71%
Amasya	2,14	Malatya	6,40%	Elazığ	5496	Konya	5,69%
Niğde	2,12	Aydın	6,38%	Erzurum	5447	Hakkari	5,68%
Kırıkkale	2,11	Trabzon	6,37%	Bayburt	5424	Aksaray	5,67%
Karaman	1,99	Edirne	6,36%	K. Maraş	5423	Elazığ	5,64%
Burdur	1,95	Kırklareli	6,34%	Ordu	5329	Isparta	5,63%
Karabük	1,86	Gümüşhane	6,31%	Iğdır	5271	Balıkesir	5,62%
Erzincan	1,81	Ardahan	6,30%	Yozgat	5201	Muğla	5,61%
Nevşehir	1,78	Elazığ	6,29%	Sinop	5127	Adana	5,60%
Ağrı	1,69	Kütahya	6,24%	Kilis	5053	Amasya	5,55%
Muş	1,63	Afyon	6,24%	Giresun	5041	Kayseri	5,50%
Kırşehir	1,44	Sivas	6,13%	Malatya	5011	Mersin	5,50%
Artvin	1,37	Bartın	6,11%	Tokat	4577	Sinop	5,47%
Siirt	1,30	Niğde	6,10%	Hakkari	4576	Kastamonu	5,46%
Kars	1,29	Nevşehir	6,07%	Mardin	4548	Niğde	5,45%
Hakkari	1,29	Kars	5,92%	Kars	4511	Eskişehir	5,41%
Bitlis	1,24	Kırşehir	5,71%	Adıyaman	4469	Burdur	5,40%
Bingöl	1,23	Isparta	5,68%	Bingöl	4383	Van	5,40%
Çankırı	1,18	Burdur	5,65%	Şırnak	4311	Diyarbakır	5,38%
Sinop	1,12	Çankırı	5,44%	Batman	4004	Bursa	5,35%
Bartın	1,12	Tokat	5,37%	Diyarbakır	3978	Tekirdağ	5,30%
Iğdır	1,05	Amasya	5,34%	Muş	3977	Aydın	5,24%
Gümüşhane	0,91	Bolu	5,32%	Siirt	3951	Batman	5,18%
Kilis	0,72	Kastamonu	5,23%	Bitlis	3564	Şanlıurfa	4,99%
Tunceli	0,65	Çorum	5,21%	Şanlıurfa	3219	Bolu	4,61%
Ardahan	0,54	Sinop	5,02%	Van	3209	Ankara	4,51%
Bayburt	0,46	Yozgat	4,87%	Ağrı	3144	Antalya	4,40%

Source: Author’s calculations

The second column shows the average GDP growth rates of the provinces over the 1992-2019 period in the U.S. dollar term. Kocaeli has been the leading province with an annual average increase of 9.72 percent of the GDP growth according to the latest data. At this point, there could be some doubts about the reliability of the dataset since the GDP growth rates of the provinces are quite high. Even the worst performer province, Yozgat, has a growth rate of 4.8 percent which is more or less equal to the potential GDP growth rate of Turkey.

The fact behind these high growth rates is the employment of the "current U.S. dollars" as the calculation method and the strong Turkish Lira over the period 2002 to 2010.[9] Moreover, the ranking of the provinces based on the GDP growth rates in terms of Turkish Lira through the chained volume index shows similar results to the ranking in the second column which is consistent with the potential GDP growth of Turkey. The best performer province Kocaeli's average growth rate has been 6.79% while the worst performer Yozgat's average GDP growth has been about 2.13% in Turkish Lira terms.[10] In short, the aggregate GDP growth rates in the U.S. dollars may not represent the real economic performances of the provinces but the internal consistency of the computation method gives us the true ranking of the provinces due to their economic performances. One may ask why the current U.S. dollar form is chosen for the statistical information in Table 1. The answer is related to the internal consistency of the study. In the next section, the empirical investigation of the income convergence and income distribution among provinces will be made in terms of the current U.S. dollars following other studies in the literature.

The third column represents the GDP per capita rankings of the Turkish provinces in 2019. As can be seen in Table 1, Kocaeli and Istanbul provinces are differentiated from other provinces in terms of per capita income levels. Dusundere (2020) classified Turkish provinces into three groups for each year over the 1992-2019 period, based on the changes in their per capita income levels. The latest classification indicates that only Kocaeli and Istanbul can be evaluated as high-income provinces in 2019 while the provinces Ağrı, Bitlis, Urfa, and Van belong to the lower-middle-income group. The rest of the provinces are between these two income groups and are classified as upper-middle-income provinces.[11]

The fourth column is about the average increase in the per capita incomes of the provinces over the period 1992-2019. According to the results, Ardahan has been the province with the highest average increase in per capita income level. Kocaeli took 12th place while Istanbul took 52nd place according to the ranking.

[9] The average annual growth rate of the per capita income levels of all provinces over the period 2002-2010 has been 16 percent despite the negative effect of the 2008 financial crisis. The average growth rate increases to 19.97% if the year 2009 is excluded from the computation.

[10] The per capita income growth rates in Turkish Lira terms were not provided via Table since the calculation was made to check the ranking in dollar terms. The calculation shows that there is a consistency about ranking at both Turkish Lira and US dollar terms.

[11] This classification of the Turkish provinces is compatible with the per capita income thresholds of the World Bank which are announced each year in the 1st day of July. In other words, the Turkish provinces were classified as if they were countries classified according the existing thresholds computed by the World Bank.

In the light of the descriptive statistics provided above, the following statements can be made; (i) there are huge differences among the Turkish provinces regarding their contributions to the economy[12], and (ii) two provinces, Kocaeli and Istanbul, differ from other provinces as they belong to the high-income status based on the per capita income classification of the World Bank, (iii) despite Istanbul has a high GDP growth rate and took the fifth position in the GDP growth category as the biggest province in Turkey, its' performance about the income per capita GDP growth is below the average, (iv) there are some provinces with poor GDP growth performances and high per capita income growth rates like Ardahan.[13]

4. Methodology

In this study, two procedures are employed to investigate income inequality among the Turkish provinces in the context of income convergence. The first procedure was taken from the study of Nieswiadomy and Strazicich (2004) who upgraded the empirical model suggested by Tomljanovich and Vogelsang (2002). Nevertheless, the inspirer of both models is the study of Carlino and Mills (1993) in which an alternative time-series test for beta convergence has been employed. The second procedure is based on the standard deviation approach which has been suggested by Quah (1993) to explore the income convergence across countries and is known as sigma convergence.

According to the first procedure, beta convergence can exist only under the existence of stochastic convergence as a pre-condition. Carlino and Mills (1993) define stochastic convergence as the stationarity of the series that are acquired by the division of the logarithm of each year's per-capita income in one region by the logarithm of the same year's national average. The underlying idea is the fact that stationary series are converging to their long-run averages or their trends in the long-run while non-stationary series may diverge from this path. (Islam, 2003: 321-323) In this context, the stationarity of the series (existence of stochastic convergence) indicates that the shocks to a region are temporary. The beta convergence, on the other hand, is defined as the statistically negative relationship between the initial level of relative GDP and relative growth rate. In summary, the pre-condition shows whether the shocks to the region/province are temporary or not while beta convergence shows whether the poor regions/provinces converge to the national average or not. Carlino and Mills (1993) find beta convergence for three of eight regions after adding the trend break date of 1946 to the empirical analysis while there has been no evidence for a convergence in the "no break" version. Tomljanovich and Vogelsang (2002) investigate the robustness of the empirical results of Carlino and Mills (1993) and re-examine it by adding the "unknown break date" to the procedure where the break date is chosen with the help of the new econometric tests developed by Vogelsang (1997, 1998). In addition, Tomljanovich and Vogelsang (2002) employ two simple OLS regressions to test the beta convergence with one break in trend and intercept. Their empirical findings are in line with the neoclassical approach and support the income convergence across regions in the U.S. On the other hand, the contribution of Nieswiadomy and Strazicich (2004) has been to investigate the stationarity of the log of relative incomes and time-series tests for beta convergence around one or two structural breaks.

[12] The output created by Istanbul in 2019 was 512 times that of Bayburt.
[13] Ardahan holds the first position in the per capita income growth category while the ranking decreases to 62 when we look at the GDP growth rates.

The empirical investigation in this paper follows the methodology of Nieswiadomy and Strazicich (2004) with two structural breaks since our research period 1992-2019 has witnessed three important economic turbulences in the years 1994, 2001, and 2008 respectively. In terms of its impact on the economy, the economic crisis in 2001 is expected to have a greater impact than the other two dates that are just mentioned. Moreover, due to the economic slowdowns, 1998 and 1999 may be other alternative potential break dates. The empirical analysis starts with the investigation of stochastic convergence. First, it is checked whether the series which are acquired by the division of the logarithm of each year's per-capita income in one region by the logarithm of the same year's national average has a unit root or not. For this purpose, Augmented Dickey-Fuller (ADF), Zivot-Andrews (ZA), and Lagrange Multiplier (LM) unit root tests were employed for no structural break, one structural break, and two structural breaks, respectively. Second, the beta convergence was explored as suggested by Carlino and Mills (1993). Following this aim, we performed the OLS procedure on the log relative income series to detect the beta convergence for the Turkish provinces by employing the following model which is developed by Nieswiadomy and Strazicich (2004);

$$y_{it} = \alpha_{i1} D1_t + \alpha_{i2} D2_t + \alpha_{i3} D3_t + \beta_{i1} time1_t + \beta_{i2} time2_t + \beta_{i3} time3_t + \varepsilon_t \qquad (1)$$

where y_{it} stands for the log of the difference between the per capita income of the province i and the national average per capita income at the time t. $D1_t$, $D2_t$ and $D3_t$ represent dummy variables for the intercepts while $time1_t$, $time2_t$ and $time3_t$ are linear time trends. α_{i1}, α_{i2} and α_{i3} denote the level of per capita income level of the country i before the first break, after the first break, and after the second break, respectively. The signs before the coefficients show whether the level of per capita income of the province i is above (+) or below (-) the average level of the country's per capita income level before and after the breaks. The OLS regressions for each province are performed under the following procedure: (1) If $t \geq T_{B1}$, $D1_t = 1$ and 0 otherwise; (2) if $T_{B1} < t \leq T_{B2}$, $D2_t = 1$ and 0 otherwise; (3) if $t > T_{B2}$, $D3_t = 1$ and 0 otherwise; (4) if $t \leq T_{B1}$, $time1_t = t$ and 0 otherwise; (5) if $T_{B1} < t \leq T_{B2}$, $time2_t = t - T_{B1}$ and 0 otherwise and, (6) if $t > T_{B2}$, $time3_t = t - T_{B2}$ and 0 otherwise; where T_{B1} and T_{B2} stands for the first break and the second break, respectively. This procedure is used when there are two significant breaks with an economic background like an economic recession or crisis. The estimated coefficients α_{i3} and β_{i3} are expected to have opposite signs if the per capita income level of the province i is converging to the mean. If there is only one significant break, equation (1) would be estimated without α_{i3} and β_{i3}. In this case, the signs of the coefficients α_{i2} and β_{i2} are expected to have opposite signs if the per capita income of the province i is converging to the mean. The last alternative is provinces with no significant breaks. In this version, α_{i1} and β_{i1} are the two coefficients that are used to decide about the convergence. The opposite signs of the coefficients are evaluated for convergence to the mean.

The second procedure employed in the empirical investigation is based on the model developed by Quah (1993) as mentioned before. The main idea here is to state whether the income differences among Turkish provinces are increasing or decreasing over time. The decreasing gap among provinces is called "the sigma convergence" in the convergence literature and is evaluated as an indicator of decreasing income inequality. The standard deviation methodology is employed to investigate the direction of the convergence. The decreasing values of the standard deviation are evaluated as a sign of a decrease in the per capita income disparities among the provinces.

Besides, the coefficient of variation (CV) is used to provide more insights into the per capita income differences by adding the relative size of the standard deviation as a share of the changing average per capita income levels of all Turkish provinces. Similar to the standard deviation approach, smaller values of the coefficient of variation (CV) indicate a closing income gap among provinces. The equations for the standard deviation and the coefficient of variation are as follows;

$$std_t = \sqrt{\Sigma_{i=1}^{N} \frac{(y_{it} - \bar{y}_t)^2}{N}} \tag{2}$$

$$CV_t = \frac{\sqrt{\Sigma_{i=1}^{N} \frac{(y_{it} - \bar{y}_t)^2}{N}}}{\bar{y}_t} \tag{3}$$

where y_{it} denotes the per capita income level of the province i at the time t; $\bar{y}_t$ denotes the average per capita income level of all Turkish provinces at the time t and, N stands for the number of the provinces.

In summary, the empirical results of the first procedure are critical since the second one provides only information about the changing standard deviations of the per capita income levels among the Turkish provinces which seems an incomplete measure by itself to evaluate income inequality. Principally, the decrease in the standard deviations in time is evaluated as a positive sign from the perspective of income inequality since it represents a closing income gap between provinces. On the other hand, the decrease in the standard deviation may exist due to an economic crisis since high-income provinces may be more negatively affected than lower-income provinces. (Ersungur and Polat 2006; Soyyigit 2018) In this context, these two models are expected to complete each other and provide more specific information about income inequality in Turkey at aggregate and disaggregate levels.

5. Empirical Results

In this section, the empirical findings are represented. Table 2 provides the Augmented Dickey-Fuller (ADF thereafter) unit root test results of the natural log of the per capita income of the province i divided by the average per capita income level of 81 Turkish provinces in the year t. The null hypothesis of a unit root is tested and rejection of the null hypothesis is evaluated as a sign of the stochastic convergence. As can be seen in Table 2, the null hypothesis can be rejected at a 1% significance level for all Turkish provinces without a break. In other words, there is strong evidence for the stochastic convergence of the Turkish provinces in the case of "no structural break".

Table 2. ADF Unit Root Tests for Stochastic Convergence (1992-2019)

Provinces	t-statistics	Provinces	t-statistics	Provinces	t-statistics
Adana	-5.689***	Edirne	-4.879***	Malatya	-5.238***
Adıyaman	-6.144***	Elazığ	-5.777***	Manisa	-5.163***
A. Karahisar	-5.426***	Erzincan	-4.957***	Mardin	-4.959***
Ağrı	-6.009***	Erzurum	-5.933***	Mersin	-5.126***
Aksaray	-6.924***	Eskişehir	-5.752***	Muğla	-4.606***
Amasya	-5.546***	Gaziantep	-5.374***	Muş	-5.357***
Ankara	-4.929***	Giresun	-4.744***	Nevşehir	-4.988***
Antalya	-4.829***	Gümüşhane	-4.686***	Niğde	-6.045***
Ardahan	-5.831***	Hakkari	-5.958***	Ordu	-5.196***
Artvin	-4.904***	Hatay	-4.545***	Osmaniye	-5.918***
Aydın	-5.270***	Iğdır	-5.125***	Rize	-6.124***
Balıkesir	-5.049***	Isparta	-4.979***	Sakarya	-5.411***
Bartın	-5.312***	İstanbul	-4.964***	Samsun	-5.090***
Batman	-5.580***	İzmir	-4.926***	Siirt	-5.698***
Bayburt	-5.507***	K. Maraş	-5.722***	Sinop	-4.840***
Bilecik	-4.601***	Karabük	-5.954***	Sivas	-5.475***
Bingöl	-6.287***	Karaman	-5.466***	Şanlıurfa	-5.528***
Bitlis	-5.218***	Kars	-5.936***	Şırnak	-5.138***
Bolu	-5.605***	Kastamonu	-5.503***	Tekirdağ	-5.491***
Burdur	-4.714***	Kayseri	-5.116***	Tokat	-5.134***
Bursa	-5.414***	Kırıkkale	-5.390***	Trabzon	-5.810***
Çanakkale	-5.076***	Kırklareli	-5.604***	Tunceli	-4.833***
Çankırı	-4.625***	Kırşehir	-5.658***	Uşak	-9.872***
Çorum	-5.517***	Kilis	-5.076***	Van	-9.636***
Denizli	-5.024***	Kocaeli	-4.896***	Yalova	-10.071***
Diyarbakır	-5.506***	Konya	-6.150***	Yozgat	-10.397***
Düzce	-5.600***	Kütahya	-5.271***	Zonguldak	-9.483***

Note: *,** and *** denote significance at the 10%, 5% and 1% respectively. For the critical values see MacKinnon (2010)
Source: Author's calculations

Table 3 shows the ZA and LM unit root test results for the Turkish provinces over the 1992-2019 period. Like in the ADF procedure, the null hypothesis of a unit root is tested and the rejection of the null is evaluated as the stochastic convergence. The only difference here is the inclusion of the structural breaks into the analysis. ZA and LM unit root tests are employed for "one structural break case" while "two structural breaks case" is only explored with the help of the LM procedure. All unit root tests include intercept(s) and trend(s). The LM unit root test results show that in almost all provinces there are two statistically significant structural breaks. On the other hand, the empirical results obtained should not be just statistical numbers, instead, there should be some economic facts behind them. In other words, empirical results and economic facts should have a meaningful relationship with each other. Hence, the break years which are unrelated to the economic developments in the Turkish economy over the period 1992-2019 are eliminated. As can be seen, 2002 is a common, statistically break year which is stated by both of the unit root tests. For the "two structural breaks case", in addition to 2002, the year 2010 seems to be the common breakpoint for five provinces. The years 1998, 2008, and 2004 are other years in which structural breaks are identified. The structural break years are compatible with the facts of the Turkish economy since one of the most severe economic crises in Turkish economic history has arisen in 2001. The one-year lagged negative effect of the crisis seems quite reasonable to support the statistical structural break year in the year 2002 in almost all provinces. Besides, the global financial crisis in 2008 and its impact on the world economy and the economic turmoil in

1998 make the other break years logical from the perspective of real economic facts. The unit root test results indicate that the log of per-capita income of all Turkish provinces relative to the log of the national average is stationary around one or two structural breaks. In short, there is again strong evidence for the stochastic convergence for all Turkish provinces with a maximum of two structural breaks.

Table 3. ZA and LM Unit Root Tests for Stochastic Convergence (1992-2019)

Provinces	t-Statistic	Break(s)	Provinces	t-Statistic	Break(s)
Adana	-7.028***	2002	Kahramanmaraş	-4.896***	2002,2010
Adıyaman	-4.949*	2008	Karabük	-7.145***	2002
Afyonkarahisar	-7.907***	2002	Karaman	-7.014***	2002
Ağrı	-7.343***	2002	Kars	-8.274***	2002
Aksaray	-8.181***	2002	Kastamonu	-5.780***	2002,2010
Amasya	-6.157***	2002,2010	Kayseri	-8.015***	2002
Ankara	-8.296***	2002	Kırıkkale	-8.185***	2002
Antalya	-6.442***	2009	Kırklareli	-6.804***	2002
Ardahan	-7.632***	2002	Kırşehir	-7.968***	2002
Artvin	-8.332***	2002	Kilis	-7.100***	2002
Aydın	-5.258**	2008	Kocaeli	-6.695***	2002
Balıkesir	-6.736***	2002	Konya	-4.970***	2004
Bartın	-7.252***	2002	Kütahya	-7.505***	2002
Batman	-6.404***	2002	Malatya	-7.900***	2002
Bayburt	-7.492***	2002	Manisa	-5.012***	2008
Bilecik	-6.669***	2002	Mardin	-4.940*	2002
Bingöl	-7.569***	2002	Mersin	-5.012***	2002
Bitlis	-6.870***	2002	Muğla	-6.178***	1998
Bolu	-8.162***	2002	Muş	-7.724***	2002
Burdur	-6.582***	2002	Nevşehir	-7.215***	2002
Bursa	-6.359***	2002	Niğde	-7.532***	2002
Çanakkale	-6.708***	2002	Ordu	-7.344***	2002
Çankırı	-8.206***	2002	Osmaniye	-4.655	2002
Çorum	-6.488***	2002,2010	Rize	-7.543***	2002
Denizli	-6.062***	1998	Sakarya	-6.721***	2002
Diyarbakır	-6.884***	2002	Samsun	-7.442***	2002
Düzce	-7.239***	2002	Siirt	-6.288***	2002
Edirne	-7.123***	2002	Sinop	-7.223***	2002
Elazığ	-8.037***	2002	Sivas	-7.585***	2002
Erzincan	-7.114***	2002	Şanlıurfa	-6.471***	2002
Erzurum	-4.661***	2002,2010	Şırnak	-4.838*	2002
Eskişehir	-7.874***	2002	Tekirdağ	-5.492**	2008
Gaziantep	-6.221***	2008	Tokat	-8.628***	2002
Giresun	-8.099***	2002	Trabzon	-7.145***	2002
Gümüşhane	-7.179***	2002	Tunceli	-7.943***	2002
Hakkari	-6.343***	2002	Uşak	-5.310**	2002
Hatay	-6.369***	1998	Van	-7.602***	2002
Iğdır	-7.036***	2002	Yalova	-4.879**	2008
Isparta	-6.574***	2002	Yozgat	-8.612***	2002
İstanbul	-7.109***	2002	Zonguldak	-6.550***	2002
İzmir	-6.028***	1998			

Note: *,** and *** denote significance at the 10%, 5% and 1% respectively. For the critical values of the LM test, see Lee and Strazicich (1999,2003) and for the critical values of the ZA test see Zivot and Andrews (1992)
Source: Author's calculations

Besides, the significance of these coefficients can be used to make proper decisions about the convergence or divergence. These different results are shown with different letters in Table 4. Accordingly, (C) denotes the case in which both point estimates are consistent with beta convergence (they have opposite signs) and they are statistically significant at least at the 10% level. (c) denotes consistent point estimates with beta convergence with only one estimate which is statistically significant at least at the 10% level. (D) represents the divergence case at which the point estimates have similar signs and both are statistically significant at least at the 10% level. (d) stand for divergence case but only one of the point estimates is statistically significant at least at the 10 % level. (E) represents point estimates which are statistically insignificant and very small in magnitude so it is interpreted as "convergence has occurred". In short; (C),(c), and (E) imply convergence to the mean, while (D) and (d) indicate divergence from the mean. The small letters (u) and (d) after (C),(c) (D), and (d) denote the direction of the divergence and convergence according to the position of the dummy variables for the intercepts which could be above or below the average. In this context, (u) stands for up and (d) for down.

Table 4. Summary Table of the OLS Results for Beta Convergence (1992-2019)

Provinces	Converging	Provinces	Converging	Provinces	Converging
Adana	cd	Edirne	Cd	Malatya	Dd
Adıyaman	dd	Elazığ	cd	Manisa	Du
A. Karahisar	cd	Erzincan	cd	Mardin	Cu
Ağrı	dd	Erzurum	dd	Mersin	Cd
Aksaray	E	Eskişehir	cd	Muğla	Cd
Amasya	E	Gaziantep	E	Muş	Dd
Ankara	Cd	Giresun	dd	Nevşehir	Cd
Antalya	Cd	Gümüşhane	cd	Niğde	E
Ardahan	cu	Hakkari	dd	Ordu	E
Artvin	cd	Hatay	E	Osmaniye	Cu
Aydın	E	Iğdır	dd	Rize	Cd
Balıkesir	Cd	Isparta	Cd	Sakarya	Cd
Bartın	cd	İstanbul	Cd	Samsun	Cd
Batman	Dd	İzmir	cd	Siirt	Dd
Bayburt	dd	K. Maraş	dd	Sinop	Cd
Bilecik	Cd	Karabük	E	Sivas	E
Bingöl	cu	Karaman	Cd	Şanlıurfa	Dd
Bitlis	dd	Kars	dd	Şırnak	Dd
Bolu	Cd	Kastamonu	E	Tekirdağ	Cd
Burdur	Cd	Kayseri	Cd	Tokat	Dd
Bursa	Cd	Kırıkkale	E	Trabzon	Cd
Çanakkale	Cd	Kırklareli	Cd	Tunceli	Cd
Çankırı	Cd	Kırşehir	cd	Uşak	Cd
Çorum	cd	Kilis	dd	Van	Dd
Denizli	Cd	Kocaeli	cd	Yalova	Cd
Diyarbakır	Dd	Konya	E	Yozgat	E
Düzce	Cd	Kütahya	Cd	Zonguldak	E

Note: The meanings of the letters in the Table are as follows: Cd (strong convergence-down), cd (weak convergence-down), Cu (strong convergence-up), cu (weak convergence-up), Dd (strong divergence-down), dd (weak divergence-down), Du (strong divergence-up), du (weak divergence-up) and E (convergence has occurred)
Source: Author's calculations

One may ask whether the empirical findings satisfy the neoclassical theory in the Turkish case. Table 5 provides some answers to this question. In Table 5, provinces are ranked in the "A"

columns according to their per capita income levels in 2019 while the convergence or divergence conditions are shown in the "B" columns. In 2019, the average per capita income level of the Turkish provinces is $6799 which represents the benchmark income level from which provinces diverge or to which they converge. As can be seen all provinces with a higher per capita income level than the average are converging to the average which satisfies the expectation of the neoclassical theory. The only exception is the province of Manisa. On the contrary, most of the provinces below the average are diverging from the average except Osmaniye, Ardahan, and Mardin. The provinces Konya, Gaziantep, Zonguldak, Kastamonu, Aydın, Amasya, Hatay, Karabük, Kırıkkale, Ordu, Sivas, Aksaray and Yozgat have very close per capita income levels to the national average and the empirical investigation shows that the convergence has occurred for these countries.

Table 5. The Relationship between Income Convergence and Per Capita Income Level

Provinces	A	B	Provinces	A	B	Provinces	A	B
Kocaeli	cd	15.643	Edirne	Cd	7.338	Gümüşhane	cd	5.535
İstanbul	Cd	15.183	Mersin	Cd	7.248	Elazığ	cd	5.496
Ankara	Cd	11.498	Kayseri	Cd	7.243	Erzurum	dd	5.447
Tekirdağ	cd	11.278	Trabzon	cd	7.235	Bayburt	dd	5.424
İzmir	cd	10.914	Burdur	Cd	7.190	K. Maraş	dd	5.423
Bursa	Cd	10.328	Isparta	Cd	7.010	Ordu	E	5.329
Bilecik	Cd	10.253	Konya	E	6.950	Iğdır	dd	5.271
Yalova	cd	10.177	Gaziantep	E	6.864	Yozgat	E	5.201
Eskişehir	cd	9.415	Zonguldak	E	6.794	Sinop	cd	5.127
Manisa	du	9.282	Kastamonu	E	6.664	Kilis	dd	5.053
Kırklareli	Cd	9.249	Kütahya	Cd	6.605	Giresun	dd	5.041
Antalya	Cd	9.201	Adana	cd	6.474	Malatya	dd	5.011
Çanakkale	Cd	9.133	Aydın	E	6.419	Tokat	dd	4.577
Bolu	Cd	9.104	Amasya	E	6.328	Hakkari	dd	4.576
Muğla	cd	8.677	Hatay	E	6.293	Mardin	cu	4.548
Denizli	Cd	8.634	A. Karahisar	cd	6.240	Kars	dd	4.511
Sakarya	cd	8.491	Sivas	E	6.176	Adıyaman	dd	4.469
Artvin	cd	8.033	Samsun	cd	6.144	Bingöl	cu	4.383
Karaman	Cd	7.839	Osmaniye	cu	6.052	Şırnak	dd	4.311
Erzincan	cd	7.710	Çankırı	Cd	6.051	Batman	Dd	4.004
Tunceli	cd	7.660	Aksaray	E	6.024	Diyarbakır	Dd	3.978
Rize	cd	7.655	Kırşehir	cd	5.944	Muş	dd	3.977
Düzce	Cd	7.538	Nevşehir	Cd	5.862	Siirt	dd	3.951
Uşak	cd	7.535	Niğde	E	5.852	Bitlis	dd	3.564
Balıkesir	Cd	7.529	Çorum	cd	5.827	Şanlıurfa	Dd	3.219
Karabük	E	7.482	Bartın	cd	5.644	Van	dd	3.209
Kırıkkale	E	7.470	Ardahan	cu	5.570	Ağrı	dd	3.144

Note: Column A denotes whether the province is converging, diverging, or has already converged. Column B denotes the per capita income level of the province in 2019.
Source: Author's calculations

From the perspective of income inequality, the income convergence of the relatively high-income provinces to the national average is a positive development. On the other hand, the divergence of the relatively poor provinces should be taken as a serious threat from the perspective of increasing income inequality and welfare loss.

The findings above can be evaluated as a sign of decreasing income inequality among Turkish provinces, but this result will be incomplete without the results of the second procedure. The changes in the standard deviation and coefficient of variation over the period 1992 to 2019

are visualized in the next two figures. Besides, Figure 1 provides information about the visual relationship between standard deviation and the real GDP growth over the period 1999 to 2019.[14] The right axis in Figure 1 shows the standard deviation in the U.S. dollar terms while the real GDP growth can be seen on the left axis as percentages. The real GDP growth is represented with the dashed line while the other black line denotes the standard deviation. Two important observations should be emphasized. The first one is the steep increase in the standard deviation over the subperiod 2002-2007 in which the Turkish economy indicated historical high growth rates. The second one is the decreasing trend of the standard deviation during the economic turbulences during the years 1993-1994, 2000-2001, and 2008-2009. These observations are compatible with the findings of Ersungur and Polat (2001) and Soyyigit (2018) which suggest a recovery in the income distribution after economic turmoils. In short, during the boom period (2002-2007), the distribution of income has been relatively unequal according to the sigma convergence. On the contrary, the distribution of income was more fairly while the per capita income has been decreasing. The second boom period after the year 2009 till the taper tantrum in 2013 verifies this argument as the trend of the standard deviation turned positive. The last period over 2013-2019 witnessed again a fairer income distribution parallel to the decreasing economic activity.

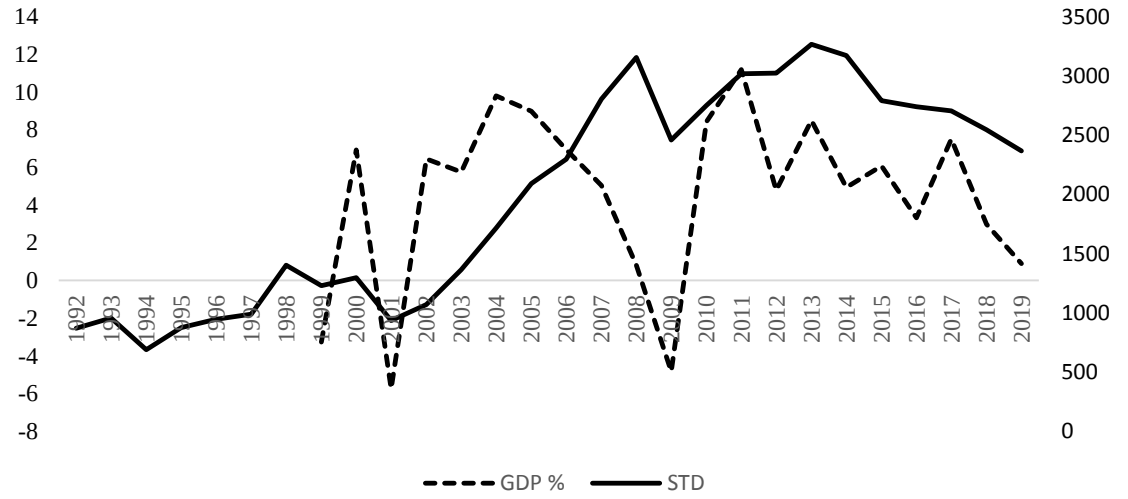

Figure 1. The Standard Deviation of the Per Capita Incomes of Turkish Provinces and Reel GDP Growth (1992-2019)
Source: EPRFT

The changes in the coefficient of variation as an alternative way to investigate the income distribution are represented in Figure 2. Similar to the standard deviation, smaller values of the coefficient of variation are interpreted as a positive development from the perspective of the income distribution. Hence the decreasing trend of the coefficient of variation over the 1992-2019 period indicates a slow recovery of the income distribution from a wider perspective. Accordingly, one can conclude that the income differences among Turkish provinces are decreasing over the 1992-2019 period.

[14] Some data about the real GDP growth is missing in Figure 1. The reason is that the real GDP series which is calculated via new chain-volume approach contains the period 1998-2021.

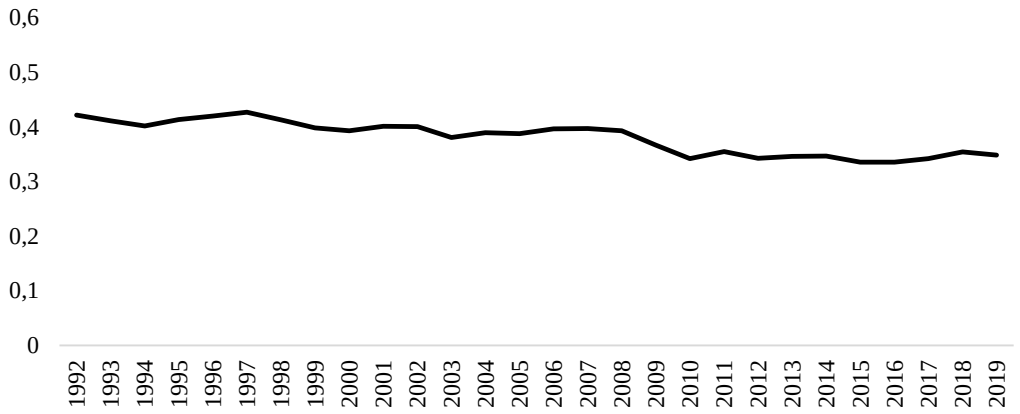

Figure 2. Coefficient of the Variation of the Per Capita Incomes of the Turkish Provinces (1992-2019)
Source: EPRFT

Both standard deviation and coefficient of standard deviation give us some idea about the changing structure of the income distribution at the country level. The “standard deviation methodology” provides more insight into the income distribution differences from one period to another one while the “coefficient of variation methodology” provides more information about the general trend in the income distribution. In this context, a decreasing income gap between Turkish provinces is observed parallel to the decreasing economic performance which can be evaluated as the existence of the “sigma convergence”.

6. Conclusion

In this study, the income convergence among the Turkish provinces was examined over the period 1992 to 2019 from the perspective of income inequality. In this context, the empirical procedures about beta and sigma convergences were followed.

The “beta convergence analysis” was performed in two steps; “ADF, ZA, and LM unit root tests” as the first step and “OLS regression” as the second step. The stochastic convergence analysis based on the mentioned unit root tests showed that all provinces in Turkey are converging to their long-run averages or their trends in the long run. These outcomes provide the basic requirement of the second step, beta convergence, according to the definition of Carlino and Mills (1993). So the beta convergence analysis was conducted with the help of the OLS regression procedure. The empirical results show that high-income provinces are converging to the average while low-income provinces are diverging from the average in the Turkish case.

The sigma convergence which is based on the “standard deviation” and “coefficient of variation” methods indicates that there is a closing income gap among the Turkish provinces over the 1992-2019 period. Another finding is the decreasing income inequality parallel to the decreasing economic performance in the Turkish case.

In the light of these empirical findings, the following answers are given to the three questions asked in the introduction part. (i) Almost all provinces above the average except Manisa are converging to the national average income while almost all provinces below the average except Osmaniye, Ardahan, and Mardin are diverging. (ii) Yes, there is a sigma convergence

among the provinces at the aggregate level and the main motivation behind this convergence is the economic slowdown. (iii) These two income convergence methodologies show that the income gap among Turkish provinces is closing in parallel to the slowdown in economic performance. In other words, Turkish provinces are sharing the decreasing income more equally.

In general, the empirical findings are consistent with the findings of the studies which found an income convergence among the Turkish provinces. On the other hand, the findings are not fully comparable with all of these studies since this study belongs to one of the few studies which approaches income convergence, although not fully, from the perspective of income inequality. (Ersungur and Polat 2006; Yildirim 2009; Akinci 2017; Soyyigit 2018; Ozturk and Gultekin 2021) Moreover among these studies, the study of Ersungur and Polat (2006), and the study of Ozturk and Gultekin (2021) seem the most comparable since both studies employed unconditional beta and sigma convergence procedures for the investigation. The empirical results of both studies are in line with the findings of our study. The common findings are a general income convergence among Turkish provinces. In addition, it has been observed that income convergence increased with the decreasing per capita income levels. In addition to these studies, the study of Akinci (2017) seems comparable with this study according to the findings it reached. Akinci concluded that the rich converge to the rich and the poor converge to the poor while in our study the rich converge to the average while the poor diverge from the average.

In this context, the main contributions of this study have been as follows. First, the beta and sigma convergence methods were not only used for the investigation of the income convergences but also the exploration of the income inequality among Turkish provinces. Second, the longest available dataset with 28 observations at the provincial level has been used for this investigation which is expected to provide more healthy empirical results than the other studies since the former two sets, (1987-2001) and (2004-2019), contains only 15 and 16 observations, respectively. Thirdly, the empirical investigation has been made by taking the economic structural breaks into account which makes the analysis more realistic.

Besides, the study has also some shortcomings. As a result of the empirical investigation, an improvement in income distribution was observed in parallel with the decrease in per capita income level, but the reason could not be explained. At this point, conditional beta convergence analysis may provide more information about the reason for this relationship since the analysis tries to explain the income convergence concept via the differences in savings, education level, population growth, etc. among countries. On the other hand, the lack of available data at the provincial level stands as a challenge for the researchers. From another perspective, the decrease in income inequality during periods of economic contraction may be a side effect of being an emerging market country. Nevertheless, the explanation of this fact is still missing and can be considered an important research topic for future studies.

Declaration of Research and Publication Ethics
This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher's Contribution Rate Statement
I am a single author of this paper. My contribution is 100%.

Declaration of Researcher's Conflict of Interest
There is no potential conflicts of interest in this study.

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Appendix:

Appendix 1. The Studies About Turkey

Author's Name(s)	Interval	Sample size	Method	Result
Filiztekin (1998)	1975-1995	65 provinces	CS and PD	Conditional convergence at a speed of 1.9%; an increase in the dispersion of the per capita income levels since the late seventies.
Tansel and Güngör (1998)	1975-1995	67 provinces	CS and PD	Absolute convergence and conditional convergence among cities; convergence speed is higher in the conditional version. Savings and human capital affect convergence positively.
Erk et al. (2000)	1979-1997	67 provinces, seven geographical regions and provinces in SAP	CS	There is an overall divergence; different reactions at the regional level.
Berber et al. (2000)	1975-1997	seven geographical regions	CS and PD	No evidence for sigma and beta convergences.
Altınbaş et al. (2002)	1987-1998	67 provinces	SD	Sigma convergence for the western provinces, divergence for the eastern, south-eastern, and black-sea provinces.
Sağbaş (2002)	1986-1997	67 provinces	CS	Absolute beta convergence across the provinces. No relationship btw gov. expenditures and growth in the context of the convergence process.
Gezici and Hewings (2004)	1980-1997	16 functional regions and 67 provinces	OLS, CS	No clear evidence for sigma convergence, for absolute and conditional convergence across provinces and functional regions.
Karaca (2004)	1975-2000	67 provinces	CS	Beta and sigma divergence.
Ersungur ve Polat (2006)	1987-2000	NUTS-1 regions	NOLS	Absolute convergence with a speed of 0.7%; conditional convergence but not significant; sigma convergence; the economic crisis affects the convergence process positively.
Kılıçaslan and Özyatağan (2007)	1987-2000	64 provinces	PD	Convergence
Kırdar and Saraçoğlu (2008)	1975-2000	67 provinces, NUTS-1, NUTS-2 regions	CS, 2SLS	Evidence for absolute divergence (speed 0,48%) and conditional convergence for regions (speed 6.4%) and provinces (speed 1.1%).
Yamanoğlu (2008)	1990-2001	67 provinces	CS, NOLS	Absolute and conditional convergence.
Yıldırım (2009)	1987-2001	67 provinces	OLS, SEM, SAR, and GWR	Absolute and conditional beta convergence across provinces, eastern and southeastern provinces show higher speeds of convergence.
Önder et al. (2010)	1980-2001	NUTS-2 regions	Pooled panel, GMM-DIF, GMM-SYS	Sigma and conditional beta convergence across regions. Per capita public capital stock has a positive effect on GDP per capita.

Appendix 1. Continued

Zeren ve Yılancı (2011)	1991-2000	NUTS-2 regions	Panel, Random coefficient	Evidence for absolute convergence for 17 out of 26 regions and conditional convergence for 25 out of 26 regions. Regional bank deposits have a positive effect on GDP per capita.
Aslan and Kula (2011)	1975-2001	67 provinces	TUR, PUR; univariate and panel LM	Absolute beta convergence across provinces except two.
Erlat (2012)	1975-2001	65 provinces	PUR	Mixed results, the majority of the provinces are not converging but there were some exceptional provinces and regions.
Karaalp ve Erdal (2012)	1993-2001	73 provinces	Panel FE and GMM	Evidence for absolute and conditional convergence across the provinces. Agglomeration effects slow down the convergence process.
Abdioğlu and Uysal (2013)	2004-2008	NUTS-2 regions	PUR	Two of the six unit root tests supports stationarity while the rest four indicates no stationarity; the authors decided for no convergence.
Gerni et al. (2015)	2004-2012	81 provinces and NUTS-2 regions	OLS	Absolute beta convergence across the regions. No evidence for absolute beta convergence across the provinces. Investment incentives have no positive effect on income per capita.
Özgül ve Karadağ (2015)	1990-2001	NUTS-2 regions	OLS	Sigma convergence across the regions. Some evidence for absolute beta convergence, socio-economic indicators do not affect regional growth.
Akıncı (2017)	1980-2014	NUTS-1 regions	TUR	Divergence, the rich converge to the rich and the poor converge to the poor.
Gömleksiz et al. (2017)	2004-2014	NUTS-2 regions	PD	Regional convergence, the role of government is likely to be decisive in solving regional economic disparities.
Orhan KARACA (2018)	1960-2014	NUTS-1 regions	PD	No convergence at NUTS-2 region level.
Semanur Soyyiğit (2018)	2004-2014	79 provinces	PD	Evidence for absolute convergence (1.22%); evidence for conditional convergence but not statistically significant.
Aksoy et al. (2019)	1987-2017	NUTS-3 regions	Phillips–Sul log(t) regression	Strong evidence for convergence clubs across Turkish regions.
Öztürk and Gültekin (2021)	2004-2017	81 provinces	CS	Evidence for the unconditional beta and sigma convergences; the public investments and government subsidies do not affect the speed of convergence.