CONVERGENCE HYPOTHESIS: AN APPLICATION ON SELECTED OECD COUNTRIES

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Abstract

Convergence in other words, with the closing of the gap between rich and poor economies, the large number of possible outcomes that may arise in the economy represents only one. While the countries in the middle income group are close to the rich, the poor countries are left behind. On the other hand, countries may experience a divergence in which rich countries are richer and poor countries are poorer than convergence as a whole. All of these possibilities are related to the change in per capita income distribution around the world. In this study, it was tried to be tested by panel unit root test methods that the growth of income levels of selected OECD countries (Argentina, Australia, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, Turkey, UK and USA) from 1961-2015 converged to each other. Findings from the study show that OECD countries converge on the convergence of national income to the US average national income in the mentioned period. Tests produced are consistent with each other in that the H_0 panel unit root process can't be accepted.

Key words: *Convergence, divergence, OECD countries, panel unit root test.*

JEL Classification: *O47.*

I. INTRODUCTION

After the industrial revolution, life standard of developed countries showed a noticeable increase. This increase measured in developed countries cannot achieved in many developing countries and the gap between the two has increased to enormous levels. The main indicator of the development of a country is economic growth. In order to maintain economic growth, many theories are introduced. Even though the initial theories of economic growth starts with the studies of Ramsey (1928), the fundamentals of the theories, such as economic equilibrium dynamics, the law of diminishing returns, physical capital and human capital, technological progress and population growth, root from the pioneers of classical economy thought. Solow (1956) and Swan (1956) growth model has been argued investigating the welfare gap between the rich and poor countries emphasizing on population growth and technological progress. Main outcome derived from this model is the convergence hypothesis. According to convergence hypothesis, developing countries catch up with developed countries as a consequence of a rapid growth path in the long run (Barro,1999, 9).

II. NEOCLASSICAL GROWTH THEORY

Fundamental Solow model investigates the labor, capital, technology and output interactions in a close economy. Labor and capital are perfect substitutes to each other. Production function is defined, Y(t) representing output level, K(t) representing physical capital, L(t) representing labor and A(t) representing technology (Romer,2006):

Y(t)=F (K(t), L(t), A(t))

According to the equation above, output level is a function of capital, labor and technology. Production function is a time dependent increasing function of up to the time capital, labor and technology. Main assumption of the Solow-Swan model is that capital and labor are subject to constant returns to scale. Accordingly, output level is an increasing function of the physical capital, labor and technology. Effectiveness of the Solow-Swan model is tested by conditional convergence hypothesis (Barro,1999, 10).

Based on this hypothesis, we can rearrange equation 1:

(1) $y = \frac{Y}{AL}$ k= $\frac{K}{AL}$

(2) $F\left(\frac{K}{AL}, 1\right) = \frac{1}{AL}F(K, AL)$

According to the equation above, output per effective labor is a function of capital per effective labor. This function satisfies the condition f(0)=0 $f'(k)<0$. .f' is the marginal return of capital. Marginal return of capital is positive but subject to diminishing returns. This condition guarantees the achievement of stationary state equilibrium.

Another assumption is the fixed rate of change of labor and technology. Technology is an external variable. Inıtial level of labor and technology are respectively L(t)=n.L(t) and A(t)=g(A(t)). n is the increase rate of population, g is the increase rate of technology. Output, consumption and investment are equal. i percentage of the investment is external and determined according to fixed investment. Depreciation rate of capital is δ:

K(t)=s.Y(t)-δK(t)

A and L are external and have constant growth path, dynamic of the model is determined by capital. The equation reveals the dynamics of k with constant A and L. change rule is used in order to find the change in capital in effective capital per labor.

$$k = \frac{K}{A.L}$$

$$k(t)=\left[\frac{K(t)}{A(t)L(t)}\right]-\frac{K(t)}{[A(t)L(t)]^2}[A(t).L(t)+L(t).A(t)$$

$$=\frac{K(t)}{A(t)L(t)}-\frac{K(t)}{A(t)L(t)}\frac{L(t)}{L(t)}-\frac{K(t)}{A(t)L(t)}\frac{A(t)}{A(t)}$$

When replaced in the first three equations:

$$k(t)=\frac{s.y(t)-\delta k(t)}{A(t)L(t)}-k(t).n-k(t).g$$

$$=s.\frac{y(t)}{A(t)L(t)}-\delta k(t)-nk(t)-gk(t)$$

K(t)=sF(K(t))-(n+g+δ)k(t)

This equation reveals the main difference equation for the Solow model. s.f(k) shows the actual investment per effective labor, (n+g+δ)k shows the required investment level. Investment per effective labor is the level of investment required at least a fixed level of investment.

Main reason of the income gap between the countries is the difference of saving-investment - capital accumulation- ratio among the countries. Neoclassical theory assumes no inconsistency between constant returns to scale and chancing factor ratios and growth rate and the economy tends to reach a stable point in time. Interest rate of the capital decreases when capital per labor increases in time. In order to fix the interest rate, capital accumulation rate should be equal to labor increase rate and technological growth. Long run growth can be achieved with the rise of technological progress and labor in this model and both of them are assumed to be an external factor. Somehow, an external factor of technology cannot explain the long term growth by the model.

III. CONVERGENCE HYPOTHESIS

When there is constant returns to scale and diminishing returns of production function, long term growth rate is determined by external factors, stationary state growth rate is independent from saving rate and production function. Long term growth rate depends on external technological progress. Long term capital per labor and income levels tend to be converge for the reason that growth rate depends on external technological developments, not the saving rates. This condition is defined as convergence hypothesis (Romer, 2006: 35).

Solow model explains the growth gap between the countries latch on to two variables: difference in capital per labor and difference in labor productivity. Only the level of labor can maintain the permanent increase of productivity per labor. For this reason, growth gap between the country can be explained with the labor productivity. As a result of Solow model, the differences of capital don't explain the differences of wealth among the countries if the return of capital is an indicator of the contribution of capital to output (Romer, 2006: 26).

Many definition of convergence is presented in the literature. σ- convergence and β-convergence are two of them. β-convergence stated a negative relationship between the initial income ratios and growth rates (Sala-i Martin,1996). β-convergence reveals when low income economics grow faster than high income economies in time. Thereby, a negative relationship between initial production level and the actual production level arises. This type of absolute convergence occurs when the countries have the same econometric parameters and production function and the only difference is the difference of the initial level of capital per labor. In these conditions, developing countries grow faster and catch up with the developed countries. Absolute convergence is observed in the similar structured OECD countries between 1960-1985 (Barro and Sala-i Martin,26). In order to present this relationship, a cross sectional data regression depending on real growth rate per capita USA initial income level, in addition with education, population, political factors.

σ- convergence states that the low income regions grow faster than rich income regions and the gap between the income level is explained with the decreasing standard deviation of the clutter (Friedman (1992), Lichtenberg (1994), Barro and Sala- i Martin (1995)). In this approach, logarithm of the real income per capita and the productivity levels are calculated as a variation coefficient (σ). When (σ) coefficient diminishes among time, economies converge to each other (Williamson,1996,279).

IV. LITERATURE

Empirical studies of the convergence hypothesis is made by time series method or cross section method. Time series method emphasizes the time series characteristics of the series. Baumol (1986) analyzed the data of 16 countries between 1870 and 1979. According to the results, the gap between the countries converge in time. This result is valid for middle income countries but not for the less developed countries.

Barro and Sala-i Martin (1991) investigated the USA data to reveal whether there is convergence among the states or sectors. Although it is found that the less developed states grow faster than the rich states, the convergence coefficient is low. A similar result is found by Barro and Sala-i- Martin (1992). Their analysis shows a convergence for USA economy emphasizing the initial level of income per capita levels. They also mention about the convergence for OECD countries.

Mankiw et.al. (1992) used an advanced Solow model including the data of 121 countries. This study indicates the importance of human capital besides physical capital for the importance of convergence. According to the results of the study, a Solow type convergence can be observed if population growth rate and capital accumulation rate is fixed.

Islam (1995) tested the convergence of three country groups (98 countries for the first group, 75 countries for the second group and 22 OECD countries for the third group) using panel data analysis that uncovers the structural differences of the countries. Together with the time series model, a cross section analysis between 1960-1985 is also tested. Results of the study shows cross section data explains the convergence of the countries much better.

Quah (1993) constructed a time series model with the income per capital data and average of world income data of 118 countries stating from 1960 and 1963 to 1984-1985. Countries are categories into two groups as an outcome of the study.

Another study using time series method is Bernard and Durlauf (1995). Firstly, convergence is defined within the context of convergence and then cross section and time series properties are studied. Evaluating the initial levels, the best explicator model is searched. Although none of the model in the study resulted certain evidence, cross section models enables to make some evaluation about the convergence. Acceptance of null hypothesis stating that there is no convergence can be due to the temporary characteristics of the data.

Bernard and Jones (1996) emphasized the importance of the technology when evaluating the concept of convergence. Technology adaptation and accumulation are important components of convergence. Empirical results show that the difference of technology and labor efficiency between the countries follow similar path and the converge in service sector is more likely.

Nahar and Inder (2002) tested convergence of 21 OECD countries and 19 of these countries tend to converge USA economy.

Filiztekin (1998) analyzed the convergence of the Turkish provinces between 1975-1995. Conditional convergence among the regions is emphasized and the difference of the steady states is the difference of initial levels. In addition, efficiency levels and growth rates of the efficiency differs among the sectors and regions. Convergence of the provinces is observed when different factors are added to the model.

Tansel and Güngör (1997) investigated whether the less developed regions catch up with the developed regions of Turkey about labor efficiency levels. On the basis, unconditional convergence of efficiency observed in the provinces. Period of the study is divided into two phases. While divergence can be stated between 1975-1980 there is convergence, there is absolute convergence between 1980-1995.

Relationship of convergence with relational instabilities and investment incentives is investigated by Gerni et.al. (2015) for two periods, between 2004-2008 and 2008-2012. Whether there is a convergence due to provinces and regions and their relationship with the investment incentives are searched. According to β convergence analysis, the increase of per capital income in the regions causes an absolute convergence. Possible causes of the convergence is immigration and the rise of income by extension.

Borluk (2015) analyzed the income level convergence in regional context. The period of 1975-2001 is taken as one period and the increase level of income in 26 regions in this period. Results of the both β convergence and σ convergence analysis show a strong income divergence.

Pehlivan and Utkulu (2015) investigated the relative per capita GDP convergence process with a cross section method for the European Union countries and candidate countries. Between 1990-2011, data of per capita income, index of openness, economical activities and government expenditure data show a strong evidence of convergence among the countries.

Görgül and Koralp (2014) researched 26 OECD per capita real income data of counties between 1970-2012. Panel unit root tests shows a convergence both for OECD countries and for OECD countries and USA.

V. UNIT ROOT TEST

In this part of the study, convergence of the income level growth of selected OECD countries using panel unit root test. In the study, data of Argentina, Australia, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, Turkey, U.K and USA is selected. All the data is collected from OECD data delivery system (http://stats.oecd.org).

A panel model is defined as follows in order to use unit root test of panel data (Levin et al. 2002):

$y_{it} = \gamma_i + \rho_i y_{it-1} + x_{it} \delta_i + \varepsilon_{it}$

$i = 1, 2, \ldots, N$, $t = 1, 2, \ldots, t_i$ represents cross section units in observation period. γi shows fixed effects, general individual trend component, ρ represents time series effects and k is the lag operator. Null hypothesis is ρ equals to zero. If we reject the null hypothesis, we can observe panel convergence.

Unit root process in the existence of trend is defined by Levin et al (2003) as follows:

$$\Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_i} \beta_{ij} \Delta y_{it-j} + X_{it}\delta + \varepsilon_{it}$$

The null hypothesis is, all the country series have unit root. The alternative hypothesis is some of the country series has unit root. Under these hypothesis, the results of income level convergence for 18 OECD countries and USA is in table above:

Y_i shows the real growth rate of GDP of OECD countries. In order to test the convergence of OECD countries to its mean and convergence of OECD countries to USA mean, H_0 hypothesis is H_1: $(Y_i / Y_{usa}) \sim I(0)$, $i = 1, 2, \ldots, 18$ for 18 panel stationary assumption is tested and also the convergence of OECD countries to group mean is H_1: $(Y_i / Y_{mean}) \sim I(0)$, $i = 1, 2, \ldots, 18$ tested.

Table 1: Convergence of OECD countries real GDP to USA real GDP-Unit Root Test

Sample Period: 1961-2015 Explanatory Variable: Individual Effects. Newey-West bant width (Barlett) Schwarz Criteria Lag Lenght			
Method	**Statistic**	**Prob**	**Cross Section**
Im, Peseran,Shin	-12.8876	0.0000	18
ADF-Fisher X^2	244.881	0.0000	18
ADF-Fisher Choi Z	-12.1233	0.0000	18
PP-Fisher X^2	342.955	0.0000	18
PP_Fisher Choi Z	-15.4592	0.0000	18
Levin,Lin,Chu	-12.6941	0.0000	18

For the convergence of OECD countries to group mean, H_0 hypothesis, panel unit root assumption, is rejected. Level of H_0 rejection is smaller than 0 showing there is a convergence.

Table 2: Convergence of OECD countries real GDP to OECD real GDP Average-Unit Root Test

Sample Period: 1961-2015 Explanatory Variable: Individual Effects. Newey-West bant width (Barlett) Schwarz Criteria Lag Lenght			
Method	**Statistic**	**Prob**	**Cross Section**
Im, Peseran,Shin	-12.8876	0.0000	18
ADF-Fisher X^2	244.881	0.0000	18
ADF-Fisher Choi Z	-12.1233	0.0000	18
PP-Fisher X^2	342.955	0.0000	18
PP_Fisher Choi Z	-15.4592	0.0000	18
Levin,Lin,Chu	-12.6941	0.0000	18

For the convergence of OECD countries to USA income level mean, H_0 hypothesis, panel unit root assumption also is rejected. Level of H_0 rejection is smaller than 0 showing there is a convergence. Results of the panel unit root tests show consistent results.

VI. CONCLUSION

Closing the gap between rich and poor economies as a whole, expressed as convergence in the convergence process, instead of the rich countries richer, poor countries poorer led to a divergence, while on the other hand, convergence of the poorest countries behind the rich countries in the middle income group, respectively. Mankiw, Romer and Weil (1992) and Barro and Sala-i-Martin (1992) authors of the country differ due to the conditions such as they have converged in a static condition after taking account of the differences that they represent the name of the condition expressed in the conditional convergence (Jones, 2001:65-66). It is a

confirmation of the conclusions of the neoclassical model in a sense that conditional convergence means. In other words, countries with similar status show convergence. This does not mean that all the countries in the world are close to the same stationary state, but only if they approximate their stationary state values according to the general theoretical model.

On the other hand, there are reasons why countries may not be stationary. For example, the outbreak of World War II; an increase in the rate of investment can lead to unusual consequences such as changes in the rate of population growth or the expansion of capital stocks of countries. For this reason, economies will cause growth rates to change until they reach their steady state values. Again, shocks such as the OPEC crisis in the economies, while creating very positive effects on the economies of the oil exporter countries, significantly undermine growth in other economies. Hyperinflation in Latin American countries in the 1980s also the growth performance of the economy macroeconomic policies such as disturbances related in a lot decreases. On the other hand, an increase in the rate of investment, specialization, knowledge accumulation and technological progress, such as positive developments during the transition leads to an increase of the growth rate of the economy.

Selected OECD countries (Argentina, Australia, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, Turkey, United Kingdom and United States) using data from conducted in this study, the growth of income levels for the years 1961-2015 panel unit root test methods has been tested with the version each other. Findings from the study show that OECD countries converge on the convergence of national income to the US average national income in the mentioned period. It has been observed that the tests produced consistent results with respect to the inability to accept the H_0 panel unit root process.

VII. REFERENCES

1. Barro, R. J., & Sala-İ-Martin, X. (1990). Economic Growth And Convergence Across The United States (No. W3419). National Bureau Of Economic Research.
2. Barro, R. J., & Sala-İ-Martin, X. (1992). Convergence. Journal Of Political Economy, 100(2), 223-251.
3. Barro, R. J., & Sala-İ-Martin, X. (1995). Technological Diffusion, Convergence, And Growth (No. W5151). National Bureau Of Economic Research.
4. Barro, R.J.(1996). “Determinants Of Economic Growth: A Cross-Country Empirical Study”, National Bureau Of Economic Research Working Paper No 5698.
5. Baumol, W. J. (1986), "Productivity Growth, Convergence, And Welfare: What The Long-Run Data Show", The American Economic Review, 76 (5): 1072-1085.
6. Baumol, W. J. (1986). Productivity Growth, Convergence, And Welfare: What The Long-Run Data Show. The American Economic Review, 1072-1085.
7. Bernard, A. B., & Durlauf, S. N. (1996). Interpreting Tests Of The Convergence Hypothesis. Journal of Econometrics, 71(1), 161-173.
8. Bernard, A. B., & Jones, C. I. (1996). Technology And Convergence. The Economic Journal, 1037-1044.
9. Borluk, S. (2014). Türkiye'de Bölgesel Gelir Dağılımı Iraksaması, Verimlilik Ve Diğer Dinamiklerle İlişkisi. Verimlilik Dergisi, (4), 19-44.
10. Filiztekin, A. (1998). Convergence Across İndustries And Provinces İn Turkey. Koç University, Http://Myweb. Sabanci Univ. Edu/Alpayf/Files/2010/04/Turkconv981. Pdf.
11. Friedman, M. (1992) “Do Old Fallacies Ever Die?”, Journal Of Economic Literature, 20, 2129-32
12. Gerni, C., Sarı, S., Sevinç, H., & Emsen, Ö. S. (2015). Bölgesel Dengesizliklerin Giderilmesinde Yatırım Teşviklerinin Rolü Ve Başarı Kriteri Olarak Yakınsama Analizleri: Türkiye Örneği.
13. Gögül, P. K., & Korap, L. (2014). Ekonomik Yakınsama Olgusunun Sınanması Üzerine Yeni Bulgular: OECD Örneği. Kastamonu University Journal Of Economics & Administrative Sciences Faculty, 4(2).
14. Gregory, M. N., Romer, D., & Weil, D. N. (1992). A Contribution To The Empirics Of Economic Growth. Quarterly Journal Of Economics, 107(2), 407-437.
15. Http://Stats.Oecd.Org
16. Islam, N. (1995). Growth Empirics: A Panel Data Approach. The Quarterly Journal Of Economics, 110(4), 1127-1170.
17. ISO 690 Bernard and Durlauf (1995) Interpreting Tests Of The Concvergence Hypothesis
18. Korap,L.(2010).“OECD Ülkeleri İçin Ekonomik Yakınsama Öngörüsünün Zaman Serisi Panel Birim Kök Yöntemleri İle Sınanması”, İstanbul Ticaret Üniversitesi Sosyal Bilimler Dergisi, 1: 189-20
19. Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit Root Tests in Panel Data: Asymptotic and Finite-Sample Properties. Journal Of Econometrics, 108(1), 1-24.
20. Lichtenberg, F. R. (1994). Testing The Convergence Hypothesis. The Review Of Economics And Statistics, 576-579.
21. Mankıw, N. G., Romer, D. And Weil, D. N. (1992). "A Contribution To The Empirics Of Economic Growth", The Quarterly Journal Of Economics, 107 (2), 407-437.
22. Nahar S. And Inder B. (2002). Testing Convergence İn Economic Growth For Oecd Countries, Applied Economics, 34 (16): 2011-2022
23. Pehlivan, G.G Ve U. Utkulu (2015). Country-Specıfıc Convergence Behavıor İn An Enlarged Europe, İşletme Fakültesi Dergisi, 16(2), 207-226.
24. Quah, D. (1993). Empirical Cross-Section Dynamics İn Economic Growth. European Economic Review, 37(2-3), 426-434.
25. Romer,D. (2006). Advanced Macroeconomics.Mcgrow Hill, Third Edition
26. Sala-i-Martin, X. X. (1996). The classical approach to convergence analysis. The economic journal, 1019-1036.
27. Sala-İ-Martin, Xavier X. (1996). The Classical Approach To Convergence Analysis. The Economic Journal, 1019-1036.
28. Tansel, A., & Güngör, N. D. (1999, March). Economic Growth And Convergence: An Application To The Provinces Of Turkey, 1975-1995. Economic Research Forum For The Arab Countries, Iran & Turkey.