PER CAPITA INCOME CONVERGENCE AMONG EUROPEAN UNION COUNTRIES: HALDANE – HALL APPROACH

Merter AKINCI[*]
Ömer YILMAZ[**]

Abstract

Despite its strong growth potential, European Union (EU), one of the most important economic powers of the world, is not able to provide sufficient instruments for the member countries to accelerate economic growth performance. This insufficiency leads to inequality in euro zone with respect to per capita income. Therefore, reaching real convergence process in the medium and long-term appears to be a crucial goal for the region. In this context, this study uses Haldane-Hall analysis to test the convergence process among the 17 EU member countries in the euro zone within the period of 1992-2011. The results of the analysis indicate that the process of convergence has been rapid among Austria, Finland, Ireland, Malta, Portugal and the founder six countries; whereas, the process decoupled among Estonia, Cyprus, Spain, Slovakia, Slovenia, Greece and the founder six countries.

Keywords: *Convergence, Haldane – Hall Analysis, Time Series Analysis, Euro Zone*

AVRUPA BİRLİĞİ ÜLKELERİ ARASINDA KİŞİ BAŞINA GELİR YAKINSAMASI: HALDANE – HALL YAKLAŞIMI

Özet

Dünyanın en önemli ekonomik güçlerinden bir tanesi olan Avrupa Birliği (AB), sahip olduğu güçlü büyüme potansiyeline karşın hızlı iktisadi büyüme performansını sağlayabilmeleri için üye ülkelere yeterli enstrümanları temin edememektedir. Bu yetersizlik, Euro alanı içinde kişi başına düşen gelir bakımından eşitsizliğe yol açmaktadır. Dolayısıyla, orta ve uzun dönemde reel yakınsama

[*] Research Assistant, Ataturk University, Faculty of Economics and Administrative Sciences, Department of Economics, e-mail: makinci86@gmail.com
[**] Assoc. Prof. Dr., Ataturk University, Faculty of Economics and Administrative Sciences, Department of Econometrics, e-mail: omeryilmaz@atauni.edu.tr

sürecine ulaşılması bölge için hayati bir hedef olarak görünmektedir. Bu bağlamda çalışma, Euro alanı içerisinde bulunan 17 AB'ye üye ülke arasındaki yakınsama sürecini 1992 – 2011 dönemi dönemi için test edebilmek amacıyla Haldane – Hall Analizi'ni kullanmaktadır. Analiz sonuçları; Avusturya, Finlandiya, İrlanda, Malta, Portekiz ve kurucu altılar arasında bir yakınsama sürecinin; Estonya, Kıbrıs, İspanya, Slovakya, Slovenya, Yunanistan ve kurucu altılar arasında ise bir ıraksama sürecinin söz konusu olduğunu göstermiştir.

Anahtar Kelimeler: *Yakınsama, Haldane – Hall Analizi, Zaman Serisi Analizi, Euro Alanı*

Introduction

The history of world economy has introduced important advances within the frame of global movements. In the process, which has primarily taken effect on capital and financial markets encompassing the years of 1870-1914, the countries have begun to lay the foundations of economic integration in line with labor and capital trends (Aslan, 2007: 7-8). Financial markets have been included into the development stage and have been considered as inherent parts of financial integration for global movements, along with the motto of *"laissez faire-laissez passer"*, which has been an extension of the 17th century thinking and has been gaining increasing validity (Taylor, 2004: 28).

Regionalization and integration movements, which have emerged in parallel with the efforts to overcome the Great Depression, were the main factors accelerating the second globalization stage. Developments on multilateral production, trade and financial relations both quickened the tendencies of second stage globalization and enforced the countries into power unity and intensive regional relations (Köse, 2003: 7). Especially, the origin of movements for the Union constitution of countries in the continent of Europe have been developed during this period (Bekmez and Karataş, 2007: 291). The idea of creating a union has been increasingly supported during the Second World War period along with decreasing sensations of nationalism and colonialism (Borchardt, 1995: 5-6) as well as preventing the wars in Europe (Wallace, 1994: 11). Furthermore, the threat of US to Europe both politically and economically, had been arised as another factor motivating the consideration of economic union (Baun, 1996: 6-7). As a result of the necessities and threats mentioned above, European Coal and Steel Community was established by Treaty of Paris, signed between Germany, France, Italy and the three Benelux countries in 1951. This treaty, whose main purpose was the elimination of trade barriers among member countries, focused on increasing the welfare in the union and balancing the economies of countries (Moussis, 2004: 25-

26). As a result of Treaty of Rome, which was signed in 1957, and Maastricht Treaty, the name of the union was formalized as "European Union".

The third globalization stage began in 1980s and went parallel with the stagflation phenomenon of Western economies, triggered by the appearance of oil shocks in 1970s. Because the collapse of Bretton Woods system which was provoked by the trade balance deficits of US, the development of euro-dollar and euro-stock markets concerning the trade of US dollar on European market, the integration of money and capital markets among countries arised (Aslan, 2007: 8). However, the last globalization process, which led the stepping up of commercial, financial and productional dependence of the countries, enforced the appearance of the "convergence clubs" phenomenon, which included all countries in the world, especially the member countries (Dowrick and DeLong, 2003: 192). The convergence process, which could be basically defined as the closing of the per capita income levels of different economies in a time period, was introduced by Solow (1956) who is thought as the founder of neo-classical growth model. The European Union, which intends to eliminate the economical differences among member and candidate countries, adopted Maastricht criteria and aimed at diriving the member states to pursue similar economical perspectives with respect to the criteria (Doğan and Saraçoğlu, 2007: 160). In order to eliminate the income gaps, especially among member countries, particular incestment support is granted to the poorest countries via structural funds and the policies in this context were formalized with the Single European Act. As a result, these reinforced policies which were developed for underdeveloped countries in EU, aimed at contributing to the convergence process (Freidas *et al*., 2003: 270).

In this study, the per capita income data of 17 EU member countries in euro zone within the period of 1992-2011 were considered, and the convergence process between related economies were investigated in the light of Haldane-Hall approach. For this purpose, the study consists of four sections. In section 1, the theoretical framework for testing convergence process is presented; in section 2, the literature on the subject is reviewed; in section 3, the methodology and data concerning the application of the study are introduced; in section 4, the empirical findings are interpreted. The study ends up with the conclusion, where a general evaluation is made.

1. Convergence Models

One of the most remarkable findings of neoclassical growth models is the convergence process between countries. In these models, the independency between per capita income level in the case of stable equilibrium and the initial output level was emphasized. Furthermore, it was mentioned that the changes on the macro and microeconomic indicators of the countries differentiate per capita income levels and

this situation was stemmed from different growth rates. In this sense, the growth rate volatilities of per capita income levels among countries, were associated to the distinctive macro and microeconomic characteristics of these countries (Bernard and Durlauf, 1995: 97).

Solow (1956), an acknowledged pioneer of the neo-classical model, identified the convergence process as the underdeveloped and developing countries would tend to grow faster in comparison to developed countries and so these country groups would converge in terms of per capita income. The basis of converge model stands for the negative relation between the value of per capita income at the initial period and the growth rate of income. The hypothesis of convergence which suggests that the increases in levels of productivity of under-developed or developing countries is higher. Thus the growth deficit between the developed and under-developed countries will vanish in time, also suggests that the significant increases in the capital supply in poor countries will accelerate the process as well as the management techniques, the technologies transferred from developed countries and the investments to be made in education (Baumol and Blinder, 2010: 137).

The results of neoclassical growth model concerning convergence hypothesis were extended by the studies of Barro (1991, 2003) and Barro and Sala-i-Martin (1991, 1992, 2003) under the assumption of "rich and poor economies". Under the mentioned assumption, the authors stated that poor economies tend to grow faster than rich economies if both economies possess similar saving rates, population increases, depreciation coefficients and technical improvement levels. Therefore, it was determined that per production and income levels of poor country economies converge to the levels of rich countries (Jan and Chaudhary, 2011: 117). The approach of capital dependent on diminishing returns was attached to the suggestion that per capita return of poor countries which is gained by additional capital is more than the returns of rich countries. Consequently, convergence hypothesis manifests that the growth rates of countries, which possess higher per capita incomes at the initial period, will be slower compared to other countries (Mbaku and Kimenyi, 1997: 121).

Analyses about convergence hypothesis were formed around three studies, which were "beta (β) convergence", "sigma (σ) convergence" and finally "log-per capita income convergence". The beta convergence coefficient corresponds to an absolute convergence concept. The beta convergence, which suggests that poor economies tend to grow faster than rich economies and correspondingly per capita income levels among these two groups economies convergence, can be denoted in equation (1): (Arbia and Piras, 2005: 13)

$$\frac{y_{t,i} - y_{0,i}}{y_{0,i}} = \alpha + \beta y_{0,i} + \varepsilon_{t,i} \quad (1)$$

In this equation, $y_{t,i}$ indicates per capita income of country i in the current period; $y_{0,i}$ indicates per capita income of country i at the initial period; the left hand side of the equation, which is the dependent variable of the model, indicates growth rate of all period; α indicates constant term; β indicates convergence coefficient and finally ε_t indicates the error term. When β coefficient is negative, it means that there is convergence among countries, and on the contrary when β coefficient is positive, there is evidence of divergence. By using equation (1), two more parameters are able to be computed. One of them is the speed of convergence and the second one is known as "half-life" in the literature, which is the time frame necessary to reach the stable equilibrium.[1]

Sigma (σ) convergence exhibits how per capita income being distributed in a particular time period and assumes that depreciation of per capita income distributions for compared economies will decrease over time (Sala-i-Martin, 1996: 1020). The criterion which is used to measure sigma convergence, is the standard deviation (σ). If the standard deviation tends to decrease in a particular time frame, convergence, otherwise divergence can be cited (Valdes, 1999: 41). Sigma convergence is illustrated in the equation (2) below: (Gündem, 2010: 3094)

$$\sigma_t = \sqrt{I^{-1} \sum_{i=1}^{I} \left(S_{ti} - \bar{S}_t \right)^2} \quad (2)$$

In equation (2), I indicates the considered countries in the analysis; S_{it} indicates income of country i in a time period *t*, and $\bar{S}_t$ indicates the average of all countries income in period *t*.

[1] The speed of convergence can be computed using the equation of $s = -\ln(1+T\beta)/T$. T coefficient represents the number of period between t and $t-1$. Half-life is obtained with regard to the equation of $\tau = -\ln(T)/\ln(1+\beta)$.

In turn, log-per capita income convergence questions whether different countries share mutual deterministic or stochastic trends. Bernard and Durlauf (1995, 1996) and Evans and Karras (1996) persisted on this convergence type in their studies (Lee *et al*., 1997: 358). Log-per capita income convergence can be expressed by using equation (3) below: (Young *et al*., 2008: 1086)

$$\log\left(y_{t,i}\right) = a + \left(1-\beta\right)\log\left(y_{t-1,i}\right) + u_{t,i} \tag{3}$$

In equation (3), y_{it} indicates average growth rate of per capita income in country i; β indicates convergence coefficient; $y_{i,t-1}$ indicates per capita income of country i at the beginning of the period and u_{it} indicates the error term, the latter having constant variance and zero mean. With few manipulations, equation (3) becomes:

$$\log\left(\frac{y_{ti}}{y_{t-1,i}}\right) = a - \beta\log\left(y_{t-1,i}\right) + u_{ti} \tag{4}$$

This equation is the quasi of beta convergence equation and suggestions about convergence can be made with respect to the sign of the obtained beta coefficient.

2. Literature Review

There are numerous studies examining the convergence process among countries, which are involved in the formations of economic integration, that is increasingly depending on globalization movements. In the studies concerning EU, both the convergence between member countries and between various economic activities of the countries within their regions and indicators are examined.

In their studies investigating economic performances of countries in Western European zone and convergences among EU member countries by time series analysis, although Button and Pentecost (1995) point out that basic regression models expose findings about convergence, they underline that there is no evidence about convergence in the analyses concerning structural variables with regard to regression models.

Badinger *et al.*, who examine the convergence process of EU member countries by the agencies of spatial panel data analysis and Generalized Method of Moments (GMM) in the period of 1985-1999, compute the convergence speed among considered countries as 7 percent and come through that this ratio is quite high.

Kutan and Yiğit (2005), examine the convergence phenomenon by panel unit root testing techniques among 10 EU member countries, which joined the Union in 2004 associated with enlargement process and suggest that the settlement of Baltic countries was easier by courtesy of their strong monetary policies. In this sense, the authors illustrate that these countries have a robust convergence coefficient, however Central and Eastern European countries could not be able to establish the convergence process before the involvement to monetary union.

In their studies examining the convergence process in the period of 1950-2000 among 15 former member countries of EU and between the years of 1995-2007, 10 EU member countries, which joined the Union in 2004 associated with enlargement process, Jelnikar and Murmayer (2006) find that both sigma and beta coefficients are statistically significant for any country groups. These findings introduce the reliability of convergence process among considered countries.

In their studies surveying the absolute and conditional convergence processes of the former Eastern Bloc countries joining the EU within the scope of different convergence models in 1995-2003 period, Eckey *et al.* (2006) acquire findings on convergence among considered countries. Furthermore, although the authors come through the findings on convergence by taking Geographical Weighted Regression (GWR) approach into consideration, they indicate that certain countries tend to break away from stable equilibrium.

In their studies investigating long-term growth rates of 15 member countries that joined EU in 2004, concerning the convergence process by panel data analysis, Cuaresma *et al.* (2008) indicate the positive effects of the length of EU membership period on growth rates and in this manner they conclude that the convergence process among considered countries are in the question.

In their studies examining the significance of convergence hypothesis among EU member countries in the period of 1980-2001 by deterministic econometric models, Delgado-Rodriguez and Alvarez-Ayuso (2008) suggest that the driving forces of the growth process of EU are physical and human capital stocks and they prove that capital stock and increases of efficiency concerning capital stocks are the most important factors which stimulate the convergence.

There are numerous studies which are intended to test of the significance of convergence hypothesis concerning the regions of EU member countries. Neven and Gouymte (1995) survey the convergence process of sub-regions of European Community in the period of 1975-1990 and within the scope of time series analyses and they mention that the sub-regions of Northern Europe tend to be in divergence in the early 1980s, merely a robust convergence arises when approaching to the late of the period. The authors attribute this situation to successful applications of economic policy regimes of Northern European countries, furthermore they state

that internal market constitution and coming up of free trade depending on liberalization movements have important effects on convergence process of considered countries. Additionally, it is stressed that there is no convergence after the year 1985 because of the differences on wages and unemployment rates in parallel with population levels of southern regions. Some other studies concerning regional based convergence are accomplished by Fingleton (1997), Tondl (1998), Carrington (2003), Cappelen *et al.* (2003), Brasili and Gutierrez (2004), Fischer and Stirböck (2004), Armstrong (2005), Corrado *et al.* (2005), Brauninger and Niebuhr (2005), Pittau (2005), Ezcurra *et al*. (2005), Marelli (2007), Geppert and Stephehn (2008) and Petrakos and Artelaris (2009). Analyses of Battisti and De Vaio (2008) exhibit that there is no convergence process among EU member countries.

In addition to studies concerning EU member countries and significance of convergence among their regions, there are analyses which investigate whether the convergence process is in question based on economic indicators. Several authors conclude the existence of convergence process among EU member countries an account of various disciplines such as Greve (1996) on social policies; Serletis and King (1997) on capital markets; Paci (1997), Doyle and O'Leary (1999), Tsionas (2000), Canaleta *et al.* (2002) and Villaverde and Maza (2008) on efficiency levels; Bürzel (1999) on constitutional structure; Hitiris and Nixon (2001) on health expenditures; Beliu and Higgins (2004) on inflation versus interest rates; Sosvilla-Rivero and Gil-Pareja (2004) and Cihak and Holub (2005) on price levels; Albrecht and Arts (2005) on climate change policies; and finally Casu and Girardone (2010) on banking sector activities.

3. Method and Data

In this study, the Haldane-Hall approach is used to investigate whether convergence of per capita income exists among the 17 EU member countries[2] in the euro zone. For the purpose of establishing convergence process among considered countries, annually time series are used between the period of 1992-2011 and it is examined whether the member countries of monetary union converge to the average per capita income of the EU founder six countries[3]. The real time series data in terms of U.S. dollar is gathered from the official web site of International Monetary Fund (IMF).

While studying with time series data, in order to gain significant results it is important to establish whether these data possess particular properties. In this sense,

[2] These countries are France (FR), Germany (AL), Greece (GR), Ireland (IR), Italy (IT), the Netherlands (NT), Portugal (PO), Spain (SP), Belgium (BE), Austria (AV), Cyprus (CP), Estonia (ES), Finland (FI), Malta (MA), Slovakia (SL), Slovenia (SLO) and Luxembourg (LU).

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the time series data have to be stationary. A model estimated by using non-stationary data may cause spurious regression which can be defined as the appearance of the non-existent relationship by Granger and Newbold (1974). For this reason, it was examined whether variables which were used for model solutions were stationary and the stationary levels if a stationary existed, by using ADF unit root test introduced by Dickey and Fuller in 1979, PP unit root test which was built up by Phillips-Perron (PP) in 1988 and KPSS unit root test which was built up by Kwiatkowski-Phillips-Schmidt-Shin (KPSS) in 1992. With the help of stationary procedure, both the problem of spurious regression would be eliminated and the results of the analyses would be more reliable (MacKinnon, 1991, pp. 266-267). The process of ADF and PP unit root tests was shown by using equation (5):

$$\Delta Y_t = \alpha + \gamma Trend + \rho Y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta Y_{t-i} + \varepsilon_t \quad (5)$$

In equation (5), *Y* denotes the variable which was subject to the stationary test; Δ denotes the first order difference operator; γ denotes linear time trend; ε denotes error residual and finally *k* denotes the number of lag for dependent variable (Taban, 2008: 155). By using PP test, it was determined whether the ρ indicator in the estimated equation (5), is equal to zero. If null hypothesis of $\rho = 0$ can be rejected, then it is concluded that *Y* is stationary at its original level, and otherwise *Y* is non-stationary (Yamak and Küçükkale, 1997: 6).

The null hypothesis of no unit root in KPSS test as distinct from PP test; despite that the alternative hypothesis denotes there is a unit root in the series (Kwiatkowski *et al.*, 1992: 159). The authors use Lagrange Multiplier (LM) statistics for testing the hypotheses (Yavuz, 2004: 241). KPSS statistic basically stands for the error residuals which are obtained from the results of Ordinary Least Squares (OLS) regression model when x_t denotes external variable and for the series of y_t. This model can be illustrated using the equation (6) below:

$$y_t = x_t' \delta + u_t \quad (6)$$

LM statistic can be acquired as shown in equation (7) via taking the regression equation (6) into consideration:

$$LM = \sum_t S(t)^2 \Big/ \left(T^2 f_0\right) \quad (7)$$

In equation (7), f_0 denotes zero frequency residual spectrum estimator; *T* denotes the number of period; *S(t)* denotes cumulative error residual function and is derived from the following equation (8):

$$S(t) = \sum_{r=1}^{t} \hat{u}_r \tag{8}$$

After all these procedures, information about stationary of considered series in the model is acquired via comparing LM test statistic with critical values which are computed by Kwiatkowski *et al.* (1992: 166).

To determine the long-run reletionship among the variables, Johansen-Juselius cointegration analysis is applied in this work. This cointegration test using the methodology developed by Johansen (1991, 1995) performs using a group object or an estimated VAR object. A VAR of order *p* can be written with the help of equation (9):

$$y_t = A_1 y_{t-1} + ... + A_p y_{t-p} + Bx_t + \varepsilon_t \tag{9}$$

where y_t is a *k*-vector of non-stationary *I(1)* variables, x_t is a *d*-vector of deterministic variables, and ε_t is a vector of innovations. We may rewrite this VAR as;

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p=1} \Gamma_i \Delta y_{t-i} + Bx_t + \varepsilon_t \tag{10}$$

where, $\Pi = \sum_{i=1}^{p} A_i - I$ and $\Gamma_i = -\sum_{j=i+1}^{p} A_j$. If the coefficient matrix Π has reduced rank *r*<*k*, then there exist *kxr* matrices α and β each with rank *r* such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is *I(0)*. *r* is the number of cointegrating relations and each column of β is the cointegrating vector. The elements of α are known as the adjustment parameters in the Vector Error Correction (VEC) model.

If cointegration relations among the variables are found, then a VEC model is applied. A VEC model is a restricted Vector Autoregression (VAR) designed for use with non-stationary series that are known to be cointegrated. The VEC has cointegration relations built into the specification so that it restricts the lon-run behavior of the endogenous variables to converge to their cointegrating

relationships while allowing for short-run adjustment dynamics. The cointegration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. If the cointegrating equation is considered as $y_{2,t} = \beta y_{1,t}$, the corresponding VEC model can be written with the help of the equations (11) and (12):

$$\Delta y_{1,t} = \alpha_1 \left(y_{2,t-1} - \beta y_{1,t-1} \right) + \varepsilon_{1,t} \tag{11}$$

$$\Delta y_{2,t} = \alpha_2 \left(y_{2,t-1} - \beta y_{1,t-1} \right) + \varepsilon_{2,t} \tag{12}$$

In these simple models, the only right-hand side variables are the error correction term. In long-run equilibrium, this term is zero. However, if y_1 and y_2 deviate from the long-run equilibrium, the error correction term will be non-zero and each variable adjusts to partially restore the equilibrium relation. The coefficient α_i measures the speed of adjustment of the *i*-th endogenous variable towards the equilibrium.

One of the analyses which were built up to measure convergence process lately was introduced by Haldane and Hall (1991). Haldane-Hall approach which is based on OLS regressions, predicts that the considered coefficients of the model follow up a random process in a particular time frame (Serletis and King, 1997: 49). The model which is developed to determine whether stochastically changing coefficients cause unobservable deterministic or stochastic parameter changes in the model, manifests the convergence process among estimated relations (Datta, 2003: 236). Haldane-Hall method is affiliated with time-varying parameter model and Kalman filter technique. Time-varying parameter model is stated via following equation (13) below: (Drake, 1995: 366)

$$y_t = \delta'_{z_t} + \varepsilon_t \tag{13}$$

In equation (13), y_t denotes measured variable; z_t denotes vectors related to unobservable variables; δ denotes parameter vector and finally ε_t denotes error term. Regression equation which is related to unobservable variables is illustrated in equation (14) below:

$$z_t = \Psi_{z_{t-1}} + \psi_t \tag{14}$$

Using equations (13) and (14) time-varying parameter model is estimated. After that, Kalman filter, which is denoted by $\hat{z}_t$, is indicated via equation (15) and equation (16) below, because it is the robust estimator of z_t with respect to t and P_t as a covariance matrice of $\hat{z}_t$ estimator:

$$\hat{z}_t = \hat{z}_{t|t-1} + P_{t|t-1}\delta\left(y_t - \delta'\hat{z}_{t|t-1}\right)\Big/\left(\delta' P_{t|t-1}\delta + \Gamma_t\right) \tag{15}$$

$$P_t = P_{t|t-1} - P_{t|t-1}\delta\delta' P_{t|t-1}\Big/\left(\delta' P_{t|t-1}\delta + \Gamma_t\right) \tag{16}$$

Haldane-Hall method which is used to measure the convergence of per capita income among monetary union member countries, predicts that convergence can also be observed among monetary union member countries towards non-EU member countries, concerning the acceleration of the convergence process. Basic Haldane – Hall equation can be illustrated considering equation (17):

$$\left(\log X_{KAORT} - \log X_{PBU}\right)(t) = \alpha(t) + \beta(t)\left(\log X_{KAORT} - \log X_{BDU}\right) + \varepsilon_t \tag{17}$$

In regression equation (17), X_{KAORT} denotes the average income levels of the founder six EU member countries; X_{PBU} denotes income level of monetary union member country; X_{BDU} denotes per capita income level of non-EU member country; $\alpha(t)$ denotes stochastic constant term and finally $\beta(t)$ denotes the convergence relations of monetary member country among founder six and non-EU member countries. When a convergence is possessed among founder six and monetary member countries, than it is expected that $\beta(t)$ coefficient converges in zero positively.

4. Empirical Findings

It is highly possible for series not to be stationary while studying with time series data. In models formed by instable data, it is highly probable to encounter spurious regression. Thus, estimating results may reflect spurious relations. In the event of finding that seriess are not stationary in level value, they may be stabilized by examining their differences. In this way, it is possible to obtain more reliable results by solving spurious regression problem. Thereby, it is likely to reach more robust results by eliminating spurious regression problem (MacKinnon, 1991: 266-276).

ADF, PP and KPSS unit root tests were used to examine whether considered time series in the study were stationary. When performing the process in unit root test, series are primarily tested for consant trend; if a stationary is possessed in this phrase these values are grounded on without getting through constant and non-constant tests (Enders, 1995: 256-259).

Table 1 illustrates the test results of the unit root tests. According to ADF test result some of the variables are found as stationary in their levels and the others are found stationary in their first difference levels. According to PP and KPSS unit root test results, considered variables in the model are founded as stationary in their levels.

Table 1: The Results of ADF, PP and KPSS Unit Root Tests

Variables	ADF TEST		PP TEST	KPSS TEST
	Level	First Difference	Level	Level
KAORT	-3.360(4)*	-	-3.806(1)**	0.125(3)**
USAGDP	-3.459(1)*	-	-3.400(0)*	0.148(2)***
AVGDP	-3.415(3)*	-	-3.610(2)*	0.127(3)**
ESGDP	-4.794(1)***	-	-3.727(1)**	0.086(2)*
FIGDP	-3.761(3)**	-	-3.845(2)**	0.111(2)*
CPGDP	-2.881(3)	-4.226(1)***	-3.318(2)*	0.126(2)**
IRGDP	-2.217(1)	-3.474(1)***	-3.476(0)*	0.116(2)*
SPGDP	-3.533(3)*	-	-3.448(0)*	0.138(2)**
MAGDP	-2.227(3)	-4.823(1)***	-4.215(3)**	0.174(2)***
POGDP	-3.639(3)*	-	-3.496(1)*	0.117(2)*
SLGDP	-2.421(1)	-3.468(0)***	-4.678(2)***	0.109(3)*
SLOGDP	-2.190(1)	-4.375(1)***	-3.415(1)*	0.137(2)**
GRGDP	-3.372(1)*	-	-3.914(1)**	0.120(2)**
Critical Values				
***: 0.01	-4.728	-2.717	-4.532	0.216
**: 0.05	-3.759	-1.964	-3.673	0.146
*: 0.10	-3.324	-1.605	-3.277	0.119

Notes: The logarithmic values of the series are taken into account for unit root tests. In ADF test the values in parenthesis show the optimum lag length determined by SIC criterion and in PP and KPSS tests the values in parenthesis indicate Bandwith values and these values imply the optimum lag lengths which are determined by taking Newey-West information criterion into consideration.

To determine the long-run relationship among the variables, multiple Johansen-Juselius co-integration test is applied and the test results are shown on Table 2. The test results of multiple co-integration analysis show the existence of four co-

integrated vectors. Thus, it is appropriate to apply the VEC analysis to investigate the relations among the variables.

Table 2: The Results of Johansen - Juselius Cointegration Test

Null Hypothesis	Alternative Hypothesis	Trace Statistic	Critical Value of 1%	Critical Value of 5%
$r = 0$	$r = 1$	331.815***	326.735	311.123
$r \leq 1$	$r = 2$	267.321**	278.801	264.231
$r \leq 2$	$r = 3$	222.549**	234.654	221.567
$r \leq 3$	$r = 4$	184.103**	194.127	182.453
$r \leq 4$	$r = 5$	139.627	157.538	146.751
$r \leq 5$	$r = 6$	110.298	124.610	114.969
$r \leq 6$	$r = 7$	81.638	95.372	86.960
$r \leq 7$	$r = 8$	55.453	70.221	62.615
$r \leq 8$	$r = 9$	35.112	48.458	42.205
$r \leq 9$	$r = 10$	20.331	30.655	25.473
$r \leq 10$	$r = 11$	6.004	16.397	12.390
$r \leq 11$	$r = 12$	3.671	7.854	3.884
$r \leq 12$	$r = 13$	1.002	2.549	1.712

Note: ** and *** indicate the significance at the level of 5 per cent and 1 per cent, respectively.

In this step of the study, the VEC analysis is applied and hence the test results of the analysis are shown on Table 3. According the test results, a positive and significant relationship is found between AVGDP, FIGDP, IRGDP, MAGDP, POGDP and KAORT, while a negative and significant relationship between ESGDP, CPGDP, SLGDP and KAORT is observed. In addition, no significant relationship is detected between USAGDP, SPGDP, SLOGDP, GRGDP and KAORT. Because the error correction term, EC(-1), is found negative and significant, the short-run macroeconomic imbalances in terms of per-capita income will be adjusted in the long-run. Due to the fact that both short and long-run dynamics are discovered, to determine the per-capita convergence process among the economies Haldane-Hall analysis can be applied.

Table 3: The Results of VEC Analysis

Dependent Variable	Independent Variable	Coefficient	*t*-Statistic	Independent Variable	Coefficient	*t*-Statistic
ΔKAORT	C	0.165**	3.426	ΔSPGDP(-1)	0.970	1.298
	ΔUSAGDP(-1)	-0.606	-0.411	ΔMAGDP(-1)	2.017*	2.135
	ΔAVGDP(-1)	3.133**	3.255	ΔPOGDP(-1)	1.576*	1.954
	ΔESGDP(-1)	-1.135**	-3.229	ΔSLGDP(-1)	-1.289**	3.153
	ΔFIGDP(-1)	3.829***	5.092	ΔSLOGDP(-1)	-0.124	-0.142
	ΔCPGDP(-1)	-5.861***	-4.606	ΔGRGDP(-1)	-0.154	-0.216
	ΔIRGDP(-1)	1.266*	2.062	EC(-1)	-5.703**	-2.318
Descriptive Statistics						
R^2: 0.925 **F-Stat:** 4.799* **F(Prob):** 0.073 **DW:** 2.131						

Notes: The logarithmic values of the series are taken into account for VEC model. The values in parenthesis show the optimum lag length determined by AIC and SIC criterions. *, ** and *** indicate the significance at the level of 10 per cent, 5 per cent and 1 per cent, respectively. EC(-1) indicates the error correction term.

Haldane-Hall analysis is applied to determine whether per-capita income levels of 11 EU member countries in the euro zone converge to per capita income levels of the founder six countries. On Table 4 below, results of Haldane-Hall analysis are shown.

Test results of Haldane-Hall convergence analysis on Table 4 show a convergence process among per capita income levels of the founder six EU member countries and per capita income levels of Austria, Finland, Ireland, Malta and Portugal in considered periods. It could be suggested that only the convergence process of Ireland is weak because the country experienced both the Global Financial Crisis in 2008 and the European debt crisis that followed, harder than the other countries.

Table 4: The Results of Haldane-Hall Analysis

Country Pairs	Coefficients		Descriptive Statistics			
	$\alpha(t)$	$\beta(t)$	R^2	F-Stat	F(Prob)	DW
KAORT-Austria	0.125***	0.041**	0.930	106.769	0.000***	2.041
KAORT-Estonia	1.067***	-0.408	0.977	347.161	0.000***	2.001
KAORT-Finland	0.151***	0.081**	0.400	5.350	0.016**	2.231
KAORT-Cyprus	0.593***	-0.048	0.930	106.863	0.000***	1.894
KAORT-Ireland	0.072	0.259**	0.936	118.530	0.000***	1.992
KAORT-Spain	0.584***	-0.057	0.756	24.806	0.000***	2.102
KAORT-Malta	1.004***	0.107**	0.630	13.658	0.000***	1.991
KAORT-Portugal	0.889***	0.109**	0.725	21.126	0.000***	1.885
KAORT-Slovakia	1.024**	-1.184**	0.964	215.321	0.000***	2.004
KAORT-Slovenia	0.843***	-0.126	0.790	30.231	0.000***	1.879
KAORT-Greece	0.672***	-0.296**	0.892	66.407	0.000***	1.934

Notes: ** and *** shows the significance level of 5 per cent and 1 per cent, respectively. The problem of autocorrelation has been eliminated by including AR(1) process into regression models. The term KAORT indicates the average income levels of the founder six EU countries.

No significant convergence relations have been observed among founder six EU member countries and Estonia, Cyprus, Spain, Slovakia, Slovenia and Greece. Findings of the analysis have showed that although the convergence process could accelerate with respect to the duration of EU membership, Greece and Spain have not been able to succeeded to involve in the convergence process despite they joined to EU in 1981 and 1986, respectively. The most important factors accounting for this situation were the heavy effects of 2008 global economic crisis on these countries and therefore the heavy debt charges which the countries managed to carry. Insufficiency of precautions and lack of gathering enough support packages from EU have both been significant factors of a divergence for these countries among former member countries. Although Estonia, Cyprus, Slovakia and Slovenia accommodated Maastricht criteria since joining the Union in the 2004 enlargement process, because of their comparatively lower per capita income levels, a divergence process among founder six countries have been noticed. Results of the analysis manifested that only Malta set out a favorable performance within the countries which joined the EU in 2004 with enlargement process.

Conclusion

In the study, per capita income convergence process among considered economies was investigated in the light of Haldane-Hall model and by using annual

real time series data for the 17 EU member countries in the euro zone concerning the period of 1992-2011.

While ADF unit root test indicates that some of the variables are found as stationary in their levels and the others are found stationary in their first difference levels, PP and KPSS unit root tests demonstrated that all variables in the model were stationary in their level values. Afterwards, determining the long-run relationship among the variables, multiple Johansen-Juselius co-integration test is applied and the results show the long-run relationship among the variables. Due to this result, it is decided to apply the VEC analysis to investigate the relations among the variables. According the results of VEC analysis, a positive and significant relationship is found between AVGDP, FIGDP, IRGDP, MAGDP, POGDP and KAORT, while a negative and significant relationship between ESGDP, CPGDP, SLGDP and KAORT is observed. In addition, no significant relationship is detected between USAGDP, SPGDP, SLOGDP, GRGDP and KAORT. Because the error correction term, EC(-1), is found negative and significant, it can be said that the short-run macroeconomic imbalances in terms of per-capita income will be adjusted in the long-run. Besides, gathering the relations among the variables, convergence possibility of per capita income levels for 11 monetary union member countries to the average per capita income levels of founder six EU member countries in the period of 1992-2011 is surveyed by using Haldane-Hall analysis. The reason of selecting the particular time period in question is that basic step of the participating monetary union has occurred with the Maastricht Treaty signed in 1992. Results of the analysis illustrate that there is a convergence among per capita income levels of the founder six EU member countries and per capita income levels of Austria, Finland, Ireland, Malta and Portugal. It is determined that per capita income levels of only one country, Ireland, within these countries possessed weak convergence relations. No convergence relation is encountered among the founder six EU member countries and Estonia, Cyprus, Spain, Slovakia and Greece. Although the findings suggest that the convergence process is quickened in parallel to the duration of EU membership, the results indicate that Greece and Spain are not involved in the convergence process despite these countries joined to EU in 1981 and 1986, respectively. Furthermore, it is possible to assert that the reason of this result is the heavy effects of 2008 Global Financial Crisis and the European debt crisis on mentioned countries. In addition, although the countries which joined the EU in 2004 with enlargement process, accommodated Maastricht criteria, they have faced to a divergence process, because of failing to achieve macroeconomic policies which the Union predicted and possessing comparatively lower per capita income levels.

While the findings of the study underline a robust convergence among former EU member countries except for Greece and Spain, the put forward that there are

no convergence process observed among the countries which joined the EU in 2004 with enlargement process. It can be suggested that euro zone countries, which is the most important economic power of the world, cannot achieve to use its policy instruments efficiently despite the strong developing potential which possesses. In addition, there are important differences among member countries in performing several fundamental policies. In this sense, providing permanency of factors which stimulate growth dynamics in the short and long-term, will significantly contribute to the real convergence process among member countries. Furthermore, it should be underlined that countries which are in divergence process in terms of per capita income levels possess high probability to execute tendencies towards convergence as long as the durations of membership for these countries increase.

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