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Testing Pair-Wise Convergence of Western Balkan and European union Countries

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Abstract
The present research performs the GDP per capita convergence analyses of Western Balkan (WB) countries to European Union (EU) countries. There are few testing convergence methods based on theoretical insights on the neoclassical model, however pairwise convergence method doesn't seem usually applied in the case of WB and EU countries. The test of convergence hypothesis in this research is based on the GDP per capita's data, constant 2017 international $ in PPP terms, made available by the World Bank. The pairwise convergence test suggested here can be considered as an extension of Webber and While (2003, 2004, 2009) methodology. The outcomes have been compared to Bernard, Durlauf (1995) and Pesaran (2006) methodology of the pairwise convergence, by adapting ADF time series tests of the stationarity. In conclusion, despite to the controversy of one pair case, the comparative process of both methods seems to be aligned. However, further investigation needs to be performed to confirm the effectiveness and efficiency of this suggestion.

Keywords: GDP per capita, pairwise convergence, Western Ballkan countries, methodology.

1. Introduction

WB's[1] countries are developing countries. Their approach towards the EU market integration is in progress, regardless of the country's different speeds of such integration. According to World Bank data, this region has 17.4 Million residents in 2021, which represents only 3.9% of EU's population, and the averaged GDP per capita of WB for the same year was $16,4612, representing only 35.7% of EU.
During the first decade of third millennium the enlargement of EU's frontiers involved continuous integration processes of the Central European countries[3] (CEE) and, due to this transformation process, is observed a similar sociopolitical growth trend between CEE's and WB's countries despite by a different time lags. In fact, after the end of the army conflict of the 90th, EU institutions increased their interest towards the WB and started the integration processes negotiations. Similar process was previously followed by CEE countries with the aim to achieve the market and institutional required conditions for the EU accession. This institutional path towards the EU, and of course their

[1] For the purpose of this research BW countries are represented by: Albania, Bosnia-Herzegovina, Montenegro, Kosovo; North Macedonia, and Serbia.
[2] Measured by PPP and $US international, constant, 2017
[3] Bulgaria, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovak Republic, Slovenia,

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unavoidable impact in the economic agent's behavior, suggests that the candidate countries must experience similar structural changes and "club convergence" of Abramovitz (1986), Baumol (1986) and Galor (1996) becomes the most convenient hypothesis. Due to the deep and rigorous impacts on the institutional life and politics decision making, the integration process have improved the overall performance of the countries. This positive effect should be reflected also in the trend of GDP per capita. For this reason, the EU countries are classified into two main groups: CEE countries and Non-CEE[4] countries. Together with WB countries, they provide three main groups for the purpose of data analyses. This classification permits to identify the differences in terms of GDP per capita. It is important to stress that during this time the EU has become the larger trade partner of the WB countries. This pattern reflects the trade agreements mentioned during all the process of Central European free Trade Agreement (CEFTA). Nowadays, except Kosovo, WB countries apply zero tariffs to the EU imports and vice versa.

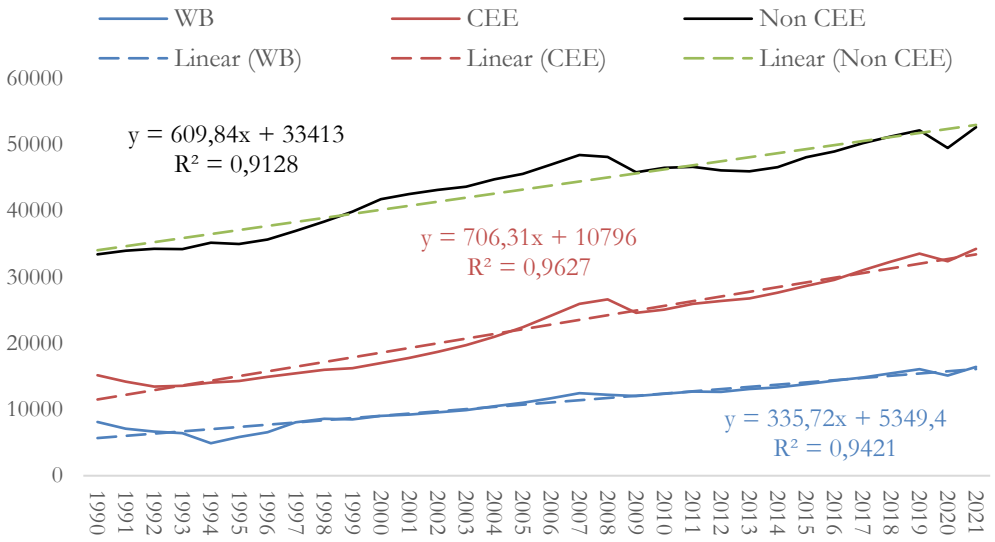

Figure 1: Trend of Averaged GDP per capita, PPP constant $US by groups, 1990-2021. Source: World Bank 2022, and author's calculation

Notwithstanding the similarities mentioned above while implementing EU acquis comunautaire, these countries groups clearly show significant differences between them. This can be observed in the following graphs of their GDP per capita (Figure 1). WB countries seem to have lower positive trend compared to the other groups. The graph shows the crisis effects of 2008; 2020 and the trend similarities, despite of their differences considering the variance of fluctuation during the crisis effect.

[4] Austria, Belgium, Cyprus, Croatia, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Spain, Sweden, Portugal, and United Kingdom which left the EU in 2020.

2. Convergence literature and findings for WB countries

Once Solow (1956) and Swan (1956) provided fundamental improvements in the neoclassical model of growth, the concept of convergence became more than interesting. Based on the steady state of macroeconomic variables, this model suggests that all countries should converge at the same level of income per capita, independently from the initial conditions. This phenomenon is called unconditional convergence. However, due to observed structural differences between countries, the conditional convergence hypothesis seems to be more than appropriate. Following the neoclassical model, Barro and Sala-i-Martin (1992) performed empirical research on convergence hypothesis by obtaining beta-convergence equal to 2%. This means that long run income per capita should converge to steady growth equal to 2%. From that time, several empirical studies, based on econometrics techniques in cross sectional and panel data, confirmed the approximate value of 2% beta-convergence in different regions worldwide (Durlauf et.al 2005). Despite the wide acceptance and application of this approach, there are found fundamental critic in the literature. For example, Quah (1996b) suggests that the empirical results of 2% beta-convergence could be a result of statistical pattern of applied models rather than driven by convergence reasons. In addition, theoretical suggestions provided by different endogenous models, such as Lucas (1988) and Romer (1986, 1990), does not fit well with the beta-convergence. This is supported by the suggestions that the production function could breaks the pattern of constant return to scale[5]. Finally, beta-convergence method is widely used when data include larger number of observed countries, and the conclusion of convergence are common to all of them rather than in pairs.

A different method of convergence investigation is represented by Bernard and Durlauf (1995, 1996). This method proposes the long run pair-wise convergence investigation by applying time series unit root tests. According to the unit root test, if the differences in income per capita between two countries becomes stationary at zero mean, then the convergence hypothesis is accepted. This method is supported by Pesaran (2006) suggestions. The stationarity of forecasted zero mean, can be substituted by the probability of having positive constant mean, and if the differences are lower than this value to infinite time horizon, then convergence hypothesis is accepted. In accordance with this method, regardless theoretically behaviors of macroeconomic fundaments under the neoclassical model or not, the test shows the existence (or not) of any catch-up process in terms of income per capita.

Both mentioned methods of testing convergence are widely applied by the researchers, while the pairwise method is not so evident for WB countries. Beta-convergence in WB countries has gained a bigger focus overtime. For example, Ouardighi and Somon-Kaperanovic (2009) have adopted the theoretical method suggested by Barro and Sala-i-Martin (1992) in terms of beta-convergence. The authors observed beta-convergence

[5] The better way of thinking of non-convergence, but same path of growth, if different countries, in different conditions and times, represent increasing rather than constant return of scale. And of course, how progressive is this increment, determine how fast they move.

between WB (including Croatia) from 1989 to 2008 by using Ordinary Least of Square (OLS).
Duro (2013) applies panel data techniques and suggests beta-convergence of WB towards CEE countries into the EU. This distinction is based on the concept of "club convergence" and this idea could be in the right direction if two speeds of growth among the EU countries is accepted. Other authors, like Meksi and Xhaja (2015), observed beta-convergence of WB to EU countries from 1995 to 2015, however this convergence was faster after 2004 when new members joined the EU.
Krstevska (2018) considered the period data sample of 2000-2016 to investigate the WB convergence in average EU income per capita. The author mentioned a higher speed of unconditional convergence (beta-convergence) during 2000-2008, and the presence of convergence during the whole data sample. Furthermore, in terms of macroeconomic policy, based on the panel data cointegration into the fully modified OLS method, the author stresses the importance of the nominal convergence by gap reduction in real convergence.
Gockov and Antonovska (2018) investigate beta-convergence between WB, new member states and Baltic countries, and EU-14 during the period 1997-2017. While proposing OLS method in cross sectional data, they considered as a regressors the gap of GDP per capita, based on the averaged EU-14, and the dummy variable for each group country. Their conclusions are not in line with the neoclassical theory of convergence.
Nagy and Siljak (2019) used the OLS estimation on cross sectional data during the period 2004 to 2016 for WB and EU 15. They found out the unconditional and conditional convergence of WB however they accepted that conclusions could be impacted by the data availability limitation.
Data analyses of pairwise convergence is quite poor. Botrić (2013) is the only researcher who adapted the pairwise method for WB countries. Despite interesting results, pair-wise unit root tests have been performed between GDP per capita of each WB country and average EU-15 by using WIIW database. The outcomes are based on ADF and KPSS tests and they do not suggest any convergence among the countries, although the presence of data restrictions.

3. Data research methodology, an extension

Webber and White (2003, 2004 and 2009) provide the methodology of testing pairwise convergence between two given time period of income per capita as follows.
If yit and yjt are income per capita of country i and j and yit > yjt, they can provide the identity equation of:

$$\left(\frac{y_{it}}{y_{jt}}\right)^{X_{ij}} = \left(\frac{y_{it+k}}{y_{jt+k}}\right) \qquad \text{[formula 1]}$$

Proceeding with the natural logarithmic transformation, the equation (1) can be written as:

$$X_{ij} = \frac{w_{i,t+k} - w_{j,t+k}}{w_{i,t} - w_{j,t}} \qquad \text{[formula 2]}$$

This means that the ratio of difference in ln per capita between the two moments of time periods t and t+k, for two given country, can provide the metrics of X_{ij}, and this metrics can provides in turn the information of probable convergence or divergence following the below conditions:

- $X_{ij} > 1$, countries i and j diverge in ratio without switching;
- $0 < X_{ij} < 1$, countries i and j converge in ration without switching;
- $-1 < X_{ij} < 0$, countries i and j converge in ratio with switching;
- $X_{ij} < -1$, countries i and j diverge in ration with switching. [formula 3]

Based on this approach, X_{ij} does not consider the different stage of business cycle at the time t and t+k of each country, means that the ratio of given data in time t and time t+k could suffer by the interference of probable expansion/restriction of the economy at the momentum of time considered. In order to smooth this threat, we suggest extending X_{ij} ratio during all available time of data information by fixing the nominator at time n, and then to compare the percent of converging/diverging condition by the equation [3] throughout all the time period for each pair of country. This adapted method is represented as below.

Let consider wit = lnyit, wjt = lnyjt, and "n" the last period of data information[6], so n-k the interval of data information for each pair of country during the time, where k = {1, 2, 3 …, 23[7]} represents the time data horizons information for each pair of country. Then $X_{ij,\,k}$ represents the time interval by the formula:

$$X_{ij,k} = \frac{w_{i,n} - w_{j,n}}{w_{i,n-k} - w_{j,n-k}} \quad \text{for k} = \{1, 2, \ldots, 23\} \qquad \text{[formula 4]}$$

This represents the creation of time series data for each pair during time extension of k records. At this stage, following the convergence condition of [3], we count the absolute value following the criteria:

$$B_{ij} = Count\left|X_{ij,k}\right| > 1 \quad \text{for k} = \{1, 2, \ldots, 23\} \qquad \text{[formula 5]}$$

B_{ij} represents the amount of $X_{ij,k}$ records for each countries pair during the interval of time [n; n-k] which fulfills the condition of the convergence suggested by Webber and While's methodology, regardless with switching or not. In short, we suggest explicating the convergence and divergence by the probable value of metrics as follows:

$$C_{ij} = \frac{B_{ij}}{k} \qquad 0 \leq C_{ij} \leq 1 \qquad \text{[formula 6]}$$

Determine it by the listed intervals:

- C_{ij} = [0.00-0.24], countries i and j strongly converge;
- C_{ij} = [0.25-0.49], countries i and j weakly converge;

[6] Last year of data information by the database is 2021.

[7] By the data availability, we can create difference pairs without missing data during the period 1998-2021, means 24 years. However, we have not considered the ratio of end of period with itself, means, we have generated 23 records during the time period 1998-2021.

- C_{ij} = [0.50-0.74], countries i and j weakly diverge;
- C_{ij} = [0.75-1.00], countries i and j strongly diverge. [formula 7]

The equal division of each interval for C_{ij} metrics could be accepted if we consider the equal probability of business cycle interference in the real data. Independently from the economy's stage at the end of the observed period, the ratio will have equal probability as the expansion and contraction of economy during same period.
The distinction between strong and weak either in convergence or in divergence was leveraged from Webber and While's methodology terminology.
However, our rationality in extending the methodology, as a deduction of well confirmed method of pairwise convergence testing, we compare our outcomes with the stochastic definition of convergence given by Bernard and Durlauf (1995) as follows:

$$\lim_{k\to\infty} E(w_{i,t+k} - w_{j,t+k} \,|I_t) = 0 \quad \text{[formula 8]}$$

Where $w_{it} = \ln y_{it}$, $w_{jt} = \ln y_{jt}$, and I_t is the information available at the fixed time t, and the horizon time of k that tends to infinity. This formulation suggests the cointegration of process of I (1;-1), however Pesaran (2006) suggests that cointegration may not be followed in case of finite value of C:

$$\lim_{k\to\infty} Pr(\left|w_{i,t+k} - w_{j,t+k}\right| < C \,|I_t) > 0 \quad \text{[formula 9]}$$

Which can be interpreted as the probability (Pr) of having a value lower than C to infinite horizons of time. Considering this, time series augmented Dickey-Fuller (ADF) test of stationarity can be performed to the ln differences of income per capita to the sample. This test will perform the time series generated by $d_{ij} = (w_{it} - w_{jt})$ and provides the statistics test. Then, by comparing with critical value of 10%, 5% and 1%, we can conclude to hold null hypothesis of non-stationarity or not. If the absolute value of test statistics is higher than the critical value, the hypothesis of stationarity can be accepted. In case of positive value of statistics test null hypothesis of non-stationarity can be hold. ADF test performs the regression including lag length of a given series. Akaike Information Criterion (AIC) is performed to choose adequate lag selection.

4. Potential sources of post-war rebuilding support

World Bank database information of GDP per capita[8] has been considered in the analyses. Needs to be highlighted that the data related to the time period from 1990 to 1997, at least for WB group, are impacted from the several structural breaks caused by the crisis during that period. For this reason, pair-wise tests consider the period 1998-2021. Unfortunately, this sample does not include Kosovo due to limited data availability up to 2008. The interval of 2008-2021 is not sufficient to have efficient estimators of convergence for this country.

[8]Data information for some countries are not available from 1990. For Croatia, Lithuania, Latvia and Slovenia data availability starts from 1995. For Bosnia Herzegovina starts from 1994, Montenegro starts from 1997.

Pair of Country	ALB		BIH		MKD		SRB		MNE	
	Cij	*stage*	*Cij*	*stage*	*Cij*	*stage*	*Cij*	*stage*	*Cij*	*stage*
BIH	26.1%	Weak conv.								
MKD	0.0%		0.0%							
SRB	39.1%	Weak conv.	52.2%	Weak diver.	100.0 %	Strong diver.				
MNE	4.3%		4.3%		43.5%	Weak conv.	4.3%			
BGR	0.0%		13.0%		100.0 %	Strong diver.	4.3%		82.6%	Strong diver.
ROU	60.9%	Weak diver.	82.6%	Strong diver.	100.0 %	Strong diver.	82.6%	Strong diver.	95.7%	Strong diver.
LVA	21.7%		34.8%	Weak conv.	91.3%	Strong diver.	43.5%	Weak conv.	91.3%	Strong diver.
POL	56.5%	Weak diver.	73.9%	Weak diver.	100.0 %	Strong diver.	60.9%	Weak diver.	95.7%	Strong diver.
LTU	65.2%	Weak diver.	87.0%	Strong diver.	100.0 %	Strong diver.	69.6%	Weak diver.	95.7%	Strong diver.
HUN	21.7%		17.4%		69.6%	Weak diver.	21.7%		73.9%	Weak diver.
HRV	39.1%	Weak conv.	34.8%	Weak conv.	65.2%	Weak diver.	30.4%	Weak conv.	69.6%	Weak diver.
SVK	0.0%		0.0%		73.9%	Weak diver.	0.0%		78.3%	Strong diver.
EST	30.4%	Weak conv.	43.5%	Weak conv.	87.0%	Strong diver.	26.1%	Weak conv.	82.6%	Strong diver.
PRT	0.0%		0.0%		4.3%		0.0%		4.3%	
MLT	17.4%		4.3%		78.3%	Strong diver.	21.7%		73.9%	Weak diver.
SVN	0.0%		4.3%		39.1%	Weak conv.	0.0%		34.8%	Weak conv.
CZE	0.0%		0.0%		17.4%		0.0%		13.0%	
GRC	0.0%		4.3%		8.7%		4.3%		8.7%	
ESP	0.0%		0.0%		4.3%		0.0%		0.0%	
CYP	0.0%		0.0%		26.1%	Weak conv.	0.0%		30.4%	Weak conv.
GBR	0.0%		0.0%		4.3%		0.0%		4.3%	
FRA	0.0%		0.0%		4.3%		0.0%		8.7%	
ITA	0.0%		0.0%		4.3%		0.0%		8.7%	
FIN	0.0%		0.0%		4.3%		0.0%		8.7%	
DEU	0.0%		0.0%		0.0%		0.0%		4.3%	
SWE	0.0%		0.0%		4.3%		0.0%		8.7%	
BEL	0.0%		0.0%		8.7%		0.0%		8.7%	
DNK	0.0%		0.0%		21.7%		0.0%		13.0%	
AUT	0.0%		0.0%		0.0%		0.0%		4.3%	
NLD	0.0%		0.0%		8.7%		0.0%		8.7%	
IRL	69.6%	Weak diver.	91.3%	Strong diver.	100.0 %	Strong diver.	87.0%	Strong diver.	100.0%	Strong diver.
LUX	0.0%		0.0%		13.0%		0.0%		8.7%	

Table 1: Pair wise convergence of WB countries during 1998-2021. Source: Authors calculation

According to the equation [6] of the suggested methodology we have performed the metrics Cij for each country. Then, considering the classification criteria of [7], we have performed the results represented in Table 1. Under the column "stage" of each WB country, we have nominated the stage of convergence or divergence, and strong convergence of pair's means where the cell is empty. We follow this approach to avoid possible information overload in the table. We point out that the results are approximate due to several stochastic factors, and they need to be followed by individual analyses and interpretation of each pair of country. However, this is not the goal of this research. We are limited only to the obtained results of proposed methodology to find out if there exist the convergence or not, without finds out the reasons of the outcomes and arguments related.

Can be easily noted divergence of each WB pairwise, mostly with CEE countries like Romania, Poland and Lithuania, despite the intensity of this divergence. For example, Albania represents weak divergence with Romania, and the rest of WB shows strong divergence with this country. Meanwhile, the pairwise divergence is present in all WB with Non-CEE countries. WB countries also strongly diverge with Ireland despite weak intensity of such divergence with Albania. Malta shows weak divergence with Montenegro and strong divergence with North Macedonia, but the country shows a strong convergence with Albania, Bosnia Herzegovina, and Serbia. In addition, can be observed the non-presence of strong divergence in Albania and the higher level of pairwise divergence in North Macedonia and Montenegro, mostly with CEE countries.

Between WB countries, Albania shows pairs convergence with all countries, but with Bosnia Herzegovina and Serbia this convergence is weak. Montenegro shows convergence with all countries, however weak ones with North Macedonia. The cases of divergence are shown by pairs North Macedonia – Serbia and Bosnia Herzegovina – Serbia. The first one is strong divergence and second one is classified as weak one. More detailed information is represented in Table 1.

As showed in the methodology paragraph, we followed ADF test for each pair under analysis and the obtained results by this method are compared to those obtained following the classification criteria reported in [7]. However, no distinction between "weak" and "strong" stage in each case of divergence has been considered so far. We chose to perform ADF test only for divergence pairs by each WB country at three level of significance, at 10%, 5% and 1%. The results are represented in Table 2.

ADF test suggestions for Albania are the same as the classification in Table 1. The divergence stage is represented in both cases, in pairs Poland, Lithuania, Romania and Ireland. In case of Poland, divergence is hold only for 10% level of significance. For Bosnia Herzegovina and Serbia, ADF test confirms the divergence results hold in Table 1 and this is confirmed by the three levels of significance for each pair. The results of ADF test for both countries appear in line with the results represented in the Table 1, although the lower level of significance for Bulgaria, Slovakia, and Estonia.

The controversy of ADF test is noted in North Macedonia – Bulgaria pair related which the test shows that the null hypothesis of non-stationarity can be rejected by three levels of significance. ADF tests shows unchanged results for this pair regardless we include or not the constant in the test. The presence of this controversy needs further investigation!

Divergence Country	lag length	Test Statistics	Significance of Divergence
Albania pairs divergence country			
POL	1	-3.371	at 10%
LTU	2	-2.468	at 10%; 5%;1%
ROU	2	0.048	at 10%; 5%;1%
IRL	2	-0.247	at 10%; 5%;1%
Bosnia Herzegovina pairs divergence country			
SRB	3	-2.452	at 10%; 5%; 1%
ROU	1	-2.023	at 10%; 5%; 1%
POL	3	-2.073	at 10%; 5%; 1%
LTU	1	-2.08	at 10%; 5%; 1%
IRL	1	-1.339	at 10%; 5%; 1%
Serbia pairs divergence country			
ROU	1	-0.83	at 10%; 5%; 1%
POL	2	-1.407	at 10%; 5%; 1%
LTU	1	-1.271	at 10%; 5%; 1%
IRL	2	-1.566	at 10%; 5%; 1%
North Macedonia pairs divergence country			
SRB	2	-2.322	at 10%; 5%; 1%
BGR	1	-5.467	Convergence at 10%; 5;%;1%*
ROU	1	-1.721	at 10%; 5%; 1%
LVA	2	-3.12	at 10%
POL	1	0.209	at 10%; 5%; 1%
LTU	2	-2.46	at 10%; 5%; 1%
HUN	3	-3.046	at 10%; 5%
HRV	3	-1.984	at 10%; 5%; 1%
SVK	1	-2.243	at 10%; 5%; 1%
EST	2	-2.523	at 10%; 5%; 1%
MLT	1	-2.463	at 10%; 5%; 1%
IRL	4	-1.246	at 10%; 5%; 1%
Montenegro pairs divergence country			
BGR	3	-3.699	at 10%
ROU	1	-1.342	at 10%; 5%;1%
LVA	1	-2.43	at 10%; 5%;1%
POL	2	0.353	at 10%; 5%;1%
LTU	1	-1.796	at 10%; 5%;1%
HUN	3	-2.49	at 10%; 5%;1%
HRV	3	-1.999	at 10%; 5%;1%
SVK	2	-2.681	at 10%
EST	2	-3.102	at 10%
MLT	1	-2.605	at 10%; 5%;1%
IRL	1	-0.59	at 10%; 5%;1%

Table 2: ADF test for divergent pairs by each WB country. Source: Authors calculation

5. Conclusion

WB counties, as developing ones, are approaching towards EU integration, a process that CEE countries have already successfully completed. According to the neoclassical growth model, there should be a convergence process between developed and developing countries in terms of income per capita. There are several studies that test convergence of WB towards EU, however these studies are mostly based on beta-convergence methodology. Their conclusions generally refer to the convergence process, but in most of them, reference data point of convergence is considered averaged incomes per capita of EU countries. Studies on pairwise convergence for WB were not usually found at this time.

To fill this gap pairwise convergence to each pair of WB and EU countries has been undertaken. In order to realize this investigation, it is suggested to extend the methodology provided by Webber and While (2003, 2004, 2009). This extension is our contribution and of course, the statistical outcomes are based on this.

The obtained results shows that WB mainly diverge from several CEE countries and converge to Non-CEE countries of EU, by excluding Ireland that shows mostly strong divergence with all WB countries. The cases of pairs divergence have been mostly found by North Macedonia and Montenegro. North Macedonia diverges from 12 counties, by them only 2 Non-CEE countries, while Montenegro diverges from 11 countries, by them only 2 No-CEE countries. Albania shows divergence from 4 countries, however this divergence is weak in all cases. Serbia and Bosnia Herzegovina seem more similar in terms of pair's divergence. Among WB countries generally, the method applied shows the process of convergence. Serbia is the only country that shows a divergence approach among WB countries in our outcomes. These conclusions could be a proposal for other investigations to understand and interpret the probable causes of the convergence or divergence for a given pair of countries. However, this is not the goal of this investigation.

Finally, we have compared the obtained results of the methodology extension. The alternative methodology of ADF unit root tests techniques of pairwise convergence has been considered for convergence hypothesis of each pair. The obtained results in both cases are compatible in their conclusions, except for one case which calls for more attention. However, further research and investigation should be conducted to sustain this new approach on the methodology.

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