SPATIO-TEMPORAL ANALYSIS OF THE CONVERGENCE OF CONSUMPTION EXPENDITURES IN THE EUROPEAN UNION COUNTRIES

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Abstract. *The paper presents an analysis of the convergence process of the households' final consumption across European Union countries in the period of 2004 – 2016, considering spatial dependencies. The consumption is the main factor of the Gross Domestic Product. Previous studies focused on the economic convergence – a few researchers analyzed consumption convergence. This paper is based on previous studies on consumption convergence. The primary aim of the study is to verify hypothesis about the occurrence of the convergence process in households' final consumption expenditures across EU countries. The second aim is to verify whether the sustainable consumption significantly influences the researched process. The sustainable consumption is one of the several Sustainable Development Goals (SDGs) defined in the 2030 Agenda for Sustainable Development. However, some EU countries that want to align the level of consumption expenditures do not pay attention at sustainability. It depends among others on the consumerism idea. In the analysis, the level of the households' final consumption expenditures per capita is applied as the consumption. The sustainable consumption process is calculated using Hellwig's taxonomic measure of development (TMD), based on four diagnostic variables: final energy consumption, energy productivity, share of renewable energy in gross final energy consumption, resource productivity and domestic material consumption (DMC). To verify spatial dependencies in considered processes the spatial autocorrelation is tested. Consumption convergence process is verified with absolute and conditional β-convergence approach. In the first place, β-convergence panel data models are estimated and verified. Then, models are supplemented with a spatial factor – the dependence on the neighborhood countries. The spatial autoregressive and spatial error β-convergence panel data models are used. In the investigation of the conditional convergence the following indicators are added: the sustainable consumption and the period of financial crisis. The financial crisis slowed down the consumption convergence process in EU countries. As a result of the study, the sustainable consumption does not have a significant influence on the convergence process.*

Keywords: *convergence process; households' final consumption; spatial autocorrelation; spatial panel data models; sustainable consumption; sustainable development.*

Introduction

One of the most important goals for a country is to grow fast and to catch up with the richer and more developed economies. That is why many researchers are interested in the convergence process, e.g. Barro et al. (1991), Carnicky et al. (2016), Corrado et al. (2005), Dall'Erba and Le Gallo (2008), Górna et al. (2013), Górna and Górna (2014), Kulhánek (2012) and von Lyncker and Thoennessen (2017). The convergence process means that the level of the Gross Domestic Product (GDP) of countries is becoming more

and more similar. Consumption is the main component of the GDP in most economies. According to Huang and Rust (2011) the final consumption expenditures of households mainly reflect the standard of living in every country. Many authors analyzed the convergence of the level of living (e.g. Attia & Bérenger, 2009; Kuc, 2014; Muszyńska & Müller-Frączek, 2015), but only a few of them identified this process with the level of consumption. The households in the EU poorer economies are seeking to increase the consumption in order to overcome the differences in its level. In some of them, sustainability in consumption can be violated. Sustainable consumption and production is one of the goals of the sustainable development.

The primary aim of the investigation is to analyze spatial dependence in the formulation of households' final consumption level across the European Union countries (excluding Croatia, Cyprus and Malta) in the period of 2004-2016. Next aim is to evaluate the convergence of the consumption process using absolute and conditional β-convergence approach for pooled time series and cross-sectional data (TSCS). In the conditional approach the influence of the level of sustainability in consumption on the convergence process is considered.

Sustainable development and sustainable consumption

The sustainable development is defined in many different ways. The most popular is Brundtland Report definition: "development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (WCED, 1987). Other definitions have offered a slight change in emphasis or added further requirements. Sustainability is the basis for today's leading global framework for international collaboration – the 2030 Agenda for Sustainable Development. In this Agenda the Sustainable Development Goals (SDGs) are presented. The one of them is the 7th goal called Sustainable Consumption and Production (SCP). Analysis of this topic and relation between the SCP and the economic growth was conducted e.g. by Alshehry and Belloumi (2015), Bhattacharya et al. (2016), Lukman et al. (2016), Salimath and Chandna (2018). The following specific goals in SDG7 are identified (the 2030 Agenda for Sustainable Development):

a) "ensure universal access to affordable, reliable and modern energy services",
b) "increase substantially the share of renewable energy in the global energy mix"
c) "double the global rate of improvement in energy efficiency"
d) "enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology"
e) "expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmers of support".

Subject and scope of the investigation

The study concerns the consumption convergence process in the European Union Countries (excluding Croatia, Cyprus and Malta) in the period of 2004-2016. Moreover, the influence of the level of sustainable consumption on this process is considered. The households' final consumption per capita indicator has been analyzed. The indicator of

the sustainable consumption (SCP) has been evaluated using Hellwig's taxonomic measure of development (TMD). Table 1 presents the diagnostic variables used in enumeration of this measure.

Table 1. Diagnostic variables used in enumeration of the TMD (author's own elaboration)

Variable	Process	Character
X_1	Final energy consumption (millions of TOE)	destimulant
X_2	Energy productivity (euro per kilogram of oil equivalent)	stimulant
X_3	Share of renewable energy in gross final energy consumption	stimulant
X_4	Resource productivity and domestic material consumption (DMC) (euro per kilogram)	stimulant

In the Eurostat database, there are more variables characterizing sustainable production and consumption goal (for example CO_2 emission). However due to incomplete data these characters are not included in the investigation.

The adopted spatial aggregation and time range of this study makes it easy to adopt tools of the spatial econometrics to analysis of the consumption convergence process. The spatial dependence is investigated using the spatial autocorrelation (based on the Moran's *I* statistics). In the previous analysis of the consumption in EU the spatial dependence approach was used by Author (Jankiewicz, 2018). The pooled TSCS data models and spatial panel data models are estimated in order to verify the convergence hypothesis.

The first hypothesis in this study concerns the large diversity of the households' final consumption expenditures in the EU countries. The second one applies to significant influence of the spatial location on the consumption convergence process. Moreover, the third hypothesis concerns the dependence of the consumption on its sustainability (whether the improvement in the sustainable consumption and production has a positive impact on the consumption convergence).

Data

The data applied in this study come from the Eurostat database. All analyzed variables are taken directly from database. The calculations and figures are made using R-Cran software (version 3.4.1).

First of all, the spatial differentiation of the households' final consumption per capita (Y) in the first and the last year of the investigation is analyzed. Figure 1 shows the spatial formation of values in this process. High level of consumption is observed in West (except Portugal in 2004 as well as Spain and Portugal in 2016) and North part of Europe. Maps in Figure 1 clearly indicate the fact that the EU is divided into two parts: Central-Eastern and Southern-Western. Most of the EU countries that joined the EU in 2004 (except Cyprus and Malta) are characterized with a low level of consumption per capita (less than mean) in both years of the study.

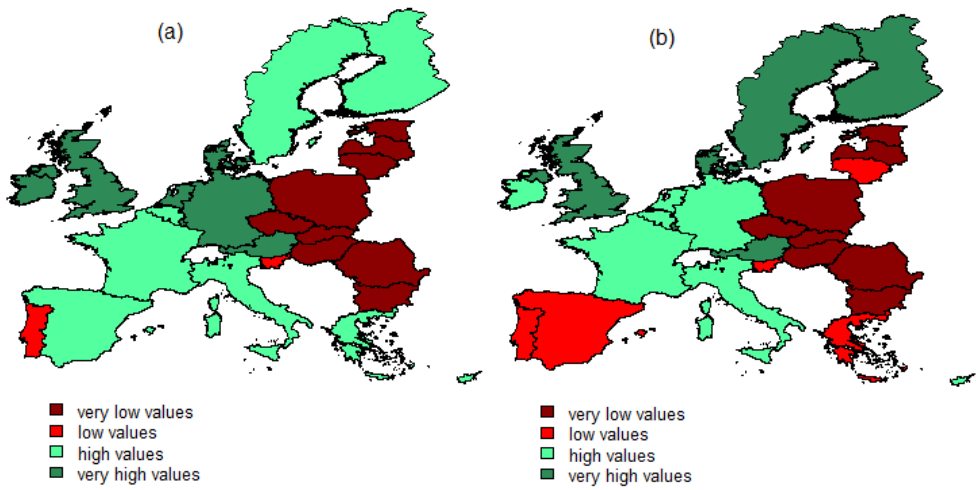

Figure 1. Spatial differentiation of the households' final consumption expenditures per capita across the European Union countries in the years 2004 (a) and 2016 (b) (author's own elaboration)

Methodology

The research starts with a calculation of the SCP indicator. The synthetic variable is calculated with the use of the TMD. Few steps are needed to get the value of TMD. The first step is to choose the diagnostic variables – the ones which characterize the process. The diagnostic variables used in this research are presented in Table 1. Next step is to define a character of these variables – which is a stimulant (having a positive influence on measured process) and which is a destimulant (having a negative influence on measured process) (Kolenda, 2006). The third step of calculation is to normalize values of variables. The standardization formula was used:

$$x_i' = \frac{x_i - \bar{x}}{S(x)},$$

where: x_i' - standardized value of the process X for ith object, x_i – real value of the process X for ith object, $\bar{x}$ – mean value of the process X, $S(x)$ – standard deviation of the process X.

Next step of the TMD calculation is to determine the pattern of development (fixed for all period of analysis) – vector of standardized coordinates:

$$Q = [z_{01}, z_{02}, z_{03}, z_{04}],$$

where coordinates of pattern are identified as follows:

$$z_{0j} = \begin{cases} \max\limits_i x'_{ij}, for\ j \in \{S\} \\ \min\limits_i x'_{ij}, for\ j \in \{D\}' \end{cases}$$

where: {S} and {D} are sets of stimulants and destimulants respectively.

After determining the pattern of development the distance of all objects (countries) from the pattern. The Euclidean distance formula is used:

$$d_{i0} = [\sum_{j=1}^{4}(z_{ij} - z_{0j})^2]^{0,5} \ (i = 1, \dots, 27).$$

The TMD is identified as follows:

$$SCP_i = 1 - \frac{d_{i0}}{d_0} \ (i = 1, \dots, 27),$$

where: $d_0 = \bar{d}_0 + 2s_0$ – the norm of distance d_{i0}, where $\bar{d}_0$ is mean of distances of all objects, s_0 – standard deviation.

Based on this synthetic measure rankings of countries were created.

Next step of the study is to analyze spatial dependence of households' final consumption expenditures and sustainable consumption. The spatial dependence is evaluated using Moran's test based on Moran's *I* statistics (Moran 1950, Schabenberger and Gotway 2005). The test statistic takes the following form (Suchecki, 2010):

$$I = \frac{1}{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}} * \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}\,[y_i - \bar{y}][y_j - \bar{y}]}{\frac{1}{n}\sum_{i=1}^{n}[y_i - \bar{y}]^2} = \frac{n}{S_0} * \frac{\boldsymbol{z}^T\boldsymbol{W}\boldsymbol{z}}{\boldsymbol{z}^T\boldsymbol{z}},$$

where:
y_i – an observed value of the phenomenon in the region *i*,
$\boldsymbol{z}$ – a column vector with elements $z_i = y_i - \bar{y}$,
$S_0 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}$ – a sum of the corresponding elements of the weights matrix (in the study weights matrix based on the common border criterion is used),
n – number of regions.

Spatial autocorrelation investigates whether the values of spatial process in neighboring spatial units are similar or not. Statistically significant positive value of the Moran's *I* statistics says that the processes in the neighboring spatial units are at the similar level. The negative value of this statistics says that the processes in the neighboring spatial units are at the different level. Random position of the values of the considered process is verified when Moran's *I* statistics is statistically non-significant.

After the investigation of spatial dependence, the convergence of the households' consumption expenditures is verified. The β-convergence approach is used (Barro & Sala-i-Martin, 1992) and the panel data and spatial panel data models are estimated (Baltagi, 2008; Suchecki, 2012). Models take the following forms:

1. Absolute convergence pooled model (Pooled)
$$lnY_{i,t} = \alpha_0 + (1 + \beta)lnY_{i,t-1} + \varepsilon_{i,t}$$
2. Absolute convergence panel data model with individual fixed effects (FE_IND)
$$lnY_{i,t} = \alpha_i + (1 + \beta)lnY_{i,t-1} + \varepsilon_{i,t}$$
3. Conditional convergence pooled model (Pooled)
$$lnY_{i,t} = \alpha_0 + (1 + \beta)lnY_{i,t-1} + \gamma lnSCP_{i,t} + \delta CR + \varepsilon_{i,t}$$

4. Conditional convergence panel data model with individual fixed effects (FE_IND)
$$lnY_{i,t} = \alpha_i + (1+\beta)lnY_{i,t-1} + \gamma lnSCP_{i,t} + \delta CR + \varepsilon_{i,t}$$
5. Absolute convergence spatial autoregressive model (SAR_pooled)
$$lnY_{i,t} = \alpha_0 + (1+\beta)lnY_{i,t-1} + \rho W(lnY_{i,t}) + \varepsilon_{i,t}$$
6. Absolute convergence spatial autoregressive panel data model with individual fixed effects (SAR_FE_IND)
$$lnY_{i,t} = \alpha_i + (1+\beta)lnY_{i,t-1} + \rho W(lnY_{i,t}) + \varepsilon_{i,t}$$
7. Absolute convergence spatial error model (SE_pooled)
$$lnY_{i,t} = \alpha_0 + (1+\beta)lnY_{i,t-1} + \eta_{i,t}, \quad \eta_{i,t} = \lambda W(\eta_{i,t}) + \varepsilon_{i,t}$$
8. Absolute convergence spatial error panel data model with individual fixed effects (SE_FE_IND)
$$lnY_{i,t} = \alpha_i + (1+\beta)lnY_{i,t-1} + \eta_{i,t}, \quad \eta_{i,t} = \lambda W(\eta_{i,t}) + \varepsilon_{i,t}$$
9. Conditional convergence spatial autoregressive model (SAR_pooled)
$$lnY_{i,t} = \alpha_0 + (1+\beta)lnY_{i,t-1} + \gamma lnSCP_{i,t} + \delta CR + \rho W(lnY_{i,t}) + \varepsilon_{i,t}$$
10. Conditional convergence spatial autoregressive panel data model with individual fixed effects (SAR_FE_IND)
$$lnY_{i,t} = \alpha_i + (1+\beta)lnY_{i,t-1} + \gamma lnSCP_{i,t} + \delta CR + \rho W(lnY_{i,t}) + \varepsilon_{i,t}$$
11. Conditional convergence spatial error model (SE_pooled)
$$lnY_{i,t} = \alpha_0 + (1+\beta)lnY_{i,t-1} + \gamma lnSCP_{i,t} + \delta CR + \eta_{i,t}, \quad \eta_{i,t} = \lambda W(\eta_{i,t}) + \varepsilon_{i,t}$$
12. Conditional convergence spatial error panel data model with individual fixed effects (SE_FE_IND)
$$lnY_{i,t} = \alpha_i + (1+\beta)lnY_{i,t-1} + \gamma lnSCP_{i,t} + \delta CR + \eta_{i,t}, \quad \eta_{i,t} = \lambda W(\eta_{i,t}) + \varepsilon_{i,t}$$

The CR variable denotes the financial crisis period (years 2008-2010), Y is the level of the households final consumption expenditures, SCP – level of consumption sustainability, $W(Y)$ – spatial lagged dependent variable, ε – spatio-temporal white noise.

The convergence process is confirmed when in models (1) – (12) the parameter β is negative and $(1+\beta)$ is statistically significant. The significance of parameters ρ/λ confirms the meaningful influence of the spatial dependencies on the considering convergence process. Choice between the spatial autoregressive (SAR) model and the spatial error (SE) model is done using the Lagrange Multiplier tests (LM) and their robust versions (RLM) (Anselin et al., 2004; Arbia, 2006). The β parameter serves to calculate the $t_{half-life}$ value, which presents the time needed to reduce the difference by half. It is expressed as follows (Kusideł, 2013):

$$t_{half-life} = \frac{\ln(2)}{b},$$

where: : $b = -\ln(1+\beta)$ expresses the convergence rate.

Results of the research

The first step of the investigation is to analyze the spatial dependence of the considered variables. The level of the consumption sustainability for all EU countries is evaluated using the TMD. The spatial differentiation of the variable Y is shown in the Figure 1. Figure 2 presents the spatial differentiation of the level of consumption sustainability

across EU countries in the years 2004 (a) and 2005 (b). The Central-Eastern EU countries are characterized by a low and very low level of the considered process. Despite the very high values of the consumption in Germany and United Kingdom in 2004 (see Fig. 1), its sustainability is at the level below the EU average. The situation changed for the UK in the 2016 (level of the sustainability increased above the EU average). The consumption in the Northern-Western EU countries (except Germany and UK in 2004 and also Germany and Belgium in 2016) is more sustainable than in the rest part of the continent. Some countries with high level of the households' consumption expenditures are characterized by low consumption sustainability and vice versa. It is not a certain tendency in formation of the *SCP* variable.

Table 2 shows the rankings of countries based on the level of the households' final consumption expenditures (*Y*) and *SCP*. The certain differences in the rankings for both processes are observed. Portugal is in the second part of the ranking of the Y process (positions 15-16), while in the ranking of the SCP process is in the first part (positions 4-8). Countries with the highest level of the SCP process are the Scandinavian countries – Sweden and Denmark, while the lowest level of this variable is noted in Poland and Bulgaria. In Germany the consumption level is high, but less sustainable in comparison to other countries (Germany is at the bottom of the sustainability ranking). The rankings of the *Y* and *SCP* variables are slightly different.

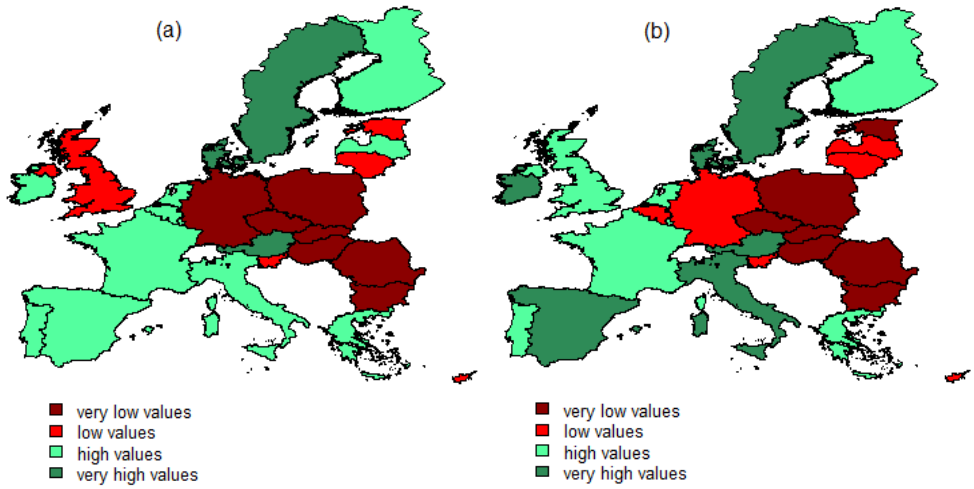

Figure 2. Spatial differentiation of the level of the consumption sustainability across the European Union countries in the years 2004 (a) and 2016 (b) (author's own elaboration)

Table 2. Rankings of countries based on the level of households' consumption and consumption sustainability (author's own elaboration)

Rank i	Final households consumption per capita			SCP		
	2004	2010	2016	2004	2010	2016
1	Luxembourg	Luxembourg	Luxembourg	Sweden	Denmark	Denmark
2	United Kingdom	Denmark	United Kingdom	Denmark	Sweden	Sweden
3	Denmark	United Kingdom	Denmark	Austria	Austria	Austria
4	Ireland	Austria	Finland	Portugal	Luxembourg	Ireland
5	Netherlands	Sweden	Austria	Finland	Ireland	Italy
6	Germany	Finland	Sweden	Luxembourg	Portugal	Spain
7	Austria	Germany	Germany	Netherlands	Italy	Luxembourg
8	Sweden	Ireland	Ireland	Italy	Spain	Portugal
9	Italy	Netherlands	Belgium	Greece	Finland	United Kingdom
10	Belgium	Belgium	Netherlands	Ireland	Netherlands	Netherlands
11	Finland	France	France	Latvia	Greece	Finland
12	France	Italy	Italy	Spain	France	Malta
13	Cyprus	Cyprus	Cyprus	France	United Kingdom	France
14	Spain	Greece	Spain	Belgium	Slovenia	Greece
15	Greece	Spain	Portugal	Slovenia	Belgium	Belgium
16	Portugal	Portugal	Greece	United Kingdom	Malta	Slovenia
17	Malta	Slovenia	Slovenia	Cyprus	Latvia	Latvia
18	Slovenia	Malta	Malta	Malta	Cyprus	Cyprus
19	Czech Republic	Czech Republic	Lithuania	Lithuania	Lithuania	Lithuania
20	Hungary	Slovakia	Estonia	Estonia	Hungary	Germany
21	Estonia	Lithuania	Slovakia	Romania	Romania	Romania
22	Slovakia	Poland	Czech Republic	Germany	Germany	Slovakia
23	Lithuania	Estonia	Latvia	Hungary	Estonia	Czech Republic
24	Poland	Latvia	Poland	Czech Republic	Slovakia	Hungary
25	Latvia	Hungary	Hungary	Slovakia	Czech Republic	Estonia
26	Romania	Romania	Romania	Poland	Poland	Poland
27	Bulgaria	Bulgaria	Bulgaria	Bulgaria	Bulgaria	Bulgaria

Table 3 shows the results of analysis of spatial autocorrelation using Moran test. For variable Y, the Moran's *I* statistics is positive and statistically significant (p-value is less

than the adopted level of significance – 0.05) in whole period of the study. It means that countries with similar values of the level of consumption are located close to each other. For variable SCP the Moran's *I* statistics is not statistically significant. It means that the spatial autocorrelation does not occur.

Table 3. The results of the Moran test for processes Y and CSP (author's own elaboration)

Year	Final consumption per capita (Y)		Sustainable consumption and production (SCP)	
	Moran's *I*	p-value	Moran's *I*	p-value
2004	0.6629	0.0002	0.1030	0.2260
2005	0.6599	0.0002	0.1286	0.1877
2006	0.6529	0.0002	0.1156	0.2058
2007	0.6462	0.0002	0.1549	0.1526
2008	0.6206	0.0004	0.1401	0.1719
2009	0.6055	0.0005	0.1623	0.1434
2010	0.6403	0.0003	0.1327	0.1817
2011	0.6555	0.0002	0.1907	0.1135
2012	0.6569	0.0002	0.1840	0.1201
2013	0.6579	0.0002	0.1304	0.1853
2014	0.6535	0.0002	0.1750	0.1299
2015	0.6516	0.0002	0.1860	0.1181
2016	0.6697	0.0002	0.1851	0.1192

Figure 3 presents comparison of the spatial differentiation of the level of consumption in the first year of investigation and its speed of growth. The certain tendency at the both maps in Figure 3 is presented. The countries with the lowest level of the households' consumption expenditures in 2004 have the highest speed of growth. Based on Figure 3, a presumption about occurrence of the convergence process is formulated.

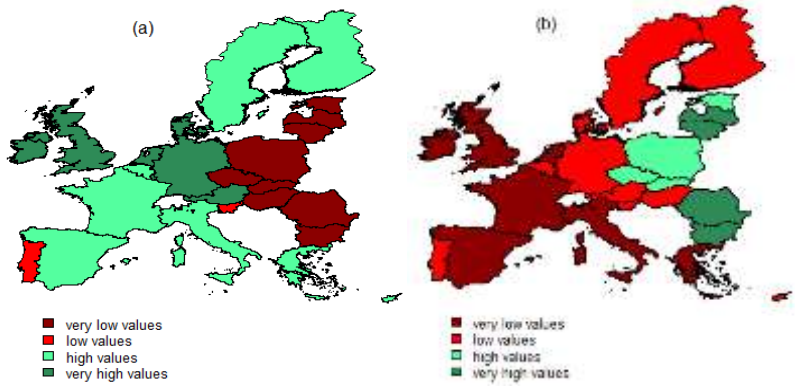

Figure 3. Spatial differentiation of the households' final consumption expenditures per capita across the European Union countries in 2004 (a) and its pace of growth in the period of 2004-2016 (b) (author's own elaboration)

To verify convergence process of consumption, the panel data model is estimated and verified. Table 4 shows the results of estimation and verification of β-convergence panel data models.

Table 4. The results of estimation and verification of the β-convergence panel data models (author's own elaboration)

Parameter	Absolute Convergence		Conditional Convergence	
	Pooled	FE_IND	Pooled	FE_IND
α_0	0.4500 (0.0000)	-	0.3852 (0.0001)	-
1+β	0.9550 (0.0000)	0.7529 (0.0000)	0.9616 (0.0000)	0.7673 (0.0000)
γ	-	-	-0.0087 (0.3860)	-0.0087 (0.6670)
δ	-	-	-0.0366 (0.0000)	-0.0327 (0.0000)
Moran test	0.6344 (0.0000)	0.5995 (0.0000)	0.5947 (0.0000)	0.5567 (0.0000)
LM_{err}	119.1900 (0.0000)	106.4400 (0.0000)	104.7600 (0.0000)	91.7840 (0.0000)
LM_{lag}	1.9681 (0.1607)	33.2320 (0.0000)	1.1768 (0.2780)	26.7670 (0.0000)
RLM_{err}	117.4200 (0.0000)	74.5350 (0.0000)	103.9800 (0.0000)	66.4340 (0.0000)
RLM_{lag}	0.2060 (0.6500)	1.3282 (0.2491)	0.3906 (0.5320)	1.4172 (0.2339)
Speed of convergence	0.0460	0.2838	0.0391	0.2648
$t_{half\text{-}life}$	15.0540	2.4421	17.7080	2.6172

Four types of models are estimated – absolute convergence pooled and fixed effect and also conditional convergence pooled and fixed effect models. The parameter *(1+β)* is statistically significant in all types of models and β is negative. It means that the convergence process of the consumption occurs. Considering models with individual fixed effects the pace of convergence is higher than for the pooled models. For residuals of all models the Moran's *I* statistics is statistically significant. That is why, it is reasonable to supplement models with spatial factor. Based on the LM and RLM statistics the spatial error model better reflects source of spatial dependencies. Table 5 presents the results of estimation and verification of the absolute β-convergence spatial panel data models.

As in the models without spatial dependencies the parameter *(1+β)* is statistically significant in all types of models and β is negative. Spatial dependencies are not statistically significant only for spatial autoregressive pooled model (SAR_pooled). Spatial autoregressive (SAR) models show the spatial autocorrelation in residuals. Based on the AIC criterion spatial error models better reflects spatial dependencies in convergence process (AIC is lower than in spatial autoregressive models). Next, the conditional β-convergence spatial panel data models are considered. Table 6 presents the results of their estimation and verification.

Table 5. The results of estimation and verification of the absolute β-convergence spatial panel data models (author's own elaboration)

Parameter	Absolute Convergence			
	SAR_pooled	**SAR_FE_IND**	**SE_pooled**	**SE_FE_IND**
α_0	0.4038 (0.0000)	-	0.4216 (0.0000)	-
1+β	0.9465 (0.0000)	0.6444 (0.0000)	0.9580 (0.0000)	0.7748 (0.0000)
ρ	0.0135 (0.1628)	0.1892 (0.0000)	-	-
λ	-	-	0.5641 (0.0000)	0.5255 (0.0000)
Moran test	0.6155 (0.0000)	0.3285 (0.0000)	-0.0815 (0.0869)	-0.0930 (0.0594)
AIC	-845.8200	-942.1800	-980.6300	-1027.0000
Log likelihood	426.9083	499.0881	494.3155	541.5141
Speed of convergence	0 .0550	0.4395	0.0429	0.2551
$t_{half\text{-}life}$	12 .6038	1.5772	16.1659	2.7172

Table 6. The results of estimation and verification of the conditional β-convergence spatial panel data models (author's own elaboration)

Parameter	Conditional Convergence			
	SAR_pooled	**SAR_FE_IND**	**SE_Pooled**	**SE_FE_IND**
α_0	0.3673 (0.0001)	-	0.5435 (0.0000)	-
1+β	0.9536 (0.0000)	0.6827 (0.0000)	0.9475 (0.0000)	0.7509 (0.0000)
γ	-0.0066 (0.5168)	-0.0223 (0.2287)	0.0117 (0.1052)	0.0357 (0.0523)
δ	-0.0360 (0.0000)	-0.0279 (0.0000)	-0.0347 (0.0057)	-0.0273 (0.0074)
ρ	0.0103 (0.2794)	0.1694 (0.0000)	-	-
λ	-	-	0.5515 (0.0000)	0.5183 (0.0000)
Moran test	0.5829 (0.0000)	0.3098 (0.0000)	-0.0760 (0.1032)	-0.0819 (0.0861)
AIC	-863.6400	-957.8200	-987.1500	-1035.8000
Log likelihood	437.8175	508.9076	499.5735	547.9108
Speed of convergence	0.0475	0.3817	0.0590	0.2864
$t_{half\text{-}life}$	14.5796	1.8161	12.8601	2.4120

To verify hypothesis about conditional convergence, models are supplemented with the following indicators: sustainable consumption level (SCP) – parameter γ and binary variable characterized financial crisis period (CR) – parameter δ. Like in previous models the parameter $(1+\beta)$ is statistically significant, and β is negative. Parameter δ is statistically significant and parameter γ is not significant in all models in Table 6. In spatial error panel data model with individual fixed effects the significance of the parameter γ is close to adopted level of significance. The spatial error models have better characteristics than the spatial autoregressive models – the AIC value is lower and residuals do not show the spatial autocorrelation.

Conclusion

In the analysis the consumption convergence process is considered. The investigation shows the differences between the Central-Eastern and Northern-Western part of the European Union. The level of consumption in Central-Eastern part of Europe is lower than in the remaining part of continent. However, their pace of growth is higher. It means that the households consumption expenditures are becoming more and more similar. Sustainability of consumption (as specified in this paper) does not have a significant impact on its convergence process. It can be the result of the consumerism idea. Countries, which want to increase their consumption spending or stay at its high level (like Germany), do not pay attention to the sustainable consumption. The financial crisis period implied that the consumption expenditures decreased and the convergence process slowed down. Moreover, a formation of processes (not included in investigation) in neighboring countries (except for consumption expenditures level) has a significant influence on the consumption convergence process.

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