Forum for Social Economics

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/rfse20

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To cite this article: Anita Pelle, András London & Éva Kuruczleki (2021) The European Union: A Dynamic Complex System of Clubs Comprised by Countries Performing a Variety of Capitalism, Forum for Social Economics, 50:4, 530-552, DOI: 10.1080/07360932.2019.1601121

To link to this article: https://doi.org/10.1080/07360932.2019.1601121

Published online: 09 Apr 2019.

Forum for Social Economics, 2021
Vol. 50, No. 4, 530–552, https://doi.org/10.1080/07360932.2019.1601121

The European Union: A Dynamic Complex System of Clubs Comprised by Countries Performing a Variety of Capitalism

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Abstract The EU can be regarded as a club where integration is the main club good. For decades, club convergence applied; however, currently there is insufficient level of convergence. The club theory approach becomes increasingly significant with Brexit and the remaining EU-27 heading towards a multi-speed Europe. Overall, the economy of the EU constructs a complex system implying the existence of sub-systems: clubs within the club. Dynamism is an inherent feature of the system. There are outside effects as well as factors influencing the system from inside, many of the latter rooting in the various capitalism models of the member states. In this work we analyse how the varieties of capitalism is related to convergence and complexity in the EU. In this context, the EU is an entity interpreted as a dynamic complex system of clubs comprised by countries performing a variety of capitalism.

Keywords: European Union, club theory, convergence, complex systems, varieties of capitalism

INTRODUCTION

European integration and the European Union (EU) can be viewed from various aspects. One of these is club theory and club formation. This approach is rather

classical and builds on rational choice principles. Convergence among the members of the club is also a relevant issue. However, the EU today, even if performing the features of a club, is apparently lacking convergence.

The current trends in the EU economy can be better understood if interpreted as a dynamic complex system. Complexity theory is critical of the classical approach, and may point to underlying institutional and evolutionary factors. In fact, we have known for quite some time now that institutions matter in economic performance (Acemoglu & Robinson, 2000; North, 2005; Rodrik, Subramanian & Trebbi, 2002; Tsuru, 1993). For the Varieties of Capitalism (VoC) literature, this conviction is among the fundamental assumptions; moreover, the comparative nature of the VoC approach may provide further insight on the specificities of the emergence and transformation of the institutional factors.

Accordingly, in this article we aim at depicting a sophisticated picture on the EU economy by combining the theoretical considerations and implications of club theory, complexity theory, and the VoC theory. We think that, by applying these various approaches to the EU simultaneously and confrontationally, we are able to contribute to our so far existing knowledge on intra-EU convergence and divergence, with special regard to the post-crisis realities and the plans for a multi-speed Europe. This multi-dimensional analysis may help us in shedding light on and provide insightful explanations for the internal differences existing among EU member states' institutional and economic settings.

CLUB-THEORY AND ITS APPLICATION FOR EUROPEAN INTEGRATION

Club theory and the category of club goods were introduced by Buchanan (1965). Preceding literature distinguished only between public and private goods (Samuelson, 1954). The main features of public goods are non-rivalry and non-excludability (Holcombe, 1997). Public goods often generate (or are generated as) externalities of consumption of other (private) goods – as such, they can be either positive or negative (Oakland, 1987). Buchanan's (1965) club goods are somewhere between private and public goods as their consumption is limited to the members of a club. An important implication is that there is supposedly an optimal club size, that is an optimal number of club members. Buchanan looked for this optimum within the marginalist theory framework. To distinguish club goods from public and/or private goods, Sandler and Tschirhart (1997) summarised the unique features of club goods: club membership is voluntary; the sharing of club goods may result in congestion and crowding which implies an optimal club size; and the club is an exclusive gathering of a finite number of members.

Club goods with regard to European integration can be viewed in several ways. In the approach of Ahrens, Hoen and Ohr (2005), the EU is a provider of a variety of goods towards its members that, with a few exceptions, cannot be enjoyed by those countries outside the EU. Ahrens et al. (2005) also cover the modes of club formation in the EU: first, clubs can form spontaneously through any legal agreement and common institutional framework (e.g. Schengen[1]). Second, they can emerge within the EU integration setup (e.g. the Eurozone). Third, they can be formulated under EU legislation, comprising all member states (e.g. trade policy); a subgroup of them (enhanced cooperation[2] serves this very type of intra-EU club formation, e.g. the European Public Prosecutor's Office (CoEU, 2017); or may in some cases include even non-EU-members (e.g. Horizon 2020[3])).

As the most evident club goods of European integration, the four freedoms or, in other words, the single market itself shall be mentioned, accompanied by its complete regulatory framework, ranging from competition provisions to commonly agreed technical standards. Similarly, all common policies belong to this type of EU club goods. An important club good available to a subgroup of EU member states is the euro. Indeed, these "goods" are non-rival to club members and, at the same time, excludable to non-members.

Expected benefits of the club goods of European integration are articulated in the official legal texts (above all, in the Treaties) as objectives: constant improvement of living conditions, steady expansion, balanced trade, harmonious development and, last but not least, the preservation and strengthening of peace and liberty. For decades, European integration was undoubtedly delivering these yields, constantly providing momentum to integration.

Nevertheless, already this short overview points to an important characteristic of the EU: it is a club in itself but there are several further arrangements of further clubs within and/or related to the EU. In this respect, we highlight the distinction between differentiated integration and multi-speed Europe: while the former can be related to the clubs-within-the-club concept embracing enhanced cooperation schemes and other, more informal cooperation initiatives and constellations of sub-groups of member states, the latter presumes that all member states are taking the same path of European integration though at different speeds and there is a core group of them showing the one common way to the others (Koller, 2012).

1 See Coleman (2016) for a brief historical description of the evolution of the Schengen Agreement.

2 http://eur-lex.europa.eu/summary/glossary/enhanced_cooperation.html

3 Associated countries to Horizon 2020, as of 1 January 2017, are: Iceland, Norway, Albania, Bosnia and Herzegovina, Macedonia, Montenegro, Serbia, Turkey, Israel, Moldova, Switzerland, Faroe Islands, Ukraine, Tunisia, Georgia, Armenia. More information: http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/3cpart/h2020-hi-list-ac_en.pdf

COMPLEXITY, COMPLEX SYSTEMS

The categories of complexity, complex systems and complexity theory have their roots in physics (Elsner, Heinrich & Schwardt, 2014). Complexity can be described in several ways. According to Holovatch, Kenna and Thurner (2017, p. 2.), "a system is complex if its behaviour crucially depends on its details." According to Arthur (2013), complexity is the study of the relationship patterns between the constituents of a system. Four main properties may distinguish a complex system from any other non-complex systems that we hereby only outline. The first is "nonergodicity" that refers to its constantly changing nature; a nonergodic system at no point can be defined by probabilistic methods, no average state or long-run behaviour of it can be predicted. Second, a complex system can undergo a "phase transition" upon affected by a change in any of its parameters. Nevertheless, this change needs to reach a critical level (Arthur, 2013). Third, as a result of the phase transition, the system can reach an "emergent property" – a novel feature that has developed as a consequence of the occurred change and the relatedly induced processes. Fourth, the properties of the system are "universal" so they are manifested in a single way across the different parts of the system. However, the presence of these four properties in a system does not necessarily imply that it is complex but at least provides us with a reliable hint for further examinations in this direction (Durlauf, 2005).

Complex systems are made up of interconnected members that are in interaction with one another and affecting the whole system through their decisions and behaviour. As such, they may be visualised by graphs, directed or undirected, where nodes are the members and edges are symbolising their relationship (Strogatz, 2001).

Complexity in economics has fundamentally changed earlier ruling theory (that was in fact relying on earlier knowledge in physics). Most lately, the new area of econophysics has emerged, blurring the boundaries between physics, econometrics and statistics (Mantegna & Stanley, 2000; Wang, Wu & Di, 2004). An inherent feature of complex systems is dynamism therefore non-equilibrium is the natural state of the economy rather than equilibrium (Arthur, 2013). Nonequilibrium is driven mainly by uncertainty (another inherent feature of the economy deducible from imperfect information) and technological change. Kornai (1971) claimed well ahead of mainstream economics that there was no equilibrium that economies were heading towards; however, he advised using biology instead of physics to better understand the underlying laws, the 'nature' of the economy (Mihályi, 2013). On the other hand, uncertainty and technological change are likely yielding novelty to the system.

Others (e.g. Hausmann et al., 2014; Hartmann, Guevara, Jara-Figuerola, Aristarán & Hidalgo, 2017) interpret economic complexity at the country level

from the products' aspect and see it as a feature dependent on the available knowledge and institutional setting. The complexity of products and industries provide a good proxy for the stock of knowledge in the economy that cannot be captured by traditional indicators of human capital (e.g. employment, education attainment), and the level of complexity may also indicate expected development path and prospects of a country.

Perhaps the most distinct feature of complex systems is that the traditional Gaussian statistics no more apply; instead, fat-tailed distributions prevail. Such systems are often characterised by scaling laws (e.g. Zipf's law), and many of their features exhibit a power law (e.g. Pareto) distribution. Path dependence is a much-mentioned critical phenomenon that might influence the emergence of power law distribution properties. Di Guilmi, Gaffeo and Gallegati (2003) found that world income distribution expressed in terms of GDP per capita showed a Pareto distribution and the time path of the power law exponent performed a negatively sloped curve. Canning, Amaral, Lee, Meyer and Stanley (1998) noted the existence of power laws in connection with GDP growth volatility and found that volatility greatly depended on the relations among the members of the system. This way, volatility can be a measure of how they are connected in the system.

Overall, complex dynamic systems are characterised by being non-equilibrium systems, which are always in the process of changing and metamorphosing. Helbing and Kirman (2013) pointed out that the potentially multiple equilibria might be unstable; the system could not be strictly optimised real-time and may be hardly predictable; feedback and unexpected side-effects are common; the system performs self-organised dynamics; cascade effects and extreme events might occur and the probability of these is higher than would be in case of normal (Gaussian) distribution.

VARIETIES OF CAPITALISM (VOC) AND THE EU AS A CLUB

The Varieties of Capitalism (VoC) literature started to evolve when the general classification of developed economies into liberal market economies (LME) and coordinated market economies (CME) of Hall and Soskice (2001) was contested from several viewpoints, although research has continued also within the LME-CME framework (Witt & Jackson, 2016). Deeg and Jackson (2007) emphasised that European integration has been affecting capitalism models in EU member states. In fact, this influence has been traceable already in the accession phase (Csaba, 2007), and expressively so for post-socialist "New Europe" (Landesmann & Rosati, 2004). Quite importantly, this has largely determined the path that the post-socialist countries were taking after the

change of the system, which we refer to with the umbrella expression of Europeanisation and, within that, as top-down Europeanisation (Börzel & Panke, 2013). Paradoxically, for these countries in that particular historical moment, it was a desired goal to reach and a constraint at the same time; however, the cost of it was never considered.

Based on institutional forms in five areas (product market, labour market, financial sector, social protection and the welfare state, and the education sector), Amable (2003) identified five different models (including EU-15 countries): market-based (UK), social-democratic (Sweden, Finland and Denmark), continental European (France, Germany, Austria, Belgium and Ireland), Mediterranean (Italy, Spain, Portugal and Greece), and Asian (none from Europe in this group). The Netherlands appeared to be a mix of elements of the market-based and the continental European models. In terms of social and labour market aspects, Sapir (2006) categorised the EU-15 into an Anglo-Saxon (Ireland and UK), a Nordic (Denmark, Sweden, Finland and the Netherlands), a continental (Austria, Belgium, France, Germany and Luxembourg), and a Mediterranean (Greece, Italy, Portugal and Spain) model.

These early classifications did not involve the post-socialist country block, whose investigation came later. Nölke and Vliegenthart (2009) saw these new EU member states constituting one distinctive, new group in the VoC setting, which they labelled as dependent market economies (DME) referring to their strong dependence on foreign direct investments and multinational corporations' decisions. At the same this model has resulted in a successful entry into global value chains, and in upgrading through technology transfer. The concern that this model might have reached its limits has been articulated lately (Galgóczi & Drahokoupil, 2017).

Farkas (2011) agreed that a new model of European capitalism can be determined: the Central and Eastern European (CEE) variation is characterised by shortage of capital, weak civil society, and the impact of the EU and other international organisations. Later Farkas (2016) reviewed the capitalism models across the whole post-crisis EU and identified six distinguishable clusters: a "Stable North-Western Europe," an "Unstable Mediterranean," a "Stable East Central Europe," an "Unstable Eastern and Southern Europe," and Luxembourg and Ireland constituting two distinct clusters themselves, tagged as "Lucky offshore financial haven" and "Victim of the banking system," respectively. Bohle and Greskovits (2007, 2012) emphasised that there was a variety within the DME model: a neoliberal variation in the Baltic states, an embedded neoliberal type in the Visegrad countries, and neocorporatist in Slovenia. Sallai (2013) talks about post-socialist network capitalism and, most lately, about the emergence of Wedel's (2003) clan state as a result of serious backsliding (Sallai & Schnyder, 2018).

If viewed at country level, Italy is perhaps calling for greatest concern regarding outlook. Not only is Italy too big to fail and thus impossible to be bailed out, but is also burdened by multidimensional and multi-layer dualities (Simonazzi, 2012) and a series of failed reforms (Rangone & Solari, 2012).

PROCESS OF CONVERGENCE AND EXISTENCE OF CONVERGENCE CLUBS IN EUROPEAN INTEGRATION

Convergence has always been a core issue in European integration, and an incentive for many countries to join. The relative positions of more and less developed members will eventually determine whether convergence is successful (Martin, 2001; Quah, 1996; Williamson, 1996). International trade positively influences per capita income convergence although it is not sufficient to reach such ends (Slaughter, 1997); technology levels, capital flows and further factors play a role. Actually, trade liberalisation has even resulted in income divergence in some cases (Slaughter, 2001). Relying on Myrdal's (1957) description of cumulative causation and Young's (1928) observation on increasing returns resulting in changes becoming endogenous, Kaldor (1978) had warned about that risk rather early, emphasising that even minor initial differences in levels of development may constantly grow over time as trade intensifies and therefore adequate policies (with adequate budgets) are needed to counterbalance the trends, and more expressively so for a monetary union. Of the endogenous changes, it is important to note that, with the increase of international trade, overall market size increases (Krugman, Obstfeld, & Melitz, 2012), from which in fact the originally more capital-intensive countries easily benefit more, which may lead to further increasing disparities (Kaldor, 1985).

We can also distinguish between nominal and real convergence: the former is assessed through nominal variables (e.g. inflation, exchange or interest rates) while the latter refers to the narrowing of differences in any real macroeconomic aggregates (e.g. real GDP per capita) (Dvoroková, 2014). Convergence occurs when the less developed is growing at higher rates and thus catching up to the more developed (Bongardt & Torres, 2013), which Ben-David (1994) classifies as upward convergence, as opposed to downward convergence. This definition implicitly supposes though that countries are converging toward one equilibrium point (Dalgaard & Hansen, 2005). In fact, multiple equilibria can arise at distinct levels of economic development and conditional convergence also allows for multiple steady states to exist for the same given group of countries or entities (Schmitt & Starke, 2011). Countries converging towards different equilibrium points are forming convergence clubs, narrowing their income levels and decreasing standard deviation of income between them (Ben-David,

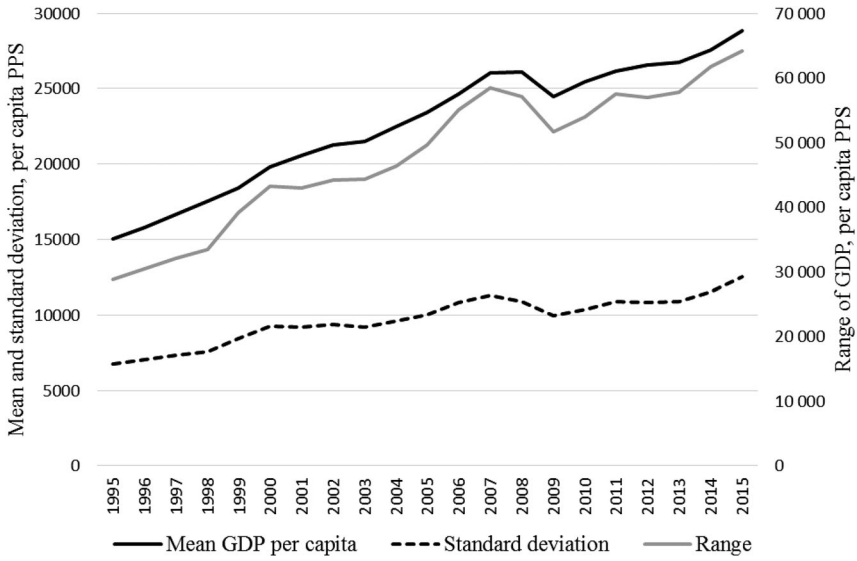

Figure 1:
Measuring σ-convergence in the EU. Source: own calculations based on Eurostat data

1994). For club convergence to occur, it is also necessary that a group of certain countries share the same initial conditions predicting such outcomes (Bartkowska & Riedl, 2012). Convergence may take a twin-peaked distribution: a "rich" and a "poor" cluster evolving, and the middle disappearing (Quah, 1996).

CLUB CONVERGENCE IN THE EU, CLUB FORMATION

To present clubs and club convergence of EU member states, we apply several methods. First, we analyse σ-convergence (Schmitt & Starke, 2011). It can be best measured by variance and standard deviation. Accordingly, we calculated the weighted mean per capita GDP in PPS values of EU member states for each year of our reference period (1995–2015)[4] and then we defined range, variance, standard deviation, and relative standard deviation (as a ratio of the standard deviation and the weighted mean of GDP per capita values). Our results imply (Figure 1) that, from 1995 onwards, there has in fact been divergence in the EU: standard deviation has grown from 7,740 EUR in PPS to 12,500 EUR in

4 As the standardised ESA-95 system of national accounts was introduced by the EU in 1995 (Eurostat, 1995), that is the earliest year we can include in our time series.

PPS while the range more than doubled (from 28,800 EUR in PPS in 1995 to 64,200 EUR in PPS in 2015). The break in the curves in 2008 is attributable to the financial and economic crisis.

As a next step, we applied a K-means cluster analysis for the EU-28 with the aim of organising the member states into clusters performing similar characteristics, that is, convergence clubs. We used data from 2015. We have tried clustering based on various combinations of indicators. In the end, the following four have proven suitable to identify intra-EU convergence clubs: GDP, final consumption expenditure, government expenditure, and GVA, all measured in per capita PPS. As a result, we have found two suitable club compositions: one of 6, and the other one of 5 clusters. We decided at the latter (Table 1, Figure 2) as in the 6-cluster formation two groups proved to be fairly similar.

Clusters 1 and 5 are composed of a single country each: Luxembourg and Ireland, respectively. Cluster 2 is the one with the lowest values in all four variables: the laggards in the EU. Eastern and South-Eastern European member states (including Greece) belong to this group. Cluster 3 is made up of the Southern Eurozone members (without Greece) and the better-performing Eastern new member states, still lagging behind as compared to the whole of the EU. Cluster 5, then, comprises the EU core countries performing best in all examined dimensions.

Such a clustering of EU member states has enabled us to assess within-club convergence (Figure 3).[5] As can be seen, from 1997 to 2006, club members were overall diverging from their club means. The trend then turned with the crisis.

We have to note that the convergence clubs we found were formed based on 2015 data therefore these results can be interpreted so that, prior to the crisis, there had been different within-EU forces influencing the relative positions of EU member states and then the crisis has induced processes that have resulted in the clusters of 2015. Quite precisely, our main intuition was that the merging of Southern Eurozone and Eastern new member states in two clusters is the very result of the crisis. To verify our hypothesis, we calculated within-club convergence for the three clusters (2, 3 and 5) with several members (Figure 4). Our results approve of our intuitions. We hereby point out that, in the 2012–2015 period, the furthest-lagging-behind cluster (2) has become more homogenous than the core cluster (5) of which, unlike the other two clusters, internal heterogeneity was stably low all throughout the period, especially in relative terms.

As a further investigation of within-club convergence, we have calculated relative standard deviations for the same three clubs, showing how the changes in the group standard deviation and mean per capita income have affected the average

5 Evidently, standard deviation and thus convergence is uninterpretable for clusters 1 (Luxembourg) and 4 (Ireland).

Table 1: Cluster composition, data in per capita PPS, 2015

Cluster number	Cluster member countries		GDP per capita	Final consumption expenditure	Government expenditure	GVA
Cluster 1	Luxembourg	Mean	77,800.00	36,100.00	12,900.00	71,298.57
		Standard deviation	n.a.	n.a.	n.a.	n.a.
Cluster 2	Bulgaria, Croatia, Greece, Hungary, Latvia, Poland, Romania	Mean	17,785.71	13,928.57	3,242.86	15,449.88
		Standard deviation	2,310.43	2,213.38	723.09	2,153.96
Cluster 3	Cyprus, Czech Republic, Estonia, Italy, Lithuania, Malta, Portugal, Slovakia, Slovenia, Spain	Mean	24,080.00	18,260.00	4,480.00	21,356.49
		Standard deviation	2,240.44	2,002.33	541.19	2,177.11
Cluster 4	Ireland	Mean	51100.00	23900.00	6400.00	47,459.91
		Standard deviation	n.a.	n.a.	n.a.	n.a.
Cluster 5	Austria, Belgium, Denmark, Finland, France, Germany, Netherlands, Sweden, UK	Mean	33,400.00	25,800.00	7,955.56	30,618.06
		Standard deviation	2,599.52	812.40	1,213.58	2,465.97

Source: own edition, K-means clustering based on 2015 per capita variables from Eurostat.

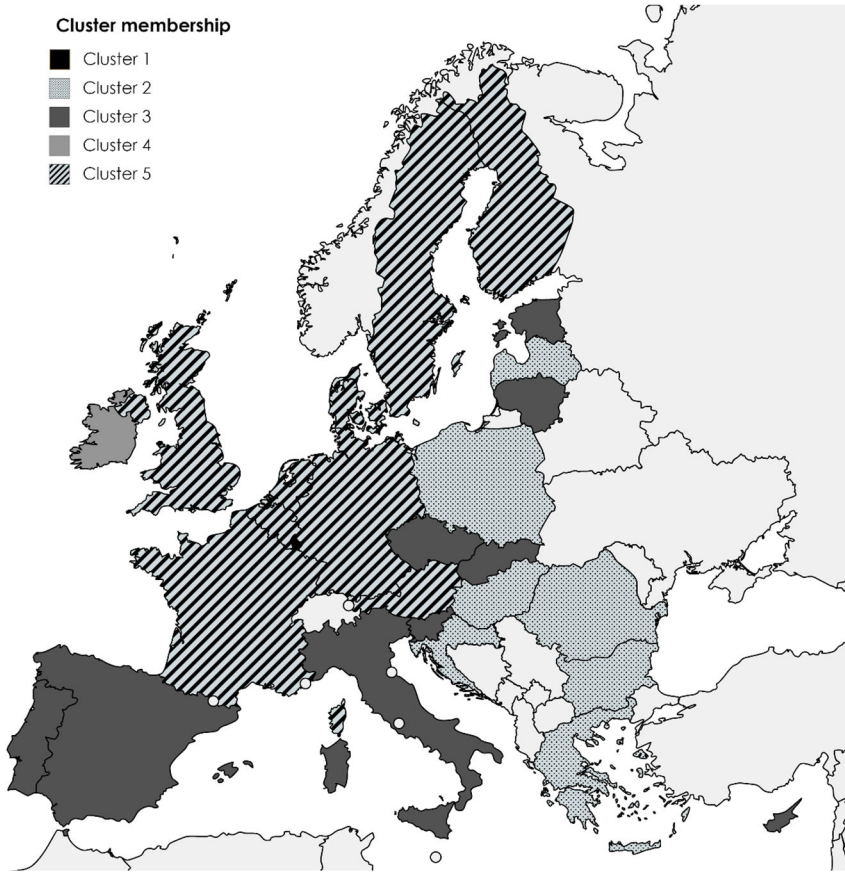

Figure 2:
Map of EU member state clusters (clubs). Source: own calculations based on Eurostat data, visualisation tool: www.mapchart.net

distance of club member countries from their own club means (Figure 5). These calculations tell us that the members in all three clubs were in fact converging to their respective group means. The core had been most homogenous originally and has preserved this homogeneity while the South-Eastern furthest-lagging-behind cluster was originally the most heterogeneous. In the 1990s, especially Greece was much more developed than the other members of that club (all of them post-socialist transition countries).

We also analysed between-club convergence as expressed in between-club standard deviation and between-club relative standard deviation. As a reference,

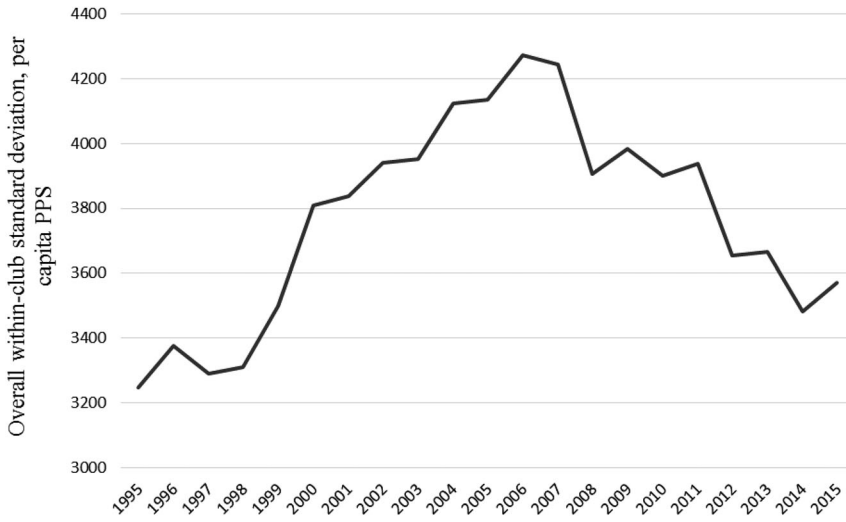

Figure 3:
Overall within-club convergence in the EU, 1995–2015. Source: own calculations based on Eurostat data

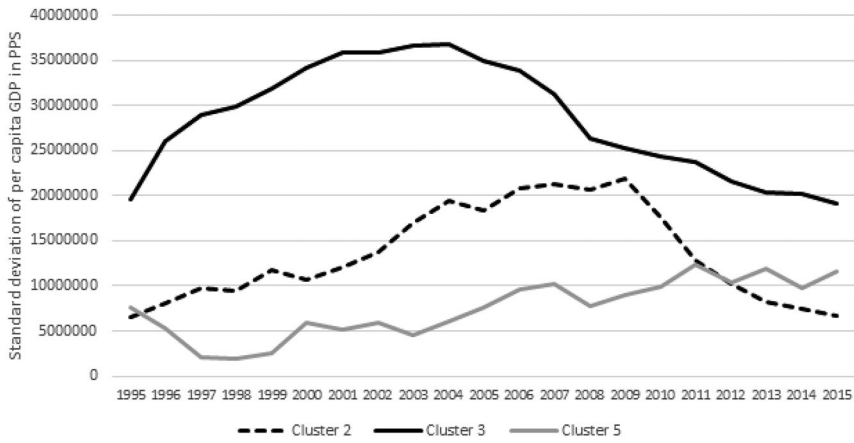

Figure 4:
Within-club convergence for Clusters 2, 3 and 5. Source: own calculations based on Eurostat data

we have also included the mean values (Figure 6). Pre-crisis growth in standard deviation paired with decreasing relative standard deviation indicates between-club convergence, that is, the different clubs becoming more similar to each

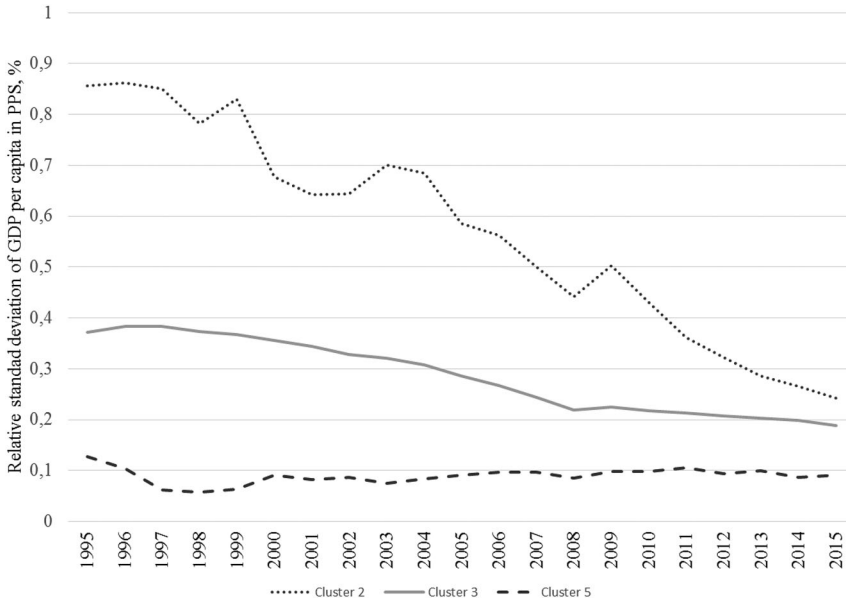

Figure 5:
Club-convergence in the EU, 1995–2015. Source: own calculations based on Eurostat data

other; however, after the crisis, the earlier convergence process stopped and clubs started diverging from each other although at a much slower pace.

As presented in our theoretical introduction, trade can also serve as a good enhancer of convergence. This has obviously been a fundamental driving force in European integration. Outside the direct gains, trade also has spillover effects: the transfer of technology and know-how, which can foster innovation and upgrading (Szalavetz, 2017). However, education, policy efforts to create fair market conditions, capital flows and financial transactions shall also complement trade-driven convergence (World Bank, 2017). We do not assess these here though.

The studies of Ermann and Shepelyansky (2015) and Zhu, Cerina, Chessa, Caldarelli and Riccaboni (2014) both examine cross-country trade flows as complex networks and apply graph theory. Trade networks have often been studied in a simplified but complexity-preserving graph model where the countries are represented by the nodes while edges represent the trading relations, often using export and import volumes as edge weights. We followed these methods in relation to intra-EU trade. To determine edge weight, we used 2016 export volumes in EUR available from the Eurostat COMEXT database. To eliminate distortions arising from country size we divided the absolute values

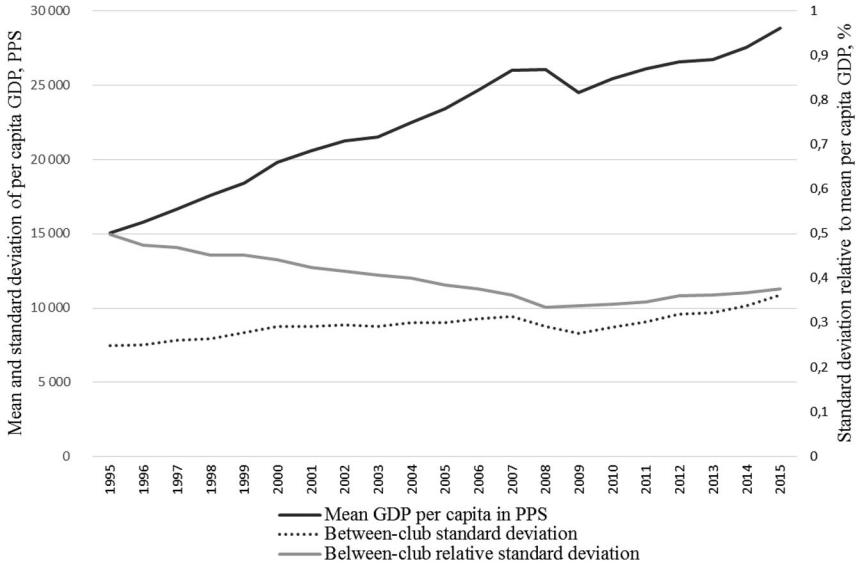

Figure 6:
Between-club convergence in the EU, 1995–2015. Source: own calculations based on Eurostat data

by population data. The obtained a graph in which edge directions are not shown but edge weights are illustrated through line thickness, and mapped it into the map of Europe (Figure 7).

To find clusters of countries exhibiting similar trade patterns or stronger relations, we ran a modularity test based on the algorithm of Blondel, Guillaume, Lambiotte and Lefebvre (2008) and identified four clusters: in the first one Belgium, France, Malta and Portugal can be found; in the second, Estonia, Latvia, Lithuania, the Netherlands and the UK; in the third, Bulgaria, Cyprus, Greece, Luxembourg, Poland, Romania, Spain and Sweden; and in the fourth one, the rest of the member states (a Germany-centred group). When conducting the same analysis on absolute export values, the resulting clusters were showing the old core-periphery distinction, yet for the per capita values we could see some mixing between countries traditionally regarded as core or periphery. Based on the obtained results we conclude that there has been some convergence in terms of trade relations in the EU; however, the resulting clusters still consist of countries that are relatively closer geographically. In fact, geography appears to matter more than capitalism models although our fourth cluster demonstrates the dependence of Central and Eastern European DME-countries on Germany and Austria – or, rather, their interdependence. The heavy-weight edges

Figure 7:
Trade relations in the EU, per capita export values, EUR, 2016. Source: own edition based on Eurostat COMEXT data (trade) and Eurostat data (population)

connecting Luxembourg and Finland to Germany have statistical reasons: we divided the export values by population data and these two countries have small populations in respect of their trade intensity with Germany.

After thoroughly examining the EU from the aspect of club formation and club convergence, we now turn our attention to its complexity features.

THE EU: A DYNAMIC COMPLEX SYSTEM

To analytically describe the EU as a complex system,[6] we considered wealth distribution among EU member states on an annual basis. We plotted GDP in million PPS values (axis *y*) of EU member states arranged in a descending order (axis *x*), a rank assigned to each value (1-28). We did that for each year

6 In this article, we do not assess trade complexity of EU member states as a complexity indicator applied by Hartmann et al. (2017) and Hausmann et al. (2014). Instead, we focus on the complex system (Arthur, 2013; Holovatch et al., 2017).

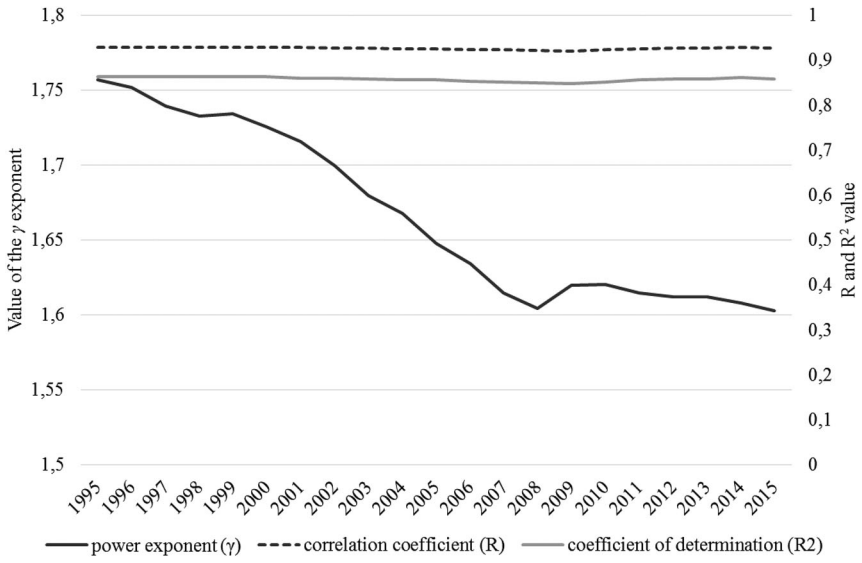

Figure 8:
γ, R and R^2 of power regression analysis on GDP in million PPS of EU member states, 1995–2015. Source: own calculation based on Eurostat data

in the examined period (1995–2015) thus we received a series of diagrams. Then we fitted a power regression line on this series of curves:

$$\hat{y}_{it} = \beta_0 x_{it}^{\gamma_t}$$

where $\hat{y}_{it}$ refers to the power law regression estimated GDP value of country $i = [1,2, \ldots, 28]$ in year $t = [1995, \ldots, 2015]$, β_0 is the intercept parameter of the regression line in year t_1, while x_{it} is the GDP rank value for country i in year t, and γ_t is the exponent of the regression function for year t.

To see the dynamics of wealth distribution along the years, we focused on the γ_t parameter (the power exponent), taking its absolute value. Because of the power law distribution, the fitted curve is expected to exhibit a negative slope. Figure 8 shows the absolute values of the power exponent (γ), alongside the correlation coefficients (R) and coefficients of determination (R^2).

The absolute value of the power exponent (γ) does indeed follow a negatively sloped curve implying deepening complexity within the EU-28 along the years. The break in the line around 2008 is a result of the financial crisis, that is, that the fall-back in GDP in PPS was greater for countries with initially larger economies than for those initially smaller. However, after the crisis,

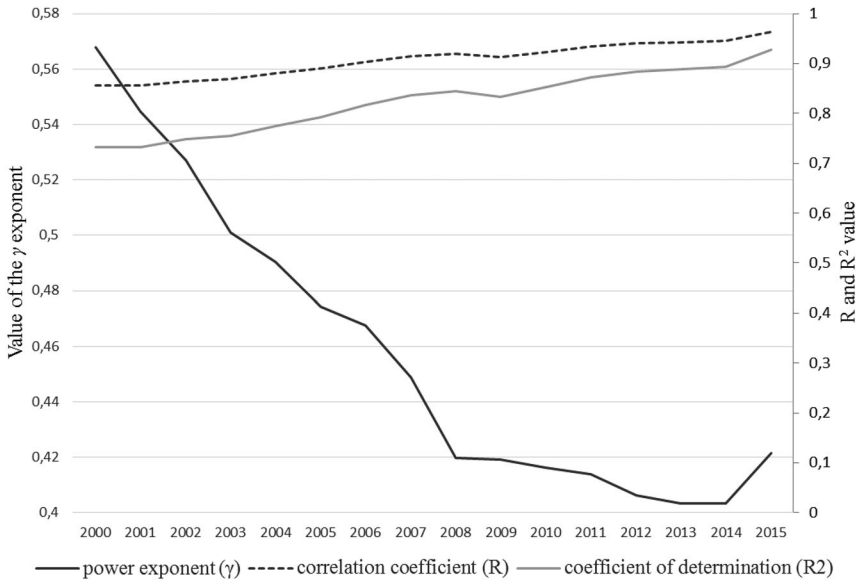

Figure 9:
γ, R and R^2 of power regression analysis on GDP in million PPS of EU member states according to Di Guilmi et al. (2003), 2000–2015. Source: own calculation based on Eurostat data

complexity in the EU started to evolve again. These findings are in line with our results from investigating σ-convergence.

As a matter of fact, in the examined time period, GDP distribution among EU member states has moved away from the 80-20 Pareto distribution towards the 90-10 distribution, manifesting even larger unevenness. The coefficient of determination (R^2) has been staying stably above 0.84 indicating that country rank explains the variability of the obtained regression values in at least 84%, which is decisive. The correlation coefficient (R), at the same time, is at about 0.92 all throughout the reference period implying a very strong connection between country rank and the predicted GDP distribution.

Another method to examine wealth distribution is that applied by Di Guilmi et al. (2003) where the distribution of GDP for country i in year t is x_{it}. The values are ordered from largest to smallest so index i of the respective variable corresponds to its rank. A scatter plot of country rank (axis x) versus GDP (axis y) is drawn in a log-log scale. For every year, we fitted a linear regression line, this time on the log-log scale:

$$\hat{y}_{it} = \beta_{0t} + \gamma_t * \ln(i_t)$$

where β_{0t} refers to the intersection of the linear regression line at $x = 0$ in year t, the component γ_t is the slope of the regression line in year t while $ln(i_t)$ is the log value of the rank of country i in year t.

The results (Figure 9) are rather similar to those in the previous case, and the obtained power exponent values again fit a negatively sloped curve,[7] similarly implying that the EU is exhibiting the features of a complex system.

CONCLUSIONS

With the aim of synthesising the results of our investigations through the various approaches and methods, we take the four main features of complex systems as guidance. First of all, the nonergodic nature of complex systems implies that their characteristics are constantly changing. Regarding the clubs of the EU created by statistical methods we have demonstrated that relative positions of EU member states are changing over time; there is no stability in the EU as a whole. The second feature of complex systems is phase transition. In this respect the major event inducing such processes was the crisis: quite precisely, it has turned the previous convergence into divergence. Thirdly, complex systems are also exhibiting some emerging property. As for the EU, the fact that European integration has lately benefitted the more developed countries more is definitely a feature of this kind. Last but not least, properties of complex systems are universal. How can this be traced in the case of the EU? We have identified several such properties. If we look at our clusters, we can see that, over time, members of the clubs have become more similar to one another. Another important aspect is that geography matters – not only in the clusters based on the levels of development, but also in the intra-EU trading clusters. All this demonstrates that there is path dependence (David, 1985) in relation to EU member states – yet another universal property of the EU as a complex system.

Overall, we have demonstrated that the EU comprises geographically rather consistent convergence clubs that have lately been diverging from each other, especially since the crisis. The crisis temporarily put growing complexity on hold as it hit the largest economies more than the smaller ones. However, after the crisis, complexity has started to develop again, which is demonstrated by the power exponent repeatedly taking a decreasing trend as we could see above. The EU as a complex system is exhibiting novelty as well – it is out of our scope to go into further details but we hereby mention that several of the EU club goods, starting with the Europeanised post-socialist countries, the

7 The break of the γ exponent graph for 2015 is caused by the unprecedented 26.3% GDP growth of Ireland, which in fact is mainly a result of restructuring of intangible assets in the accounts of a few multinationals (OECD, 2016).

Schengen zone or the monetary union with supranational economic governance but no common fiscal policy, are unique constructs in the world.

We will hereby not systematically contrast our clustering of EU member states to all the clubs that have been formed along the club goods of European integration; nevertheless, we can find, for example, Eurozone members in several of the clusters found by our analysis, or Schengen and non-Schengen countries similarly mingling in the clusters. This implies that the club goods of EU integration do not seem to (necessarily) foster club-convergence. Our results are also in line with the findings of Quah (1996): over time, distribution of wealth in the EU is taking a twin-peaked shape. Sadly, the South-Eastern cluster (2), especially Greece, is exhibiting downward within-club convergence (Ben-David, 1994).

How do our findings correspond to those of VoC literature? First of all, the EU demonstrates that there are more than two types (LME and CME) of capitalisms. Also, it is quite obvious that the post-socialist member states are substantially different from the core of Europe. Nonetheless, Farkas' (2016) clustering seems to match ours best albeit based on completely different indicators (i.e. those considered most affected by the crisis, e.g. public debt levels) and a different year. This in fact demonstrates the universal features and thus is another sign of the complexity of the EU economy.

What do our findings imply in relation to the future of European integration? In our view, differentiated integration is justifiable on grounds of club theory and historical evolution. Eventually, our timely analyses demonstrate the importance of path-dependence in countries' development. European integration exerts an overall ambiguous impact on the participating countries and country groups: some appear to have benefitted more from integration than others, and in fact the more developed core countries have been able to reap higher yields, especially since the crisis. This is not particularly a sign of success for Europe.

ACKNOWLEDGEMENTS

The first version of the paper was presented at the International Colloquium 'Complexity and Institutions' at the University of Bremen in June 2016 – the authors are grateful for the comments received there, especially Wolfram Elsner's suggestion to analyse power law distribution among EU member states. A more advanced stage of the work was presented at the Trento Festival of Economics in June 2017 where further constructive comments were received. Last but not least, the insights of the two anonymous reviewers of the originally submitted manuscript have contributed to the improvement of coherence among the various approaches. All remaining errors or shortcomings are ours.

FUNDING

This research was supported by the project nr. EFOP-3.6.2-16-2017-00007, titled *Aspects on the development of intelligent, sustainable and inclusive society: social, technological, innovation networks in employment and digital economy*. The project has been supported by the European Union, co-financed by the European Social Fund and the budget of Hungary.

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