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Suggested Citation: Slava, Svitlana (2023) : Economy and creativity multiparametric clustering: Regional comparisons and new perspectives for Ukraine, REGION, ISSN 2409-5370, European Regional Science Association (ERSA), Louvain-la-Neuve, Belgium, Vol. 10, Iss. 1, pp. 159-181, <https://doi.org/10.18335/region.v10i1.382>

This Version is available at:

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Economy and Creativity Multiparametric Clustering: Regional Comparisons and New Perspectives for Ukraine

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Received: 6 September 2021/Accepted: 7 April 2023

Abstract. This paper suggests a way to cluster Ukrainian regions by using economy and creativity-related multiparametric sets so as to reveal the main roles of players in cross-regional comparisons. Special attention was paid to an analysis of invaded regions since 2014 and 2022. The methodology is based on a consistent utilisation of structured analysis, correlation, regression and clustering modelling. Sets of parameters were selected from secondary data via correlation and regression analyses aimed at defining the most impactful factors. The study sample includes 25 regions in Ukraine. The research results contribute mainly to the theorisation of comparative regional analysis and to the relationship between the economy and creativity and their specific behaviour in regions directly linked to war crisis.

JEL classification: C10, O18, O34, O52, R12, R15

Key words: regional comparisons, economy, creativity, culture, clustering, Ukraine

1 Introduction

Regional economic development depends heavily on a capability to connect local factors in a way that results in an effective and efficient use of economic resources and high economic outputs.

These connections are dynamic and transform with changes in direct and indirect business environments with a further evolving of new structures, components and relationships.

In recent decades, creativity, as a developing economic resource and an element of business ecosystems, has received special attention ([Howkins 2001](#), [Kaufman, Beghetto 2009](#)). Its importance then grew dramatically upon its consideration as a booster of both economic activities and as a foundation for a newly formed notion of creative sectors. Even though this paper does not aim to explore the issue of creative industries directly, it is worth mentioning that many international organizations and countries, following the first governmental attentions to this area ([Government of Australia 1994](#), [UK Government's Department for Culture, Media and Sport 1998](#)), and after decades worth of studies on the concept, began adopting similar high-level policies and programs ([Mt. Auburn Associates 2000](#), [DeNatale, Wassall 2007](#), [UNESCO-UIS 2012](#), [UNESCO 2013](#), [Boix-Domènech, Rausell-Köster 2019](#)).

As a result, many countries, including Ukraine, began investigating a structured collection and utilisation of domestic statistics from creative and cultural economic activities, along with their types and industries (Vakhovych, Chul' 2014, Davymuka, Fedulova 2017, Farinha 2017, Skavronska 2017). Key goals were to align with international approaches and achieve a more open format to facilitate a broader public dissemination (Sotnikova 2017, Skavronska 2017). In this context, a recent report by the Ukrainian government indicates a steady annual growth of creative sectors for the period 2013-2018, reaching a 3,86% share of total value added across all industries, and an increase of 30% over this period (Ministry of Culture and Information Policy of Ukraine 2020). This is comparable to shares in developed countries, the same indicators in the USA (2019) and UK (2018), for example, are respectively 3,0% and 2,7% (OECD 2021). Of course, the absolute values and the structure of industries will differ significantly. Many Ukrainian regions, including those invaded or already de-occupied, due to their previous experience or remaining creative activities can develop unique paths for economic and cultural revival in such complicated circumstances.

Creativity is receiving increasing attention in many emerging and developing countries which expect to change their traditional ways of development through undertaking a creativity model and introducing it widely across economic activities (Barrowclough, Kozul-Wright 2008, Jakusenko, Kalasnikova 2012, Satrio et al. 2021). The recent report by UNCTAD (2022) specifically emphasises how new technologies can be helpful in reaching these goals.

However, the question regarding an exact definition of creativity and its relation to economic outputs remains open, and it seems there will be no visible progress in achieving consensus on this in the near future (Plucker, Beghetto 2004, Hennesey, Amabile 2010, Lazzeretti, Capone 2015), although in some papers there is a strong appeal to develop a common definition (Markusen et al. 2008).

Thus *the main purpose* of this paper is to define economy and creativity-related regional multiparametric clusters and to interpret the discovered concentrations, emerging hierarchies and disparities in analysed regional groupings, and with a special focus on regions under invasion since 2014 and those invaded since 2022.

Towards this goal, the paper is structured as follows. In the literature review, several domains of research are analysed: creativity as a term and its different perspectives, mutual connections between the economy and creativity, and the role of creativity in regional development. Next, the methodology used is described as a combination of three approaches: regional structural analysis, correlation and regression analysis and regional clustering. Finally, the research results with policy recommendations are developed and the discussions and conclusions are described.

2 Literature review

The literature review which follows is designed to focus on several research tasks: understanding creativity, its domains and relations to economy; and links between the economy, creativity and a regional context. Explaining the previous research results aims to understand why it is important to consider regional roles based on economy and creativity multiparametric concentrations.

2.1 Understanding creativity criteria and classifications

Initially, when creativity as a term started appearing in research in the 1920-1950s, the main focus was on creative personality and creative thinking techniques (Hennesey, Amabile 2010). Later, originality (novelty) and effectiveness were identified as distinctive features in the standard definition of creativity, generalised among others by Runco, Jaeger (2012). In the historical overview of the term's evolution in publications in 1950-1960s there was a consistent emphasis on a bipartite nature of creativity, and the contrary terms of pseudocreativity and quasicreativity were used to explain the absence of a product's effectiveness. In contemporary research, the same double-edged approach to creativity is used as in the standard definition (Ritchie 2007), but many others have suggested using a

larger number of criteria (Boden 2004, Simonton 2012, Amabile, Pratt 2016, Sternberg 2018, Kaufman, Glaveanu 2019).

An interesting question in discussing creativity arises in connection with knowledge: whether it is important for creativity or not. Although some authors tend to argue that there is no need for specialised knowledge in this case, it is growing more widely accepted that knowledge is necessary for achieving a creative novel result (Cropley 2011). Previously, creativity has been understood as a separate stream because of the existence of a related creative class who are the possessors of such knowledge (Florida 2002). Subsequently, the latter concept was somewhat oppositionally re-analysed (Pratt 2008).

In turn, the need for novelty and effectiveness as distinctive creativity characteristics appeared to be the same as those used by some countries for patenting inventions (Simonton 2012); among them are requirements to be new, useful and nonobvious (surprising). This explains why a perception of intellectual property objects as creativity products is so commonly and widely held.

The broader sense of the term creativity has been adopted in recent papers by Cerisola (2018), where the author distinguishes three types: artistic, scientific and economic, using the UNCTAD (2010) classification for this purpose. The more recent UNCTAD report (2022) suggests greater success would be achieved by including artistic, cultural and industrial aspects of creative economy. This conceptual approach was also applied for analysis in subsequent parts of the present paper.

2.2 *Creativity, culture and economy*

As mentioned above, in recent decades creativity has started to be considered as a very important resource for the economy (Bakhshi et al. 2008, Trüby et al. 2008, Kaufman, Beghetto 2009, UNESCO 2013). This growing emphasis on the importance of creativity started in the 1990s along with an extension of research into it and potential fields of applications (for example, the learning economy by Lundvall, Johnson 1994). Consequently, a huge variety in definitions appeared (Hennessey, Amabile 2010) or attempts at defining the term were simply abandoned.

In the latter part of that decade the UK Department for Culture, Media and Sport (DCMS) prepared the *Creative Industries Mapping Documents*, paying special attention to certain types of industries based on creative activities. Although the list of industries was specified, the definition they gave was quite broad (as widely quoted in later research, including for example Potts, Cunningham 2008): “Creative industries is a new analytic definition of the industrial components of the economy in which creativity is an input and content or intellectual property is the output”. Because creativity itself is a difficult term to measure, creativity products in the form of intellectual property can serve well for this purpose.

However, in some of research there was often an attempt to use the term “creativity” in a sense heavily weighted to cultural activities; and because “everything is cultural”, this generated some opportunistic discussions. In fact, many authors have conceptually connected the term “creativity” with art, artistic types of activities, and literature, rather than with other types of creativity, and that indeed was traditionally well accepted. Culture was considered in those works and documents as a core part of creativity or they are both articulated in such closeness that were perceived to be a truly integrated (Mt. Auburn Associates 2000, DeNatale, Wassall 2007, Markusen et al. 2008).

In other research, by contrast, it was said to be necessary to consider a broader definition of creativity, based on its occurrence in a wide range of different economic sectors. On these grounds, two domain groups of creativity were distinguished in research – aesthetic (artistic/cultural) and functional (economic) (Cropley 2011). They were also used in other investigations in conjunction with scientific creativity (for example, UNCTAD 2010, Cerisola 2018). Some authors view creativity as a mediator between culture and economy (Capello et al. 2020).

The recent two decades of the information era brought to our attention new relations between “knowledge, information, creativity, innovation, and economic structure and growth that are enabled by digitally networked information and communication technologies” (Flew 2015), which clearly vary from country to country. This approach was

previously strengthened by embedding innovations in many cultural activities (UNCTAD 2010, Sacco 2011) and further supported by new investigations of UNCTAD (2022).

As can be seen from a review of the literature, the discussion regarding an appropriate definition of creativity has resulted in a wide diversity of approaches and types of investigation in this area. Researchers have tried to reveal not only the direct outputs of creative industries, but also the relational impact of creativity on economic development in general (Cerisola 2018, Capello et al. 2020), and that is also among the tasks in the present article. These authors and indeed many others suggested that creativity and culture have a much wider effect, in that they influence the economy both directly and indirectly, and have a stabilizing impact on society, economy and territories (Bakhshi et al. 2008, EU 2010, Davymuka, Fedulova 2017, Lazzeretti et al. 2017, Cerisola 2018, Capello et al. 2020). The OECD (2021) concluded recently: “The economic footprint of cultural and creative sectors is even larger. The value-added generated directly by the sector itself does not reveal its full importance, particularly as it has large backward linkages in the economy that drive upstream production...”

Thus, on the basis of the literature analysis above, and for the purpose of the present research, the use of the term “creativity” is suggested to be spread over various domains: (1) scientific creativity, consisting of two sub-domains – industrial and copyright intellectual property; (2) aesthetic creativity (embedded in art and culture symbols, artefacts and activities); and (3) economic or functional creativity (with reported innovations). This scheme allows for a better analysis of the impact of creativity on the economy as a whole and is the one used in the methodology part of the present study, below.

2.3 Creativity, culture and regional economic context

Since the 1990s the importance of relations between creativity, culture and economic development has also been emphasized in regional and territorial research.

Regional researchers study both tangible (Lash, Urry 1994, Zukin 1997, Martins 2020) and intangible (Swedberg 1998, Tabellini 2010) culture that impacts economic development and, as a part of it, an innovative process, and also try to analyse the way they are embedded into local space (Simonsen 2001, Gregson et al. 2001, Landry 2008, Capello et al. 2020).

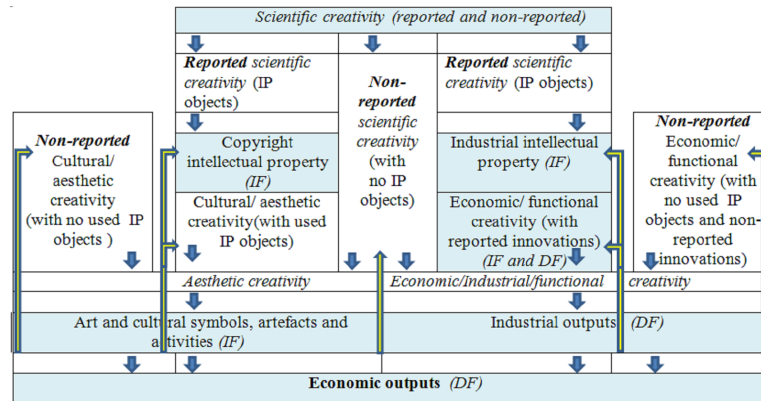
In recent research, cultural resources have also been investigated as a part of the cultural ecology (Gross, Wilson 2019). Authors have shown that, being a part of the eco-system, cultural activities can, besides their impact on site improvement, also deliver additional jobs, provide a platform for communication and exchanges of ideas, and thereby favour creativity and innovation processes. It is worth mentioning a useful and quite interesting taxonomy of cultural assets in local contexts provided by Capello et al. (2020).

In this connection, researchers have also focused their attention on concentrations of creativity in certain places. Some of them investigate determinants of creative industry locations (Serra 2015, 2016), others devote their attention to the spatial and agglomeration patterns of their location and co-location (Boix et al. 2014, Coll-Martínez, Arauzo-Carod 2017). However, there is a gap in the literature linked to the economy of agglomerations and creativity density in the less developed regions and those under crisis.

As a summarising remark in this literature review, it can be safely concluded that creativity does clearly influence economy and locality (Florida 2002, Bakhshi et al. 2008, Cerisola 2018, Capello et al. 2020, Comunian 2019, Australian Academy of the Humanities 2019, UNCTAD 2010, 2022), and vice-versa (Figure 1).

However, the UNCTAD (2010) document also indicates a fourth component – technological creativity. For the purposes of the present study this was considered as a part of economic creativity and is not treated as a separate type of creativity. Instead, the UNCTAD (2010) scheme has been modified in such a way to highlight the regional context (Figure 1), which provides (or fails to provide) possibilities for the economy and creativity to be integrated and mutually benefit from cooperation and/or co-existence. The latter is an important dimension in the framework of the present study.

The combination of the various different effects and impacts of creativity on the economy as a whole, in terms both of their possible two-sided interaction as well as their individual direct contribution, leads to a more creative, culturally oriented, flexible,



Note: IF – independent factor; DF – dependent factor; coloured cells illustrate availability of measured indicators. Source: Modified by the author and based on UNCTAD (2010, 2022), Cropley (2011), Cerisola (2018)

Figure 2: Structure of creativity domains and links to economic outputs

For these reasons, for the purposes of the present study, two groups of parameters were included in the analysis using conceptual schemes developed (Figures 1 and 2). On the one hand, the parameters of economic outputs (dependent factors) and, on the other, a group of independent creativity parameters covering: (1) scientific creativity (intellectual property objects), (2) cultural creativity (material cultural objects), and (3) economic /industrial creativity. In this paper we compared the size and the structure of the suggested groups of parameters across a regional distribution in Ukraine, as well as the correlation, regression and clustering links between them, using selected indicators which were collected through accessible official sources.

The use of correlation and regression analysis is motivated by a need to reveal the density and the depth of the relational impact between dependent and independent parameters (Figure 2). This part of the research is focused on investigating the relations between various economic indicators and the group of creativity indicators, using coefficients of correlation and regression equations.

For these purposes, the following sets of economic indicators (*the dependent parameters*) were identified: (1) economic output indicators (the number of enterprises (total, large, middle, small, microenterprises and innovative ones), gross regional product, industrial and innovative production); (2) economic input parameters (FDI and domestic investments, number of tourists); (3) HR (the number of employees in general, in the research sector, in tourism, and the number of students).

Several working groups of the selected *independent parameters* were used: (1) scientific creativity indicators covering the number of applications for inventions, utility model applications (from national applicants) and the number of publications; (2) indicators of culture, including the number of cultural objects (museums, theatres, clubs, libraries, memorials and monuments) and festivals; (3) economic creativity indicators (innovative production, new to market innovative production).

The initial set of 54 economic and creativity indicators covered regionally distributed average indicators for the period 2014-2018 (State Statistics Service of Ukraine 2019) and the number of cultural objects (Ministry of Culture and Information Policy of Ukraine 2019). Selected indicators were used in different calculations as absolute values, shares, fractional ranks and transformed values where necessary for regression modelling.

The correlation density and regression features were defined using SPSS programming with the following calculations: assessment of asymmetry and normality, data transformation (if necessary), correlation analysis, and selection of significant links of high density. In our case, logarithmic (simple, double or triple) transformations were used for dependant factors of economic indicators, since the results of asymmetry and normality analysis were not sufficient for the initial data sample and, thus, the next step of correlation calculations were not ready to be undertaken. This means that all revealed pairs of cases

with a proper level of correlation have non-linear relations; they are more sophisticated for cases with double and triple transformations.

A clustering approach is used for the purpose of defining common groups of regions in Ukraine with the same level of economic and creativity concentrations. Although there is much recent research on the clustering and mapping of creativity and culture objects and activities (Higgs et al. 2008, Boix et al. 2014, Serra 2015, 2016, Coll-Martínez, Arauzo-Carod 2017, Chapain, Sagot-Duvaurox 2018, Brydges, Hrac 2019, Comunian, England 2019), this research is distinctive in terms of its cross-regional approach and the parameters and their characteristics used to complete the tasks defined above. Clustering as a tool is particularly useful in finding the stability of relations between parameters in different regional samples. For the purpose of clustering, fractional ranks of indicators analysed were involved. All calculations were processed by SPSS.

4 Results

4.1 Recent trends in the studied sectors in Ukraine

The recent report by the Ukrainian Government has indicated a significant more than three times increase of the total value added by creative sectors during 2013 – 2018 and thus reaching a level of almost 4% of their share in the in-summing amount of all industries. At the same time the number of units in these sectors grew in almost two times, and the number of employees – by almost 23% (Ministry of Culture and Information Policy of Ukraine 2020).

But which regions are more creative than others? Are there any particular areas that show concentration of creativity and economic development? Do economically leading regions differ from creative and cultural ones?

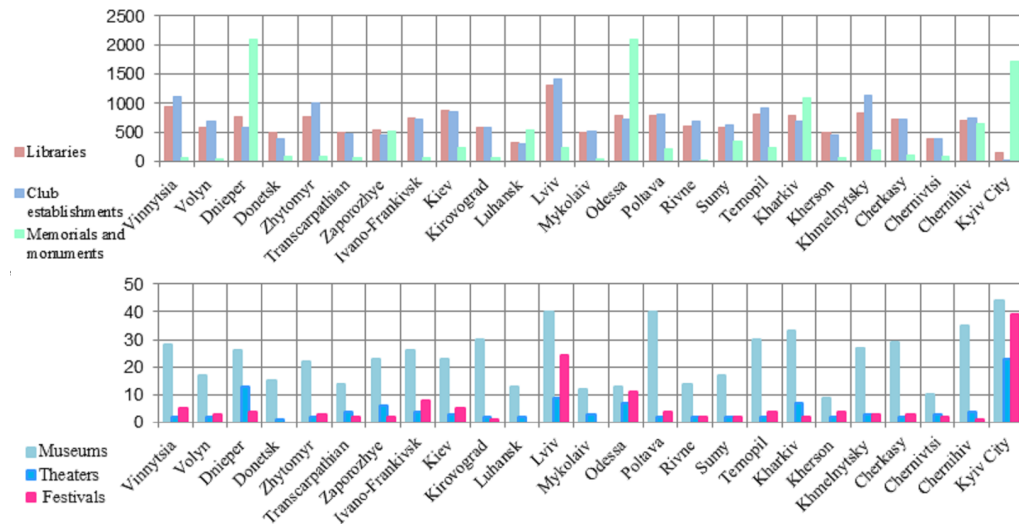
Ukraine is well-known for its cultural objects, although their role in, and impact on, the economy definitely has not been investigated fully enough. In the country as a whole, there are about 11000 memorials and monuments, 17000 club establishments, 16000 libraries, 600 museums, more than hundred theatres and almost 150 officially registered festivals, running annually (Ministry of Culture and Information Policy of Ukraine 2019). As was mentioned in connection with the Governmental report on creativity, during 2013-2018 selected cultural objects (libraries and objects of cultural heritage) and their activities transformed significantly: the number of objects grew just by 103.4%, employment by 113.4%, but value added increased almost fivefold (472.7%) (Ministry of Culture and Information Policy of Ukraine 2020).

Naturally, cultural heritage objects and activities are not distributed equally from region to region (Figure 3). There are certain leaders in cultural activities, among them Kyiv, which has the largest number of memorials and monuments, museums, theatres, and festivals. In general, the visible cultural centres are also Dnipro, Lviv, Odessa and Kharkiv.

As will be shown below, the cultural centres are also leaders in economic activities, and especially in innovative outputs (Figure 4). Thus, Kyiv City prevails in all types of enterprises; its number of micro-enterprises is about twenty times larger by comparison with some of the economically less developed regions, and the analogical proportion of large enterprises could be up to forty-five times.

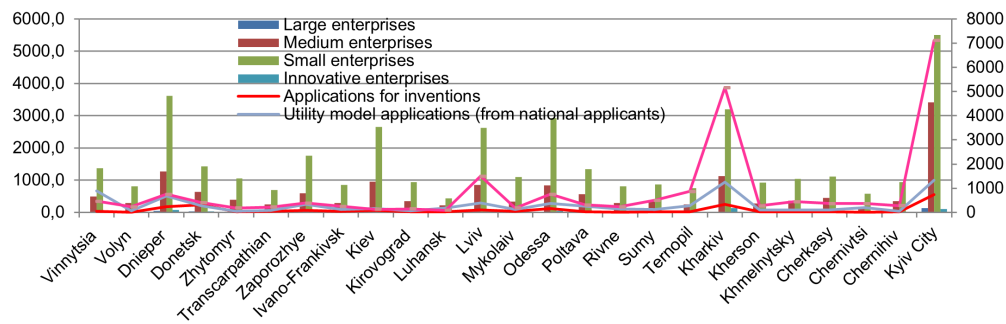
The same is true for other cultural centres. For example, Dnipro is second in terms of the number of all types of enterprises; it also has a comparatively high level of intellectual property indicators, although equal with Kharkiv, which has a comparatively high number of enterprises. Odessa leads in small and micro-enterprises, ranked third in utility model applications (from national applicants) and fourth in publishing output. By comparison, Lviv is ranked third in publications and fifth in utility model applications.

It should be noted that there are also regions with good economic production but with a somewhat lower level of cultural indicators, for example, Zaporizhzhia, however this didn't result in reaching an outlier status, as was the case with Kyiv city. Thus, the differences occurred within the acceptable dispersion of variables evaluated (see subsequent parts of this paper).



Source: developed by author, data by [Ministry of Culture and Information Policy of Ukraine \(2019\)](#)

Figure 3: Regional distribution of cultural objects and activities in Ukraine



Source: developed by author, data by [State Statistics Service of Ukraine \(2019\)](#)

Figure 4: Regional distribution of the number of enterprises and intellectual property in Ukraine

Even though this study did not aim to describe the regional distribution of IT activities as a separate part of the paper, it is worth highlighting their national trends in this analysis, because of the enormous increase in their share in creativity industries and in the economy as a whole, and their impact on other sectors' development through diffusion into other activities. During the period 2013-2018 the number of IT firms more than doubled (at 226,6%); employment grew by 182,0%, value added increased by 504,0% ([Ministry of Culture and Information Policy of Ukraine 2020](#)). In the following periods the general trends of their growth were strong as well ([State Statistics Service of Ukraine 2019](#)). They are also attractive sectors for international outsourcing contacts: more than 200 000 IT professionals are in international markets, more than 60% of Ukrainian talents are outsourced, the value of IT exports in Ukraine in 2019 reached more than 4 billion USD, and more than 20 000 IT graduates annually enter the market ([Aridi et al. 2021](#), [Ideamotive 2022](#)). As stated in some reports, Ukraine hosts more than 110 research and development centres for multinational tech companies and is a home for operations of such global giants as Apple, Boeing, Ericsson, IBM, Microsoft, Samsung Electronics, Siemens, Skype, and Oracle ([Divakova 2022](#)). During the ongoing war, many IT companies have been relocated to western regions of Ukraine, creating IT clusters and hubs there. Many moved abroad and many stayed, where possible, in their places of origin, and this allowed them to continue working, being employed and in some cases contributing to the Ukrainian economy as well.

Therefore, such facts and coincidences in the dynamics of economic and creativity

indicators are good reasons for a deeper investigation of the relations between creativity and the economy as a whole.

4.2 *The relational picture of dependencies between economy and creativity*

This part of the study covers two dimensions: the investigation of the correlation and regression between dependent (1) output and (2) input indicators, on the one hand, and creativity factors, on the other. The results of the analysis were used for further regional clustering.

It was found that some independent factors showed high connectivity with almost all dependent parameters, they are: I_{nv} , applications for inventions with the highest representation in elaborated models and also with the highest elasticity coefficients (about $0.7 - 0.75$) in some models; N_{tht} , theatres; N_{fest} , festivals; while U_{tm} , utility model applications from national applicants and N_{publ} , the number of publications were involved with reduced frequency.

Conversely, the number of different types of enterprise has the most precisely defined functional links with creativity and cultural factors, all of them highly correlate with three factors: applications for inventions (I_{nv}), the number of theatres (N_{tht}), and in some cases supplemented with the number of festivals (N_{fest}) with the highest correctness of results in some formulas at the level of 70-74% (R^2) of the sample.

The dependent parameters of production and investment showed a good relationship with the same factor of applications for inventions (I_{nv}), but supplemented with the utility model applications from national applicants (U_{tm}) and the number of museums (N_{mus}), with the highest correctness of results for 71-73% (R^2) of the sample. And finally, HR parameters including employees in research and development and tourist sectors, also demonstrated some sufficient level of correlation with applications for inventions (I_{nv}), the number of theatres (N_{tht}), and the number of festivals (N_{fest}), but the correctness of results fell down to 59-67% (R^2) of the sample.

Therefore, applications for inventions (I_{nv}) appeared to be the most frequently occurring factor with the highest presence in equations, followed by the number of theatres (N_{tht}), which was present in more than a half of equations, after that the number of utility model applications (U_{tm}), festivals (N_{fest}), and museums (N_{mus}) followed.

Interestingly, and quite expectedly, in the output models the elasticity of scientific creativity is relatively higher in comparison with Beta for parameters of culture, with the exception of tourism indicators, where the situation is the opposite. The same is true for the HR models, but again, with the exception of employment in tourism. The elasticity of scientific creativity indicators was found to be very similar to that of the enterprise number and investment input equations.

4.3 *Regional clustering, based on parameters of economy and creativity*

The aim of the next step was to define the similarities among regions in terms of co-locations of economy and creativity. For this, regional clustering was completed with the use of fractional ranks of parameters that were preliminarily selected from the correlation and regression analysis, and therefore with an already revealed level of their relational density.

Thus, regional clustering was done in several steps:

1. normality analysis of fractional ranks (FR) of the parameters;
2. correlational analysis for revealing FR's correlational density;
3. hierarchical clustering as a preliminary step;
4. k-clustering with a predefined number of clusters from the hierarchical grouping;
5. testing comparisons of clusters using different grouping methods and the respective number of regions involved in certain clusters.

For the purpose of this study at the phase of clustering, four sets of regionally distributed data were formed, with the aim of revealing the possibilities for different policy applications (Table B.1 in Appendix B and Figure 5):

1. two sets of six parameters, based on their *gross (set G6) and respective per capita (set C6) regional values*, with two indicators equally for representing the groups of economic outputs (involving GRP and FDI), creativity and cultural infrastructure;
2. two sets of nine parameters, based on their *gross (set G9) and respective per capita (set C9) regional values*, with three indicators equally for representing the groups of economic outputs (involving number of enterprises, labour and tourist parameters), creative activities and cultural infrastructure.

The results of descriptive statistics of a sample of 25 regions revealed the existence of a statistical outlier (Kyiv city), and that was quite obvious due to its extensive embodiment of the parameters analysed. This also means that Kyiv city may represent the separate single-unit cluster in all factorial groupings used for analysis. The following asymmetry and normality testing of a 24-regions-sample (excluding Kyiv city) showed that fractional ranks (FR) of selected indicators meet the necessary formal requirements and could be used for further clustering. Subsequently, the correlation testing allowed us to confirm, through checking of the sets formed of six and nine parameters, the absence of a significant density of links, which justified moving to the next phases of clustering.

At the next step, the hierarchical clustering helped to define the substantiated number of groups for the following k-centres clustering. Using the results obtained, four to six clusters was found to be the most appropriate number for the purpose defined.

Then, k-centres clustering was also done with four to six groups following a comparison of these results against hierarchical clustering. The distribution of regions into clusters using both approaches showed a good percentage of proving similarity (from 70,8% to 83,3%), confirming that the clusters are formed in correct ways (Table B.2, Appendix B).

Therefore, taking into account the above and also the obvious desire to have a more equal distribution among clusters, a four-cluster grouping was ultimately chosen for further policy development (remembering that Kyiv city remains as the additional single-unit cluster). In the analysis done, four-cluster grouping also avoided situations when clusters have only one element (with the exception of Kyiv, which was preliminarily excluded from groupings), in contrast to what we found in five- and six-cluster groupings.

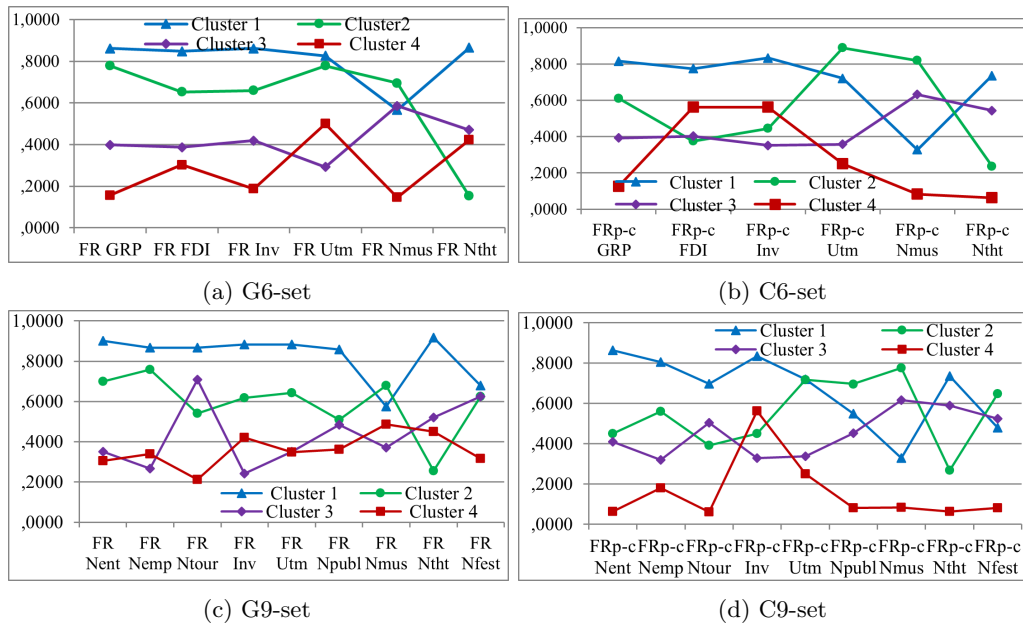
Further analysis was concentrated on clustering results. Thus, comparing the results we can conclude that cluster *number 1* is very stable and keeps almost the same set of regions under many clustering methods and with different combinations of indicators. It also possesses the highest level of summarised values of the cluster centres and consolidates the regions with almost all of the highest k-centres of parameters (Figure 5).

This cluster covers Dnipro, Zaporizhzhya, Lviv, Odesa and Kharkiv oblasts; in the case of the G6-, C6- and G9-sets it additionally involves the Kyiv region and in the case of the C6- and C9-sets it covers the Mykolayiv region. The same similarity for the core regions in each cluster is observed in other groupings of regions. The mentioned cluster clearly integrates the regions with higher parameter values and at the same time they are ones with a higher concentration of agglomerations on their terrains.

More visualisation on the disparities between clusters appeared when the clusters were compared using both the k-centres and absolute values of considered parameters in relation to the average indicators in Ukraine (Figure 6). Because the developed clusters are based on different sets of indicators and cover different regions (Figure 5), it is not possible to compare them directly; however, the results obtained illustrate quite well the general tendencies within the same regional sample (Figure 6 and 7).

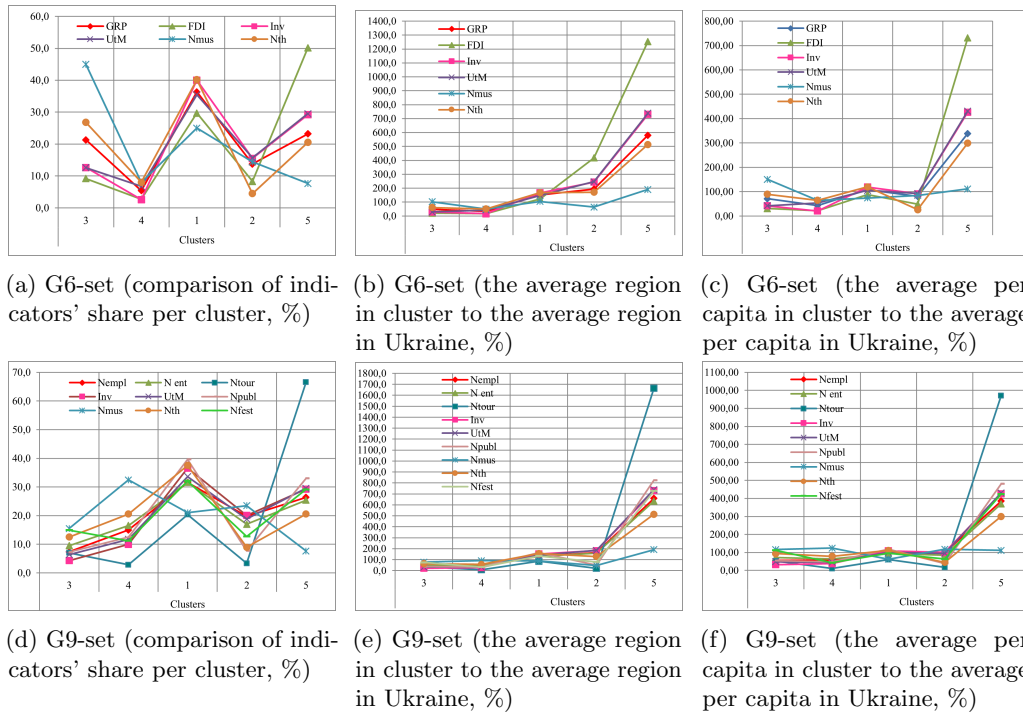
Kyiv city, previously extracted from the research as a statistical outlier, was added to these comparative diagrams, and, otherwise, the general format of clusters was kept the same as developed with k-centres approach. Kyiv city (cluster 5) demonstrates its unique competitive position in all parts of the developed graphics and mapping, despite its comparatively small area (Figure 6 and 7).

As a single-unit-cluster, it differs significantly from other clusters, and comparing it with an average region and with the average per capita from other clusters, the revealed



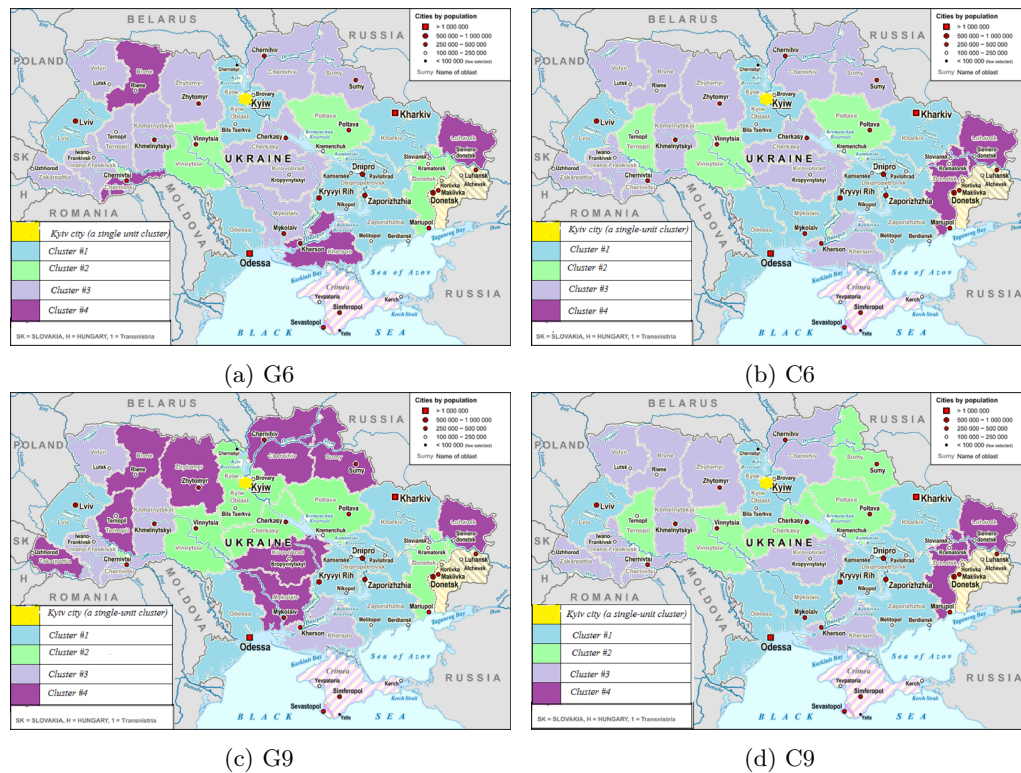
Source: Developed by author using SPSS modelling, acronyms: Table B.1, Appendix B

Figure 5: Comparative consolidation of k-centres of analysed indicators in each cluster



Source: Developed by the author; acronyms: Table A.1, Appendix A

Figure 6: Comparative distribution of shares and absolute values of analysed indicators in each cluster



Source: developed by the author, based on Figures 5 and 6

Figure 7: Mapping of clustered regions in Ukraine depending on the parametric sets used

difference is very large (Figure 6: b, c, e and f). As a separate region, Kyiv city possesses the highest FDI share (50% of Ukraine, Figure 6: a, d). Its FDI is 12 times greater than in the average region in Ukraine (Figure 6: b, e), and its FDI per capita is 7 times higher than the average FDI per capita in Ukraine (Figure 6: c, f). In almost all other indicators, Kyiv city also exceeds the average region.

Mappings of the geographical locations of regional clusters (Figure 7) were based on the results of grouping analysis (Figure 5 and 6) with a clear indication of their power weights, and thus, with a clear indication of the significant regions-stakeholders in Ukraine depending on the parameters used for grouping.

4.4 Theoretical contributions

The research results contribute mainly to the theorisation of regional comparative analysis and the relationship between the economy and creativity through defining regional clusters and their weights, hierarchy, and roles within different multiparametric sets, with special attention paid to their specific behaviour in regions directly linked to the war crisis. It emerged that in most cases, economic and creativity concentrations are localised together within the defined parameters. Crisis regions showed evidence of a degree of misbalance in the links between economy and creativity or low indicators in general.

The results can be used for general analytical and planning purposes.

4.5 Policy recommendations

The results obtained from the regional clustering with four different sets of indicators and the dynamics of some regions within the clustering process were taken into account for the development of the final regional groupings (Table 1, Figure 8).

The differences in gross and per capita indicators in regional distribution were considered important for changing the place of a given region, when it was decided to move it to lower or higher clusters within the same set of indicators, for example comparing G6

Table 1: Final groupings of regions based on cross-clustering results

Final suggestions for grouping	War crimes against objects of cultural heritage*
1) <i>Single-unit champion</i> : Kyiv city (25)	Kyiv city: 5
2) <i>Stable leaders</i> : 5 regions Dnipro (3); Zaporizhzhia (7); Lviv (12); Odessa (14); Kharkiv (19)	Kharkiv: 104; Lviv: 1; Zaporizhzhia: 18; Dnipro: 5; Odessa: 4
3) <i>Practical creators</i> : 6 regions Vinnytsia (1); Kyiv (region) (9); Poltava (15); Mykolayiv (13); Ternopil (18); Cherkasy (22)	Kyiv region: 79; Mykolayiv: 10; Vinnytsia: 2
4) <i>Learning creators</i> : 11 regions Volyn (2); I.-Frankivsk (8); Khmelnytsky (21); Zhytomyr (5); Transcarpathia (6); Kropyvnytsky (10); Rivne (16); Sumy (17); Kherson (20); Chernivtsi (23); Chernihiv (24)	Chernihiv: 38; Sumy: 28; Zhytomyr: 6; Kherson: 6;
5) <i>In need for alignment</i> : 2 regions Donetsk (4); Luhansk (11)	Donetsk: 129; Luhansk: 57

Source: developed by the author; numbering of regions are shown in Table B.2, Appendix B

* Ministry of Culture and Information Policy of Ukraine (2022a)



Source: developed by the author

Figure 8: Final mapping of regions based on cross-clustering results (*before invasion*)

and C6; G9 and C9.

However, as a result of the Russian invasion of Ukraine many economic and cultural objects were either wholly ruined or partly destroyed (Table 1).

Symbolic economic objects (as a part of economic culture) and cultural artifacts are very important for identity, including national and economic identity. Sadly, but not surprisingly, they were targeted by Russia as those to be destroyed first (the plane “Mriya”, the metallurgical plant “Azovstal” etc), and cultural objects (Opera Theatre in Mariupol, Museum of Bohdan and Varvara Khanenky, some buildings of Taras Shevchenko University etc) (Destroyed cultural heritage of Ukraine 2022).

Although statistics on economic objects are somewhat restricted during war time, the damage to cultural objects was possible to track on the site of the Ministry of culture and informational policy of Ukraine. For example, from September to October 2022 the number of damaged objects grew from 492 to 540 (Ministry of Culture and Information Policy of Ukraine 2022a,b, Destroyed cultural heritage of Ukraine 2022). It has to be stressed here that these are not the final figures; some sources have already revealed 971 damaged objects (Ministry of Culture and Information Policy of Ukraine 2022a).

All this may dramatically change the classified positions of some of the oblasts that were invaded; especially there is a concern in regard to the regions that are closely located to the Russian border as the reconstruction there will be longer and more unpredictable. The affected cities and communities in the Donetsk, Kharkiv and Luhansk regions are

examples of this.

The displacement of human resources also changed the places generating intellectual property. However, the Ukrainian regions, suffering heavily from the Russian invasion, where many economic as well cultural sectors have been significantly destroyed, are strongly motivated to use creativity in a broad sense for their economic revival.

In terms of the positions of clusters, the results obtained gave enough evidence to suggest that Kyiv (city) will remain unique with its high level of analysed indicators, which are practically unreachable by other regions (Figure 6, the fifth cluster). This is to be expected for a capital city, and means that it is best designated, for the purposes of grouping, as a *single-unit cluster*. It is also expectable that Kyiv's position would be maintained despite the invasion and consequent damage, even though it is a continued target for possible new Russian aggression.

The second cluster, the Stable Leaders, closely aligns with the position of Kyiv, but at the macro-regional level. These regions are excellently distributed geographically (with the exception of Zaporizhzhia, closely located to Dnipro), representing the regional driving centres very well. Like Kyiv city, their infrastructure is capable of supporting sophisticated high-tech, art and manufacturing projects. As was mentioned earlier, Kharkiv could potentially be moved to the subsequent group; this could also be caused by other regions' positions in the group being strengthened by the arrival of displaced enterprises. At the same time, Kharkiv, which, more than many other regions possessed a strong innovative image before the invasion, is a leading candidate for a unique creativity path in its economic revival during and after the current war in Ukraine. Having more creative sectors would lead to higher incomes and possibly allow for a decline in the share of capital intensive industries in the economy. In turn, this would improve the overall readiness for relocations if needed, and thus overall economic stability.

The third cluster, the Practical Creators, features a high level of utility model applications, especially Vinnytsia (which occupies the subsequent position after Kyiv city and Kharkiv and consistently represents this cluster in all grouping variations), Poltava and Kyiv region. As good practical applicators, they are strong candidates for the possible reception of inventions and utility models from other regions, thus, they are good partners for cooperation in knowledge exchange chains and for contributing to it too. They have also been less affected by military actions due to their geographical locations, and therefore this group may keep this position among regions in the future.

The fourth cluster, Learning Creators, represents the largest number of regions with a moderate number of indicators. These regions have demonstrated ongoing development and growth, but still require greater effort in creating economic and creativity agglomerations necessary to transfer into the third group. Potential investments and new openings should be supported under smart specialisation programs with high added value as a base for future growth and the improvement of regional economic structures. Some regions from this group that were invaded and which have suffered comparatively greater losses, could possibly move to the fifth group, especially those that will remain less safe due to their proximity to the Russian border.

The fifth cluster currently consists of only two regions (Donetsk and Luhansk) that both show quite a low level of most per capita indicators (Figure 7b, 7d, and 8). However, the Donetsk region has the third highest gross number of applications for inventions (after Kyiv city and Kharkiv), but by contrast has a smaller number of utility model applications. This is a unique position among many other regions in Ukraine, where the situation is quite the opposite. The Donetsk region occupies the fourth position in total FDI after Kyiv city, Dnipro and Kyiv region, and also in per capita indicators. These two regions (Donetsk and Luhansk) were both involved in the war conflict in the East of Ukraine from 2014, and the situation with indicators is quite understandable as the shrinkage that has occurred in their economic and cultural sectors is enormous. They are also among the regions that have suffered most since the invasion in 2022. As mentioned above, this group could possibly see the inclusion of oblasts that have experienced huge damages during the invasion and thus will be not able to recover quickly.

Apart from what has been described above, the analysis completed so far is a good source for cross-regional stakeholder analysis and policy development. For example, it

greatly helps to explain, why Kyiv city and the South-Eastern belt of regions (predominantly the stable leaders), as the most significant players, attracted special attention and were thus the first to be invaded in 2022.

From another perspective, comparisons of some regional positions (Figure 7) demonstrate that several oblasts possessing small portions in the national economy in terms of G9 indicators, show membership in the better clusters for G6 indicators (gross regional product and FDI), demonstrating the comparative efficiency of their economic structures and activities (for example, by such regions as Mykolayiv, Ternopil, Transcarpathia, Zytomyr and some others (Figure 7). Their development patterns are also a subject for deeper explorations of possibilities to use creative activities for faster advancement to higher positions in the hierarchy of clusters.

5 Discussion and conclusions

The research here presented has revealed that a large portion of attention in recent literature in the analysed field has been focused on the direct contribution of creative activities to the economic results. At the same time another part of literature has indicated that creative activities also impact the economy indirectly, providing more creative outputs and an environment for better economic results (i.e., more locations of enterprises, more employees, and forming better sites with greater attractiveness for investments, tourists and students). Therefore, the literature review, designed to highlight cross-disciplinary peculiarities, made room for the possibility of looking at creativity types as multifocal resources, which contribute directly and indirectly to the economy, and support development in many aspects; and vice versa. As a result, on the basis of selected research findings of [UNCTAD \(2010, 2022\)](#), [Cropley \(2011\)](#) and [Cerisola \(2018\)](#) the modified concept of relations between economy and creativity was developed by including (1) a regional context and (2) a reverse economic impact between components. It was also stressed that creativity has increasingly become a focus of concern in many emerging and developing countries with specific attention being paid to the role of new technologies for creative activities ([UNCTAD 2022](#)). This approach was extremely useful for Ukraine before the invasion, and has been even more so after it.

The research results have demonstrated a high density of correlation and functional regression links between many analysed indicators. The deepest relationship was revealed between, on the one hand, the different size of enterprises, investments (both FDI and domestic ones), GRP, number of employees, students, tourists and, on the other, creativity indicators, and some cultural objects, especially theatres and festivals. It is of certain interest that for static cultural objects, like monuments and museums, a much lower level of density of relations was found. Thus, an obvious conclusion is to suggest an increase of activities around static cultural objects, where possible, for example, in regard to museums (“performing museums”).

The regression equations obtained have demonstrated their complicated non-linear structure, in fact, some modifications of exponential function. The independent parameters that were mostly involved, representing creativity and culture in regressions, are applications for inventions and theatres. It can be safely assumed that they are not the only parameters impacting upon economic development, but they are clearly some kind of reflection of the general state of them, which means they appear in an environment that is already well advanced and well provided with a supporting sophisticated infrastructure. Put simply, any artificial location of, for example, a theatre in some remote place would certainly not serve to boost economic growth there. On the other hand, the indicators of creativity and culture, among others, could clearly be used as generalised indicators of site attractiveness for certain types of investments.

The results regarding regional clustering support the above conclusion, demonstrating that regions with better indicators of creativity revealed involvement into the groups with higher k-centres’ sums of economic indicators too. This conclusion is based on the reverse nature of the general model (Figure 1) in the theoretical part, and was supported by the regression functions and clustering results. From a practicality standpoint, it also means that a higher density of certain types of creativity are more likely to appear in regions

with better economic results, and vice versa.

In terms of clustering methodology, it was found that, first, using gross and per capita values as separate concurrent groupings gives a better picture with a deeper understanding of a region's position and behaviour; and, second, using several different sets of indicators gives valuable findings on the stability of clustering results, stable clusters and stable regions within the certain cluster. This method by itself is very useful for regional policy differentiation and gives the necessary information on regional convergence/divergence. Its applications could be diverse depending on the aims and indicators selected.

Finally, the clustering analysis of the positions of regions directly involved in war actions provided additional arguments for the possibility of them to achieve greater mobility and safety through implementing a creative development path. Implementing modern creative activities in crisis-stricken or less developed regions is a reliable way to improve their economic positions too. However, it requires sufficient skills and levels of education, which in turn can be improved by strong cultural values. Thus, in such places its culture serves as an engine driving core activities for developing increased creativity and a healthier economy. This is fundamentally true for any system.

In terms of future research, it is worth analysing a wider variety of indicators, specifically related to creativity, the latter including innovations and changes in industrial structure and its dynamics. Some additional analysis should be focused on the survival capacity and balance between creativity and economy in certain societies. Further differentiation within the research sample between cities and communities might well reveal more particular interesting details with regards to economy and creativity concentration and the respective links to regional areas. Lastly, special attention could be also given to deepen an understanding of the functionality of defined relations in crisis conditions and variations of relations between parameters in countries with different levels of development.

Limitations of research. The present research is limited to the sets of parameters used and to the scope of cultural indicators that are represented here mostly by the numbers of units and not by the activities. It should be kept in mind that war behaviour is highly unpredictable, and further developments can readily change some of assumptions made in this paper.

Acknowledgements

The author wishes to thank to *Zofia Stemplowska* and *Vili Lehdonvirta*, University of Oxford, for their comments and suggestions at the revision process of the paper, *Vitalia Chyniak*, Uzhhorod National University, for her help with data sorting of indicators of culture, *David Cram*, University of Oxford, and *Marion Heredia* for their helpful assistance with English grammar.

The work on the paper was sponsored by the British Academy & CARA.

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A Appendix A: Correlation analysis

Table A.1: Selected indicators and respective variables

N	Acronym	Meaning
<i>Economic indicators</i>		
1	N ent	number of all enterprises
2	N larg	number of large enterprises
3	N mid	number of middle enterprises
4	N s-m	number of small and microenterprises
5	N sml	number of small enterprises (without micro)
6	N micr	number of microenterprises
7	N inn	number of innovative enterprises
<i>Financial indicators</i>		
8	GRP	gross regional product
9	Q tot	total sales
10	Q ind	total industrial production
<i>Economic creativity indicators</i>		
11	Q inn	sales of innovative products
12	Q inn-mark	sales of new to market innovative products
<i>Tourist indicators</i>		
13	Q tour	revenue in tourism
14	Ntour	number of tourists
<i>R and D indicators</i>		
15	R and D tot-exp	total internal R and D expenditures
16	R and D fund-exp	internal expenditures for fundamental research
17	R and D appl-exp	internal expenditures for applied research
18	R and D tech-exp	internal expenditures for technical developments
<i>Investments</i>		
19	FDI	foreign direct investments
20	I d-cap	domestic investments
<i>Human resources</i>		
21	N empl	number of employees
22	N RandD-emp	number of employees in research sector
23	N stud	number of students
24	N tour-emp	number of employees in tourist sector
<i>Scientific creativity indicators</i>		
25	Inv	applications for inventions
26	Utm	utility model applications (from national applicants)
27	Npubl	number of publications
<i>Cultural indicators</i>		
28	N hist	number of monuments of history
29	N arh	number of monuments of archaeology
30	N arc	number of monuments of architecture
31	N sc-tech	number of monuments of science and technology
32	N c-build	number of monuments of city-building
33	N mon-art	number of monuments of monumental art
34	N mus	number of museums
35	N tht	number of theatres
36	N fest	number of festivals

Source: developed by the author

B Appendix B: Clustering

Table B.1: Sets of clustering indicators

N	Acronyms (absolute; per capita)	Indicators
<i>G6 and respectively C6 (G6 per capita) fractional ranks of indicators:</i>		
1	FR GPR; FR p-c GPR	GRP (gross and per capita)
2	FR FDI; FR p-c FDI	FDI (gross and per capita)
3	FR Inv; FR p-c Inv	number of applications for inventions (gross and per capita)
4	FR Utm; FR p-c Utm	number of applications for utility models (gross and per capita)
5	FR Nmus; FR p-c Nmus	number of museums (gross and per capita)
6	FR Ntht; FR p-c Ntht	number of theatres (gross and per capita)
<i>G9 and respectively C9 (G9 per capita) fractional ranks of indicators:</i>		
7	FR Nent; FR p-c Nent	number of enterprises (gross and per capita)
8	FR Nemp; FR p-c Nemp	number of employees (gross and per capita)
9	FR Ntour; FR p-c Ntour	number of tourists (gross and per capita)
10	FR Inv; FR p-c Inv	number of applications for inventions (gross and per capita)
11	FR Utm; FR p-c Utm	number of applications for utility models (gross and per capita)
12	FR Npubl; FR p-c Npubl	number of publications (gross and per capita)
13	FR Nmus; FR p-c Nmus	number of museums (gross and per capita)
14	FR Ntht; FR p-c Ntht	number of theatres (gross and per capita)
15	FR Nfest; FR p-c Nfest	number of festivals (gross and per capita)

Source: developed by the author

Table B.2: Regional k-clustering and respective testing analysis with hierarchical clustering

K-clusters	1	2	3	4	%
<i>Total gross indicators (set G6):</i>					
NR_{ECC} ¹	2;5;6;8;10;13; 17;18;21;22;24	11;16;20;23	3;7;9;12;14;19	1;4;15	
Sum CC _{abs} ²	2.5492	1.7135	4.8264	3.7153	
FRNM ³	1;18 (4)	2;6;11;13;16;20; 23 (2)	3;4;7;8;9;12;14; 19 (3)	5;10;15;17;21; 22;24 (1)	70.8
MM ⁴	1;10;15;18;21; 22;24 (1)	2;5;6;11;13;16; 17;20;23 (2)	3;7;8;9;12;14;19 (3)	4 (4)	70.8
<i>Per capita indicators (set C6):</i>					
NR_{ECC}	2;5;6;8;10;16; 17;20;21;22;23; 24	1;15;18	3;7;9;12;13;14; 19	4;11	
Sum CC _{p-c} ²	2.6788	3.3750	4.2054	1.6458	
ABGM ⁵	2;5;6;8;10;11; 13;16;17;20;21; 23;24 (1)	1;18 (2)	3;7;9;12;14;15; 19;22 (3)	4 (4)	83.3
CM ⁶	1;2;5;6;8;10;11; 13;16;17;18;20; 21;22;23;24 (1)	3;7;9;12;14;19 (3)	4 (4)	15 (1)	83.3
<i>Total gross indicators (set G9):</i>					
NR_{ECC}	5;6;10;11;13;16; 17;18;24	2;8;20;21;23	3;7;12;14;19	1;4;9;15;22	
Sum CC _{abs9} ⁷	3.2384	3.9167	7.4292	5.3250	
AIGM ⁸	2;5;6;10;11;13; 16;17;20;23;24 (1)	1;8;15;18;21;22 (2)	3;7;9;12;14;19 (3)	4 (4)	70.8
WM ⁹	1;4;8;9;15;17; 18; 22 (4)	5;6;10;11;13;16; 20;21;23 (1)	3;7;12;14;19 (3)	2;16;20;21;23 (2)	83.3
<i>Per capita indicators (set C9):</i>					
NR_{ECC}	2;5;6;8;10;16;20; 21;23;24	1;15;17;18;22	3;7;9;12;13;14; 19	4;11	
Sum CC _{p-c}	4.0813	4.9543	6.0106	1.4208	
AIGM	1;5;10;15;17;18; 22;24 (2)	2;6;8;20;21;22; 23 (1)	3;7;12;13;14;19 (3)	4;11;16	79.2
MM	1;2;5;6;8;10;15; 16;17;18;20;21; 22;24 (1)	3;7;9;12;13;14; 19 (3)	4;11 (4)	23 (2)	75.0

Source: Developed by author, using SPSS modelling

Notes: ¹ NR_{ECC} — number of clustered regions. ² Sum CC_{abs}, Sum CC_{p-c} — sum of cluster centres' values for absolute and respectively per capita values of six economic, creativity and culture indicators. ³ FRNM — Full link method (most remote neighbour). ⁴ MM — Median link method. ⁵ ABGM — Average link method (between groups). ⁶ CM — Centroid method. ⁷ Sum CC_{abs9} — sum of cluster centre values for absolute values of nine economic, creativity and culture indicators. ⁸ AIGM — Average link method (in-group). ⁹ WM — Ward method. Numbers in parentheses are the number of clusters assigned by hierarchical clustering

Regions: 1:Vinnytsia; 2:Volyn; 3:Dnipro; 4:Donetsk; 5:Zhytomyr; 6:Transcarpathia; 7:Zaporizhzhya; 8:I.Frankivsk; 9:Kyiv (region); 10:Kropyvnytsky; 11:Luhansk; 12:Lviv; 13:Mykolayiv; 14:Odessa; 15:Poltava; 16:Rivne; 17:Sumy; 18:Ternopil; 19:Kharkiv; 20:Kherson; 21:Khmelnysky; 22:Cherkasy; 23:Chernivtsi; 24:Chernihiv; 25:Kyiv (city)