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Critical Surveys Editors

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Regional Science Inquiry, Vol. XIV, (1), 2022
Editorial Note

In the first semester of 2021, the Regional Science Inquiry Journal (RSIJ), a scientific journal published under the aegis of the Hellenic Association of Regional Scientists, launches the first issue (1) of its fourteenth volume (Vol. XIII) since the first day it was published. The journal aims to freely promote the academic dialogue in Regional Science worldwide as well as to serve scientific research with solid quality standards in empirical, methodological, and theoretical contribution. To this end, this issue (RSIJ, Vol. XIV, (2), 2021) includes seven papers that were carefully selected from a large pool of candidacies for publication and comply with the journal's standards. These papers deal with timely and interesting topics of Regional research, such as polycentric and lower grade spatial structures, inequalities convergence, welfare, the digitization of the economy, investments, and regional growth, and majorly apply to the administrative and geographical scale of European Union, while two papers apply to the Russian Federation and Greece. These papers mainly build on empirical and analytic approaches, although there is a study available examining social cognition by researching primary data.

Overall, the Editor in Chief, Prof. Christos Ap. Ladias, the Editorial Board, and the signatory of this Editorial welcome the reader to the multidisciplinary journey of Regional Science that the current issue of RSIJ promises to conduct on its following pages.

In brief, the first paper entitled "*DETECTING CITY-DIPOLES IN GREECE BASED ON INTERCITY COMMUTING*", authored by Dimitrios TSIOTAS, Nikolaos AXELIS, and Serafeim POLYZOS, studies functional dipoles and polycentric structures in Greece and discriminate zones in the distribution of commuting, at three different levels of geographical scale: the intercity, the adjusted intercity (without the metropolitan regions), and the interregional. The analysis detects functional dipoles per geographical scale and reveals the distance levels where polycentric structures emerge in the setting of commuting in Greece.

The second paper entitled "*DOES EUROPEAN UNION MEMBERSHIP RESULT IN QUALITY-OF-LIFE CONVERGENCE?*", by Joel I. DEICHMANN, Dominique HAUGHTON, Mingfei LI, and Heyao WANG, investigates the perception whether European Union (EU) enlargement supports the improvement of living standards and overall quality-of-life across the continent, on data consisting of all twenty-eight pre-Brexit EU member states and eight non-member states. Special attention is paid to the population growth caused by eleven post-communist countries that joined the EU the period 2004-to 2013. The paper observes speculation on popular support for further enlargement in the wake of the 2007-08 Global Financial Crisis; the 2016-2020 Brexit process; and the ongoing COVID-19 pandemic.

The third paper entitled "*DIGITALIZATION OF ECONOMY AND LIVING STANDARDS OF POPULATION IN RUSSIAN REGIONS*, by Nadezda Vasilievna SEDOVA, Lidia Sergeevna ARKHIPOVA, Darya Mikhailovna MELNIKOVA, and Irina Fedorovna ALESHINA, examines digitalization indicators in the regions of Russian Federation and their territorial disparities, and models the indicators of living standards, as well as the use of information and communication technologies by the population and in organizations. The research configures a typology of regions according to the main indicators of digitalization and observes that, over the past fifteen years, interregional differentiation by digitalization indicators has been decreasing, while problems persist in the eastern remote and underdeveloped regions in the south of the country.

The fourth paper entitled "*MAPPING CLUSTERS IN CENTRAL AND EASTERN EUROPEAN REGIONS BASED ON FDI, REMITTANCES, AND EMPLOYMENT – A SPATIAL STATISTICS GROUPING ANALYSIS*", by Cristina LINCARU and Speranța PÎRCIOG, applies for 35 European countries, from 2013-2019, the Similarity check–Grouping Analysis ARC GIS-tool, from the Spatially Constrained Multivariate Clustering (Spatial Statistics) family, to examine (*i*) whether Central and Eastern European (CEE) and Visegrad are similar in their spatiotemporal pattern of Foreign Direct Investment (FDI) inflows and (*ii*) whether these countries are identical in their development model, described by the coordinates of FDI, remittances, and Employment. The authors distinguish inertia,

differentiation, and heterogeneity in the configuration of global patterns and observe that it is not enough to build policies to attract capital (FDI) and attract high human capital.

The fifth paper entitled "*RELEVANCE OF TYPE OF INVESTMENT FOR GROWTH: EVIDENCE FROM EU-10 COUNTRIES*", by Vladimir ŠIMIĆ and Lena MALEŠEVIĆ PEROVIĆ, investigates the effects of different types of investment on growth in a group of EU-10 economies, covering the period from 1995 to 2019, using panel data analysis. The study verifies that overall investment is strongly significant and positive, examines the importance of different types of investment for growth, and observes that not all types of investment affect growth, highlighting the importance and thus sending also an important message that it matters in which activities investment goes.

The sixth paper entitled "*INCREASING FUNDING FOR THE REGIONAL INDUSTRY OF KOSOVO AND THE IMPACT ON ECONOMIC GROWTH*, by Filipos RUXHO and Christos Ap. LADIAS, studies the role of small-medium enterprises in the economic and regional development of Kosovo, examining 103 Kosovo regional manufacturing companies in various sectors. The analysis confirms that the increase in financing in the productive sector contributes to the sustainable economic development of Kosovo and the reduction of unemployment.

The seventh paper entitled "*TOOLS OF FORMATION OF THE SYSTEM OF SOCIO-ECONOMIC SECURITY OF TERRITORIAL COMMUNITIES OF THE REGION*, by Veacheslav SHEBANIN, Iurii KORMYSHKIN, Alona KLIUCHNYK, Iryna ALLAKHVERDIYEVA, and Valentyna UMANSKA, studies the tools of formation of the system of social and economic security of territorial communities of the region and to assess the effectiveness of practical application of such instruments in the context of their regional economies. By combining methods of quantitative and qualitative analysis, the study highlights the need to ensure the socio-economic security of a given region, through the creation of effective tools for the system's formation, by taking into account the specific features of the region and its role and place in the socio-economic system, and provides insights of practical significance.

All these interesting works are available in the next pages of the RSIJ intending to promote the academic dialogue in Regional Science.

On behalf of the Editor-in-Chief and the Editorial Board
Dimitrios Tsiotas, Assistant Professor – RSI J.

Articles

DETECTING CITY-DIPOLES IN GREECE BASED ON INTERCITY COMMUTING

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Abstract

According to growth poles theory, the areas lacking critical sizes to develop polycentric structures are restricted to the development of structures of special configuration. In Greece, the development of growth poles is restricted to the emergence of "*urban dipoles*" and "*tripoles*", which are often used in the literature within a not well defined context. Based on a recently introduced method, this paper quantitatively detects functional dipoles in Greece by discriminating zones in the distribution of commuting, the number of daily movements for occupational purposes outside the city of residence. The analysis is implemented at three different levels of geographical scale, the intercity, an adjusted intercity (without the metropolitan regions), and the interregional scale. The analysis detects the functional dipoles per geographical scale and reveals the distance levels where polycentric structures emerge in the setting of commuting in Greece. Overall, this examines the applicability of a new dipoles detection method and paper provides insights into the conceptualization of hierarchy in urban structures, into the context of regional science and regional economics.

Keywords: Growth poles, urban structures, city networks, urban hierarchy, city distribution

JEL classification: R12, R40, R58

1. Introduction

The concept of city, although is easy to comprehend intuitively, is difficult to be defined within a rigorous conceptual framework because of the diverse spatial, economic, cultural, social, ideological, religious, and other characteristics describing each city (O' Sullivan, 2007; Rodrigue et al., 2013; Polyzos, 2015; Delitheou et al., 2019). Such characteristics make the conceptualization of city multivariate and even more complicated within the context of urban and regional research (Liontakis et al., 2010; Ladias et a;., 2011; Lagarias and Sayas, 2018; Napolskikh and Yalyalieva, 2019; Alexiadis, 2020), which enjoys the multidisciplinary contribution of transportation engineers (Christofakis, 2004; Tsiotas, 2020), urban and regional planners (Alexiadis and Ladias, 2011; Tsiotas and Polyzos, 2018), geographers (Ducruet, and Beauguitte, 2014; Anastasiou, 2020), economists (Korres and Tsamadias, 2009; Pougkakioti and Tsamadias, 2020; Rahmi, 2020), environmental scientists (Goula et al., 2015), even statisticians and physicists (Barthelemy, 2011; Marshall, 2018; Tsiotas, 2019). For instance, a city can be defined either according to its geographical coverage (Christofakis, 2004; Polyzos, 2015; UN, 2018), or its location and geomorphology (Sorensen, 2001; Xanthos et al., 2012, 2013; Arvanitidis, 2014; Cepaitiene, 2015), or its major economic functionality (Meijers, 2007, 2008; Duncan et al., 2013), or its population size (de Lavergne and Mollet, 1991; Rastvortseva and Manaeva, 2016; Tsiotas, 2016), or even its role in a transportation network (Mitoula et al., 2013; Rodrigue et al., 2013; Polyzos and Tsiotas, 2020). Therefore, many diverse terms determining cities are available in the literature, such as

regional metropolises (Ladias et al., 2011; Duncan et al., 2013; Polyzos and Tsiotas, 2020; Tsiotas et al., 2021), which are central economic actors in their regions; capital cities (Gottman, 1983; Theodoropoulou et al., 2009), which concentrate the majority of administrative and governance functions of a country or region; gateways (Rodrigue et al., 2013; Delitheou, 2021; Tsiotas et al., 2021), which facilitate the entrance to certain economic or administrative functions; medium and small cities (de Lavergne and Mollet, 1991), which are defined within certain population ranges; strategic cities (Soldatos, 1991), which are located at places of strategic and geopolitical importance; satellite cities (Sorensen, 2001), which depend their development on other bigger neighbor cities; rural cities (Xanthos et al., 2012, 2013; Polyzos, 2015), which base their economies on the primary productivity sector; borderline cities (Cepaitiene, 2015), which are located at the country's borders; global cities (Cepaitiene, 2015; Giannakis and Papadas, 2021), which are of great importance in terms of global economic networks, and much more (O' Sullivan, 2007; Polyzos, 2015; Tsiotas et al., 2021).

These multidisciplinary approaches upgrade the level of complexity of urban studies even in those cases where only one city is examined. For instance, in big cities, several activity-spaces emerge at different geographical locations within the city borders, developing thus different functional areas in the city-structure (Goula et al., 2015; UN, 2018; Polyzos, 2015, 2019), such as the city proper (which is the core of the socioeconomic and cultural urban activities), the area of urban agglomeration (where considerable activity is observed due to population density), and the metropolitan area (which is the zone of socioeconomic interaction with the urban centers). In the light of studying the development of urban systems in geographical space, several theories and models have been proposed in the literature (Dacey, 1965; Parr; 1973; King, 1985; Henderson, 1991; Baccini, 1997; Miller et al., 2004; O' Sullivan, 2007), the majority of which built on two fundamental theories (Rodrigue et al., 2013; Polyzos, 2015, 2019), the central place theory, introduced by Christaller and Losch (Dacey, 1965; King, 1985l; Polyzos, 2015, 2019) and the growth-poles theory, introduced by Perroux (Parr; 1973). The first one describes a hierarchical geometric procedure in urban development, where polygonal relations of vertical functional flows emerge between cities of different hierarchy, while the second one suggests a discrete (node-based or network-based) approach of urban development, where horizontal relations and functional flows emerge between cities regardless of their size.

Despite the effectiveness of these major theories (and of their modern derivatives) to describe motifs and pattern-structures in the development of urban systems, all such approaches are restricted to conceptualize centrality and connectivity of urban systems within a disciplinary framework depending on the researchers' background. This can be evident by various terminologies describing urban systems and their structural elements, such as urban networks (Dupuy, 2008), "*réseux des villes*", "*stadtenetze*", and city networks (Smith et al., 2001; Jaglin, 2012), tri-poles (Tsiotas et al., 2021), satellite cities (Sorensen, 2001), bipolar neighborhood (Galster and Booza, 2007) and bipolar cities (Verrest and Jaffe, 2012), urban dipoles and city dipoles (Cerniauskaite et al., 2008; Metaxas, 2009; Zidonis and Jaskunaite, 2013), urban cores and urban centers (Choudhary, 2012; March and Martin, 2012), hubs and gateways (Rodrigue et al., 2013; Tsiotas and Polyzos, 2018), metropolises (Rodrigue et al., 2013), and more, which imply the diverse and multidisciplinary conceptualization of fundamental notions of polycentric development in urban systems. Obviously, the polyphony in this area suggests, on the one hand, a major drive for promoting urban research but, on the other hand, it highlights the demand of integration across the diverse conceptualization of urban structures, in the light of developing a common vocabulary amongst urban science's researchers originating from various disciplines.

An open debate that can be found in academia is the diverse conceptualization of urban or city dipoles (Davis, 2006; Galster and Booza, 2007; Cerniauskaite et al., 2008; Metaxas, 2009; Hudson, 2010; Verrest and Jaffe, 2012; Zidonis and Jaskunaite, 2013; Mallach, 2016). In current literature, an urban dipole suggests a specialization of the growth pole theory (in the case of two cities) and is generally defined by the coexistence of two (usually, but not necessarily, neighbor) cities belonging to a broader urban system, which are developing links that make them seen (or behave) as a couple. Cities composing an urban dipole are supposed to be equivalent in size, to share similar roles in the way they serve their hinterland (Metaxas,

2009), and to develop bonds of synergy or cooperation (Tsiotas et al., 2021). In the Greek literature (Metaxas, 2009; Tsiotas et al., 2021), the urban dipoles that are reported are Larissa–Volos (~144k citizens-120k citizens, with an intermediate distance of 64.1km), in the region (NUTS II) of Thessaly (), Kavala-Xanthi (~54k citizens-56k citizens/ 53.4km), Kavala–Drama (~54k citizens-44k citizens/ 36.8km), and Drama–Xanthi (~44k citizens-56k citizens/ 87.6km), in Eastern Macedonia and Thrace (), Tripoli–Kalamata (~30k citizens–54k citizens/ 82.3km), Patra-Aigio (~205k citizens-26k citizens/ 38.2km), in Peloponnesus (Athanasopoulou et al., 2011; Tsiotas et al., 2021), and Kozani-Ptolemaida (~41k citizens-32k citizens/ 87.6km), in Western Greece (Tsiotas et al., 2021). Further, in Lithuania (Cerniauskaite et al., 2008; Zidonis and Jaskunaite, 2013), the cities Vilnius-Kaunas (~545k citizens-295k citizens/ 103km), which belong to different (NUTS II) regions (LT00A and LT002, respectively), are reported as an urban dipole, while, in the international literature we can find a reference (Davis, 2006) to the cases of Tokyo–Shanghai (~9,270m citizens-24,24m citizens/ 1’780km) and New York-London (8.6m citizens-8.9m citizens/ 5’890km) as “*world city dipoles*”.

The diversity observed in the population size, distance, and regional configuration of the previous cases implies that, in the current literature, the conceptualization of urban dipoles probably builds more on attributes concerning the qualitative aspects (welfare, productivity, occupation opportunities, level of technology, constitution, etc.) of the cities participating to these dipoles rather than on structural characteristics related to space (geography), size, and regional (or urban) configuration. This observation implies that any attempt to define urban dipoles within a structural context (which concerns either the socioeconomic, or size, or geographical features of the cities participating to the pole configurations) is by default indefinable because of the multidimensionality describing cities when are seen as market places. Such indefinability is even supported by the fact that current literature does not succeed to determine even whether the roles of cities within urban dipoles are competitive or cooperative (synergetic). For, instance, the cities of the dipole Larissa-Volos, in the region of Thessaly, Greece, on the one hand, share cooperative roles in attracting non-local enterprises (), while, on the other hand, they compete, for instance, in the development of public university, or hospital, or ministerial infrastructures (Polyzos, 2019). Therefore, in contrast to the physics (Serway, 2004; Griffiths and Schrieter; 2018), where the poles of a magnetic or electrical dipole are by definition heteronymous and cooperative in the development of their electromagnetic fields, in the context of urban science, the concept of urban dipoles appears, first, not well-defined and, secondly, counter-intuitive to its concordant conceptualization (i.e. of the magnetic or electrical dipoles) in physics. Consequently, any attempt to study urban dipoles within a well-defined context should build on their functionality rather than on their structure, where functionality can be easily measurable and convertible to variables, based on the type of the dipole flows. Toward this demand, this paper conceptualizes urban dipoles within the context of commuting flows, which is a functional aspect of daily labor exchange between places, and applies probabilistic and statistical analysis on available empirical data from Greece to define functional commuting urban dipoles within a well-define quantitative context.

In general, commuting is the daily mobility for labor purposes outside the city of residence, it suggests an act of spatial and economic interaction between neighbor regions, and is of great importance for urban and regional research because it develops spatio-socioeconomic structures at different scales such as interurban, regional, and similar (Rodrigue et al., 2013; Polyzos, 2019). This phenomenon has many dimensions, an economic related to transportation-cost (Van Ommeren and Fosgerau, 2009; Tsiotas and Polyzos, 2021) and to the relationship between commuting and productivity (Van Ommeren and Rietveld, 2005), a sociologic related to the psychology of mobility (Koslowsky et al., 1995), a technical related to traffic and accident analysis (Ozbay et al., 2007), a behavioral related to the selection of transportation modes and alternative routing (Murphy, 2009; Liu and Nie, 2011), and others, such as political, technological, etc (Polyzos, 2019). Despite its multivariate nature, commuting sufficiently describes labor interaction between cities, which are seen as labor markets (Rodrigue et al., 2013; Polyzos, 2019), and thus it configures an adequate functional framework for the definition of urban dipoles. Based on the flows intensity, this paper detects significant commuting flows based on a method proposed by Tsiotas et al.

(2021), defining urban dipoles in respect to the significant cases resulted from the analysis. The results are evaluated in accordance with the literature of urban dipoles in Greece and with other empirical findings of the Greek regional economics.

Within the context of the growth poles theory (O' Sullivan, 2007; Polyzos, 2019), this paper studies urban dipoles, which are often overlooked in the literature, building on a dipole detection method introduced by Tsiotas et al. (2021) in the context of network science (Barabasi, 2016). The overall analysis contributes to the demand of integration in the conceptualization of urban structures and promotes interdisciplinary research in urban science amongst researchers originating from various disciplines, by using a common vocabulary and a new method (Tsiotas et al., 2021) for defining and detecting urban dipoles according to a functional attribute.

The remainder of this paper is organized as follows; Section 2 describes an integrated terminology about dipoles in network structures, along with the conceptual and the methodological framework of the study. Section 3 shows the results of the analysis and discusses them within the context of regional and urban science and the relevant Greek literature. Finally, in Section 4, conclusions are given.

2. Methodology and Data

2.1. Functional dipoles: integrating their conceptual framework

An integrated conceptual framework and terminology about dipoles in urban network structures, builds on some elements of network science (Newman, 2010; Brandes et al., 2013; Ducruet and Beauguitte, 2014; Barabasi, 2016: Tsiotas, 2019), which is a newly established discipline emerged by the multidisciplinary study of connectedness. Network science uses the network paradigm to study communication systems and to model network structures to graphs, consisting of sets of nodes (interconnected units) and edges (their connections). Within this framework, geographical systems of socioeconomic interaction can be modeled into spatial networks, which are graphs embedded in the geographical space (Barthelemy, 2011; Tsiotas and Polyzos, 2018). In a network structure $G(V,E)=\{V,E\}$ consisting of a pair-set $\{V,E\}$ of nodes V and links E (Newman, 2010), the elementary expression of network connectivity is by definition an edge (or link) $(u,v)=e_{uv}\in E$, which represents the (either physical or immaterial) connection between two network nodes $u,v\in V$. However, a network edge $e_{uv}\in E$ does not by definition suggest a dipole-structure because it does not include the nodes participating to the connection. Therefore, a definition of a dipole based on network elements builds on a pair-set (Tsiotas et al., 2021):

$$b(u,v)=\left\{\{u,v\in V\},\{(u,v)\in E\}\middle| V,E\in G\right\} \quad (1),$$

consisting of two network nodes $u,v\in V$ along with their connection $(u,v)\in E$. By considering binary connections, the structure $b(u,v)$ can be seen as a "*binary dipole*", to the extent that it represents a (non-polarized) dipole-structure in a connected system (network) free of flaws (wherefrom the term binary stands for). Moreover, for binary directed (polarized) networks, node polarity is defined by the formula:

$$\mathrm{sgn}(u,v)=(-,+) \quad (2),$$

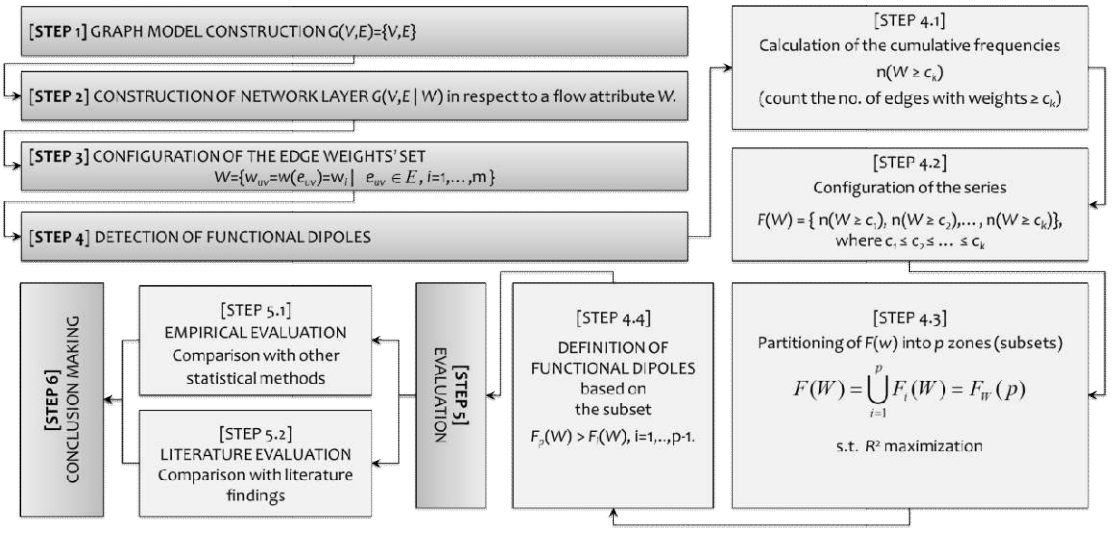
where: $\mathrm{sgn}(\cdot)$ is the signum (or sign) function; the first node in edge (u,v) represents the south (negative) pole ($\mathrm{sgn}(u)=-$) in the dipole; and the second node represents the north (positive) pole ($\mathrm{sgn}(u)=+$). The direction of the flow expressed by the edge (u,v):$u_{(-)}\rightarrow v_{(+)}$ complies with the marking of outgoing ($u\rightarrow v$:+) and incoming ($u\leftarrow v$:–) flows from node u. Within this context, a polarized binary dipole is defined as as $b(u_{(-)},v_{(+)})$, provided that directed edges $e_{uv}\in E$ exist in the network. For weighted networks, binary dipoles are equipped with weights ($w(u,v)=w_{uv}$) expressing the flow intensity of their edges. Within this context, weighted network structures $b_w(u,v)$ represent "*weighted dipoles*", defined in respect to an attribute W determining edge weights $w_{uv}=W(u,v)$ in the network. In weighted dipoles $b_w(u,v)$ of directed networks, polarity can be defined so that the negative pole ($\mathrm{sgn}(u)=-$) to be assigned to the node satisfying the inequality $w_{uv}-w_{vu}>0$.

However, in urban networks, not all weighted dipoles develop significant flows to be considered as urban dipoles in the context of urban and regional science. Such specialized structures are called "*functional dipoles*" (in respect to an attribute W), representing weighted dipoles $b_w(u,v)$ of significant flows in the network structure, as expressed by the relation (Tsiotas et al., 2021):

$$b(u,v \mid W)=\{b_w(u,v) \in G(V,E) \mid w_{uv} >> \left\langle w_{ij} \right\rangle \} \quad (3),$$

where $i,j \in V$ and $(i,j) \in E$, $\left\langle w_{ij} \right\rangle$ is the average edge weight, and $w_{uv} >> \left\langle w_{ij} \right\rangle$ is a filtering condition expressing that the edge weight w_{uv} is significantly greater than the average value $\left\langle w_{ij} \right\rangle$. According to relation (3), an urban dipole in the context of urban science and growth poles theory (Davis, 2006; Galster and Booza, 2007; Cerniauskaite et al., 2008; Metaxas, 2009; Hudson, 2010; Verrest and Jaffe, 2012; Zidonis and Jaskunaite, 2013; Mallach, 2016; Tsiotas et al., 2021), can be well-defined in terms of network science as a functional dipole $b(u,v \mid W)$ in respect to an attribute W, provided that the filtering condition $w_{uv} >> \left\langle w_{ij} \right\rangle$ can be quantitatively defined. In a recent work, Tsiotas et al. (2021) developed a statistical mechanics method to quantitatively defined urban dipoles, as described in the conceptual diagram of Fig.1.

Fig.1. Conceptual diagram of the method used for defining a functional dipole in respect to a flow-attribute W (own elaboration).



In particular, at the first step (Fig.1) of the method, we construct a graph model $G(V,E)=\{V,E\}$ representing a network structure. For a multilayer network (consisting of different layers corresponding to various types of network weights, such as distance, trade flows, labor flows, information flows, capital flows, etc.), we choose in the second step a single flow-attribute W, in which we define functional dipoles. At the third step, we convert the weights matrix of the certain attribute into a vector set $W=\{w_{uv}=w(e_{uv})=w_i \in E \mid i=1,2,\ldots,m\}$, where m is the number of network edges ($m=|E|$). At the fourth step, we define functional dipoles (for attribute W) according to an algorithm developing a partition that fits the best possible parametric curves in each compartment. To do so, we configure first a series of flow thresholds $c_1(W)=c_1 \le c_2 \le \ldots \le c_k$ (k is a natural number sufficiently large to produce a set of frequencies that will be further decomposed into compartments) and then we calculate the cumulative frequencies, according to the relation (Tsiotas et al., 2021):

$$n(W=\{w_i \in E\}_{i=1,2,\ldots,m} \ge c_k) = n(W \ge c_k) \quad (4),$$

expressing the number of edge-weights that are sequentially greater than the values $c_1 \le c_2 \le \ldots \le c_k$. Next, we configure the series of these frequencies, according to the relation (Tsiotas et al., 2021):

$$F(W) = \{n(W \geq c_1), n(W \geq c_2), \ldots, n(W \geq c_k)\} = \{n_1, n_2, \ldots, n_k\}, \quad (5).$$

Therefore, we define a partition $F(W) = \bigcup_{i=1}^{p} F_i(W) = \bigcup_{i=1}^{p} F_i = F_W(p)$ of the set F(W) into p pair-wisely independent ($F_{i=1,\ldots,m}(X) \bigcap F_{j=1,\ldots,m}(X) = \varnothing$, $i \neq j$) subsets (compartments or zones) $F_i(W)$, which is submitted to the following restrictions:

$$F(W) = \bigcup_{i=1}^{p} F_i(W) = \bigcup_{i=1}^{p} F_i = F_W(p)$$

s.t.

$$\begin{aligned} &i)\ n\left(F_i\left(W\right)\right) \equiv card\left(F_i\left(W\right)\right) >> 3, \\ &ii)\ \text{if } f_1(x), f_2(x), \ldots, f_j(x) \text{ are the best fitting curves than can apply to the compartments of a series } F_W(j), \text{ we choose the partition } F_W(p) \text{ that satisfies the criterion } < R^2(f_p\left(x\right)) >= \max\left\{< R^2(f_j\left(x\right)) >, j \in \mathbf{N}\right\}, \\ &\quad \text{where } R^2(f_j\left(x\right)) \text{ is the coefficient of determination of curve } f_j(x) \text{ and } \langle\cdot\rangle \text{ is the average operant,} \\ &iii)\ \text{if } F_W(p_1) \text{ and } F_W(p_2) \text{ satisfy the above criteria, we chose } p = \min\{p_1, p_2\}. \end{aligned} \quad (6),$$

The first restriction (6*i*) describes that the length of each compartment in the partition $F_W(p)$ should be sufficiently large to enjoy a representative curve fitting. The second restriction (6*ii*) interprets that the choice of the number (p) of compartments is made by the partition that provides best fittings, which are described by the highest possible coefficient of determination (R^2). For the purpose of this paper, we consider one type (only power-law) of parametric fittings, although the method (Tsiotas et al., 2021) is open for applying any possible fitting type. Finally, the third restriction (6*iii*) instructs to choose a partition with the smallest possible number of compartments to ensure a low modeling complexity and to avoid over-fittings.

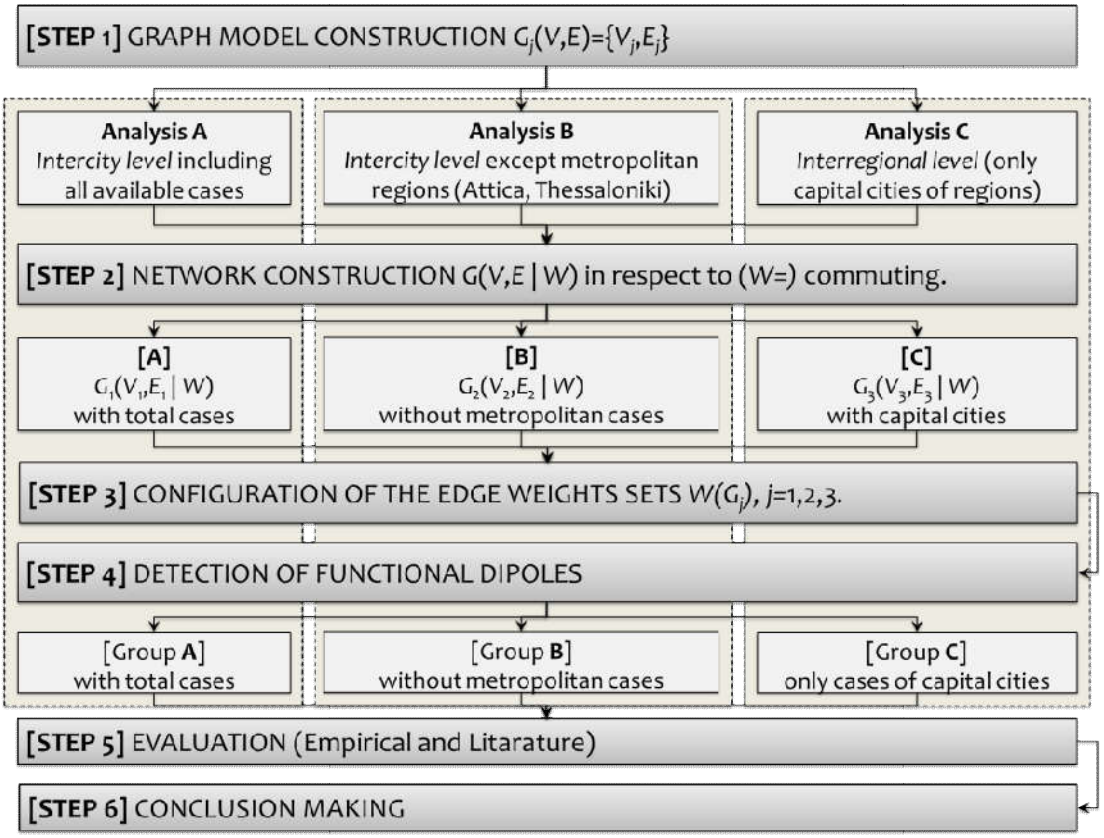
After the configuration of the optimum partition $F_W(p)$, functional dipoles (in respect to attribute W) are included in the last compartment $F_p(W)$ of the partition (Tsiotas et al., 2021). These cases are expected to have significantly higher performance than the other edge-weights, due to the cumulative configuration of the partition $F_W(p)$ in the algorithm. To test this assumption, we first compare the results with outlier detection methods, as boxplot and percentiles (Norusis, 2008; Walpole et al., 2012). In brief, outlier detection through boxplot construction is based on computing the interquartile range $IQR=Q_3-Q_1$, on which mild outliers are defined as those falling out of the interval $[Q_1-1.5 \cdot IQR, Q_3+1.5 \cdot IQR]$ and extreme outliers those falling out of the interval $[Q_1-3 \cdot IQR, Q_3+3 \cdot IQR]$. On the other hand, "*typical*" percentiles including high outliers are the P_{95} and P_{99} percentiles, which respectively include the 5% and the 1% of the highest values of a distribution. Secondly, we evaluate the results of the analysis with literature findings of functional dipoles.

2.2. Specialization of the methodological framework to the Greek commuting

The dipole detection method (Tsiotas et al., 2021) is further customized to apply in the case of Greece, as it is shown in Fig.2. As it can be observed, it consists of three different parts of the analysis: the first applies to the total dataset (analysis A, at the intercity level, including all available cases); the second one to the non-metropolitan territory (analysis B: at the adjusted intercity level, excluding cases of the metropolitan regions of Attica and Thessaloniki); and the third one to the dataset of capital cities (analysis C: at the interregional level, including only cases between the capital cities of the Greek regions). This multilevel analysis provides a multiple outcome of functional dipoles, at different levels of data resolution (total and non-metropolitan datasets) and geographical scale (total and capital city datasets). The available commuting data are records from the 2011 national census

concerning employed persons with residence in the area by place of work, at a local level (LAU 1) (ELSTAT, 2011). The dataset used in the analysis includes 16'526 registrations of commuting flows, which are measured in number of commuters between LAU 1 urban areas. The datasets used for the other two analyses are converted from the total dataset (16'526 cases): (*i*) by omitting cases of non-metropolitan regions resulting to a dataset of 11'675 cases (analysis B) and (*ii*) by retaining 120 cases of commuting flows between capital cities of Greece (analysis C). The series of the flow-thresholds $c_1 \leq c_2 \leq \ldots \leq c_k$ that is used to define the frequency series is the same for all the parts (A, B, and C) of the analysis and consists of the set C_o={0:250, with step 10}⋃{260:400, with step 20}⋃{400:1200, with step 50}⋃{1300:2000, with step 100}⋃{2'000:10'000, with step 500}⋃{10'000: 13'000, with step 1'000}. Different scales of steps are used to reduce redundant resolution of the series data. This generates a series of cumulative frequencies including 76 cases (as defined in relation 5), to which the analysis is applied.

Fig.2. The computational algorithm for detecting urban dipoles of commuting in Greece.

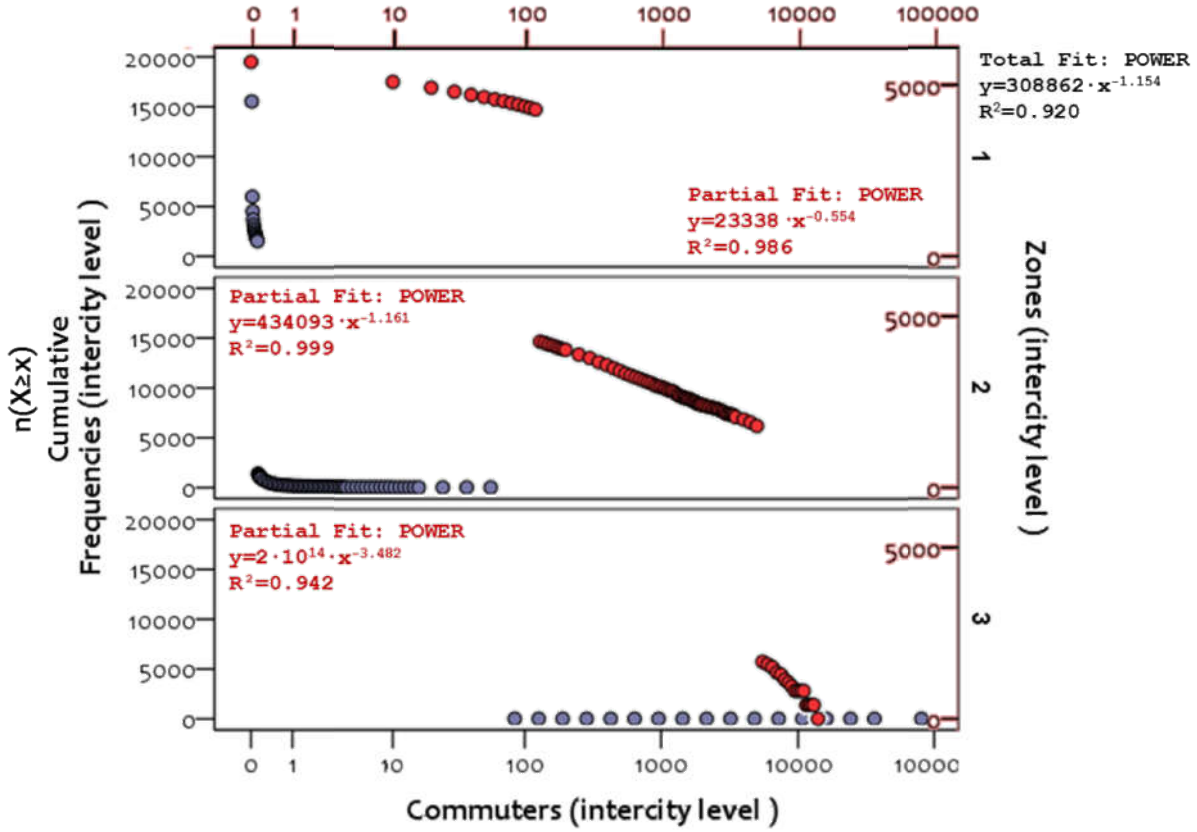


3. Results and Discussion

3.1. Analysis at the intercity level

The first part of the analysis is implemented on the total dataset including 16'526 cases. The results are shown in Fig.3, where it can be observed that the series of cumulative frequencies is divided into 3 compartments (zones). The first two compartments are described by patterns of power-law decay, where: (*i*) the first one has an exponent smaller (in absolute terms) than one (y=23'338$\cdot x^{-0.554}$, R^2=0.986), expressing a smooth decay; (*ii*) the second one is described by a heavier decay with an absolutely exponent greater than one (y=434'093$\cdot x$–1.161, R^2=0.999); whereas (*iii*) the third one is described by a pattern of exponential decay (y=150.17$\cdot\exp\{-4\cdot10^{-04}\cdot x\}$, R^2=0.958). All fittings are of high determination, describing at least 95.8% of the variability of the data. The first fitting zone includes 91.41% of commuting flows, the second one 8.49% of cases, and the third zone includes 16 cases (high flows).

Fig.3. Scatter plot with the distribution of the Greek intercity cumulative commuting flows (dataset A), divided into three compartments (zones): two of power-law and one of exponential decay (left: metric scale; right: log scale).



Among these 3 fitting zones (compartments) (Fig.3), the compartment of exponential decay (y=150.17·exp{–4·10^{-04}·x}, R^2=0.958) includes functional intercity dipoles of commuting. The dipoles included in this zone are shown in Table 1, along with additional information (commuting flows, percentiles, city population, and intermediate distance). As it can be observed, at this geographical scale, functional dipoles are Greek cities belonging to the two metropolitan regions of Attica and Thessaloniki, have population over 59'000 people, are distant within a range of 3-16km (with an average of 9.68km), and have flows of 5'730-13'037 (with an average of 8'030) commuters. In comparison with their percentile ranking, these 16 functional dipoles are "*extraordinary*" extreme outliers. In particular, the dipole Kalamaria-Thessaloniki belongs to the 100% percentile (P_{100}), whereas all the others to the 99.9% percentile ($P_{99.9}$), which are not typical outlier classes of percentile assessment. In terms of boxplot outlier detection, the mild outliers are defined by the complement (cases that do not belong to) of the interval [0,61] and the extreme outliers are defined by the complement of the interval [0,97] (both measured in number of commuters). This yields 2'509 mild outliers (15.89% of the total cases) and 1'809 extreme outliers (10.89% of the total cases), illustrating that neither the boxplot consideration succeeds to highlight the intercity functional dipoles within a realistic context.

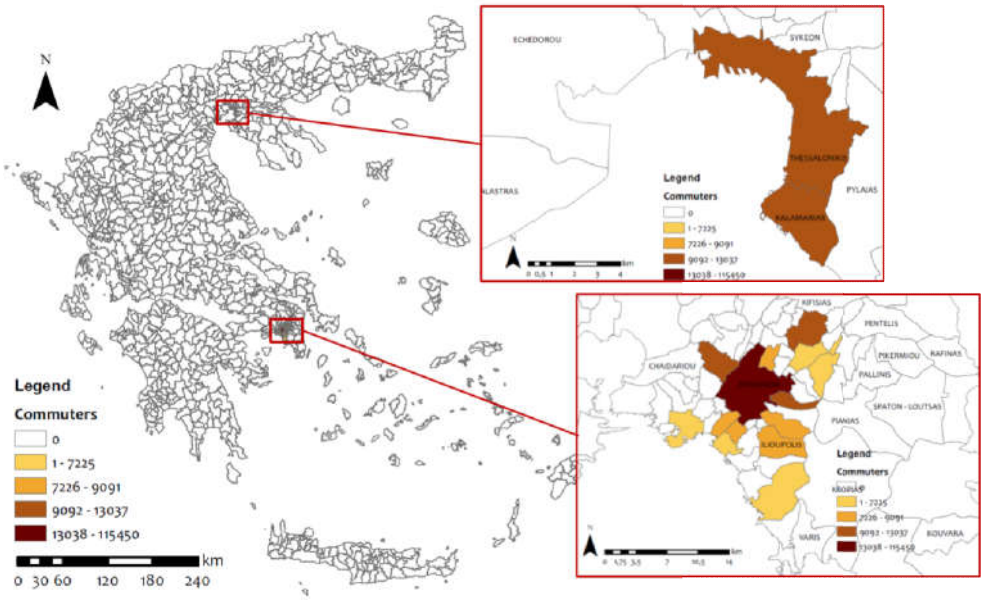
Table 1. The Greek cities configuring functional dipoles according to the first part of the analysis (A: intercity level).

Rank	Origin	Destination	Commuters (people)	Percentile	Distance (km/min.)	Origin Population (people)	Destination Population (people)
1	Kalamaria (Thessaloniki)*	Thessaloniki	13’037	P_{100}	8 (21)**	91’518	325’182
2	Peristeri (Attica)	Athens (Attica)	11’378	$P_{99.9}$	8 (18)	139’981	664’046
3	Zografou (Attica)	Athens	11’113		7 (20)	71’026	664’046
4	Kallithea (Attica)	Athens	9’091		3 (13)	100’641	664’046
5	Nea Smyrni (Attica)	Athens	8’529		5 (15)	73’076	664’046
6	Galatsi (Attica)	Athens	8’097		10 (22)	59’345	664’046
7	Vyronas (Attica)	Athens	7’848		5 (19)	61’308	664’046
8	Helioupoli (Attica)	Athens	7’664		9 (20)	78’153	664’046
9	Halandri (Attica)	Athens	7’225		12 (23)	74’192	664’046
10	Agia Paraskevi (Attica)	Athens	6’988		14 (24)	59’704	664’046
11	Helion (Attica)	Athens	6’696		10 (20)	84’793	664’046
12	Marousi (Attica)	Athens	6’616		16 (21)	72’333	664’046
13	Piraeus (Attica)	Athens	6’440		9 (19)	163’688	664’046
14	Athens (Attica)	Marousi	6’059		16 (21)	664’046	72’333
15	Glyfada (Attica)	Athens	5’976		15 (26)	87’305	664’046
16	Palaio Faliro (Attica)	Athens	5’730		8 (15)	64’021	664’046

*. Names inside parentheses refer to the city regions
**. Numbers in parentheses refer to time-distance measured in minutes.

The location of the functional dipoles of Table 1 is shown in the map of Fig.4, where it can be observed that all dipoles, except Thessaloniki-Kalamaria (which belongs to the prefecture of Thessaloniki), are included in the Attica (capital of Greece) prefecture. In terms of the growth poles theory (O’ Sullivan, 2007; Christofakis and Papadaskalopoulos, 2011; Polyzos, 2019), this observation highlights the central role of the city of Athens in the commuting functionality of the Attica prefecture, developing a pattern of a hub-and-spoke (star-like) topology, where Athens is the commuting hub enjoying 15 connections. The effect of the spatial proximity is evident to the configuration of the Attica’s cluster of dipoles, since all nodes participating in this star-like structure range within a distance of 3-16km, with an average of 9.8km. This outcome complies with the neighborhood criterion of polycentricism in the literature (Parr, 2003; Meijers, 2007, 2008), according to which polycentric areas consist of neighbor but discrete interacting urban cores.

Fig.4. Map of the functional dipoles of the first part of the analysis (A: intercity level metropolitan regions).

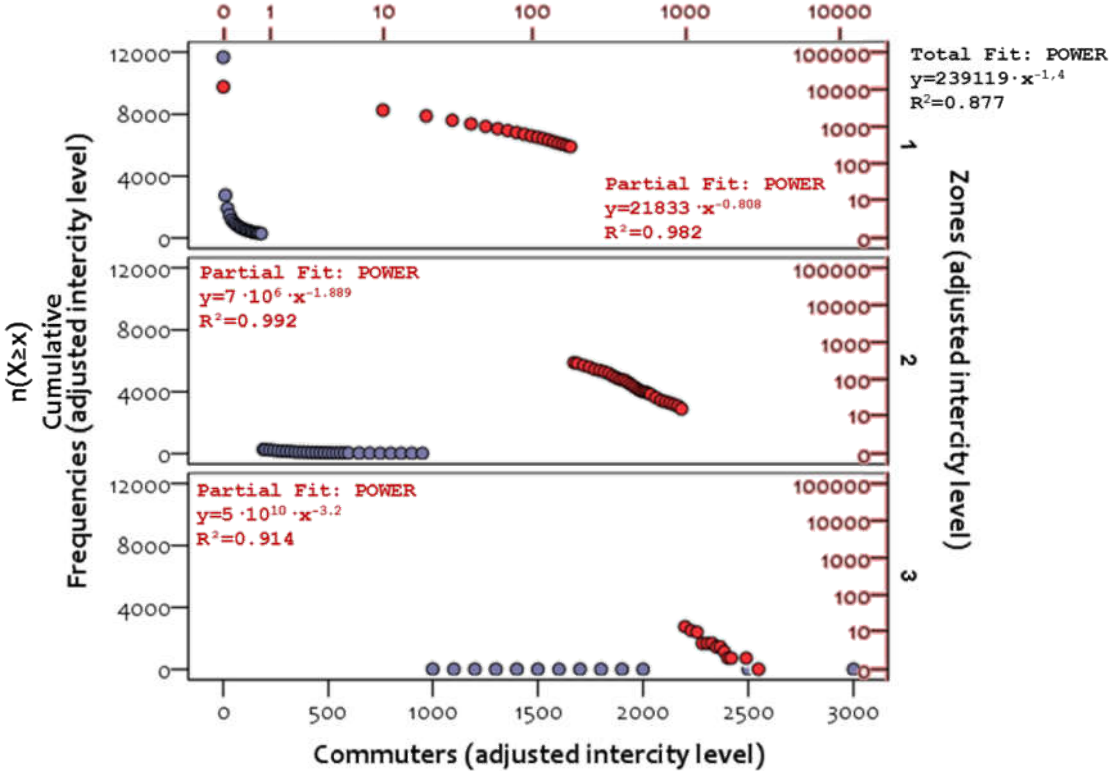


Finally, this part of the analysis highlights the gravitational drives in the configuration of the commuting functionality in Greece. In particular, the cities participating in the star-like cluster of dipoles in Attica have 1'404'867 people population, which corresponds to the 13% of the country total. On the other hand, the population of the cities participating in the commuting dipole of Thessaloniki is 416'700 people, corresponding to the 4% of the country total. The commuting distances are also very short, with an average time-distance less than 30min (Google Maps, 2021). Overall, the functional dipoles of commuting that were detected in this part of the analysis have a population share of 17% of the country total. This outcome first complies with the literature about the gravity configuration of commuting (Van Ommeren and Rietveld, 2005; Liu et al., 2012; Rodrigue et al., 2013; Polyzos, 2019) and secondly highlights the effectiveness of the method in detecting functional dipoles within a realistic context.

3.2. Analysis at the adjusted intercity level

The second part of the analysis is implemented to the dataset without metropolitan regions, including 11'675 cases. The results are shown in Fig.5, where we can also observe 3 compartments in the frequency series, all of which are described by patterns of power-law decay. All fittings are also of high determination, describing from 91.4-99.2% of the data variability. The first fitting zone includes the 97.58% of commuting flows, the second one the 2.29% of cases, whereas the third zone includes 14 cases. The power-law exponents of these curves are successively increasing (in absolute terms), where: (*i*) the first is smaller than one (y=21'833$\cdot x^{-0.808}$, R^2=0.982), expressing a smooth decay; (*ii*) the second one is near the value two (y=7$\cdot 10^6 \cdot x$–1.889, R^2=0.9917); and (*iii*) the third one is greater than three (y=5$\cdot 10^{10} \cdot x^{-3.2}$, R^2=0.914). In terms of scale-freeness, which a property related to hierarchical structures in networks (Barabasi, 2016; Tsiotas, 2019), power-law exponents within the typical range $2<\gamma<3$ are related with good structures of network hierarchy. Within this context, we can loosely claim that the last two zones of the frequency series are privileged to have structural benefits of hierarchy, although the third one (y=5$\cdot 10^{10} \cdot x^{-3.2}$, R^2=0.914) includes the functional intercity dipoles of commuting in the adjusted case (excluding the metropolitan regions).

Fig.5. Scatter plot with the distribution of the Greek intercity cumulative commuting flows (dataset B: without the metropolitan regions), divided into three compartments (zones) of power-law decay (left: metric; right: log scale).



The dipoles included in the final (third) compartment are shown in Table 2, and are Greek cities that belong to regions of the whole Greek territory, have population between 1'115-167'446 people, are distant within a range of 2-34km (with an average of 12.14km), and have a flow of 1'000-2'785 (with an average of 1'408) commuters. In comparison with their percentile ranking, these 14 functional dipoles are extraordinary extreme outliers, because the dipole Nea Ionia (Magnessia)–Volos (Magnessia) belongs to the 100% percentile (P_{100}), whereas all the other dipoles belong to the 99.9% ($P_{99.9}$) and 99.9% ($P_{99.8}$) percentile. In terms of boxplot outlier detection, the mild outliers of the second dataset distribution are defined by the complement of the interval [0,20], and the extreme outliers are defined by the complement of the interval [0,30] (both measured in number of commuters). This yields 1'915 in number mild outliers (16.4% of the total cases) and 1'474 extreme outliers (12.63% of the total cases), illustrating that neither the boxplot consideration succeeds to highlight the intercity functional dipoles within a realistic context.

Table 2. The Greek cities configuring functional dipoles according to the second part of the analysis (B: adjusted intercity level, without metropolitan regions).

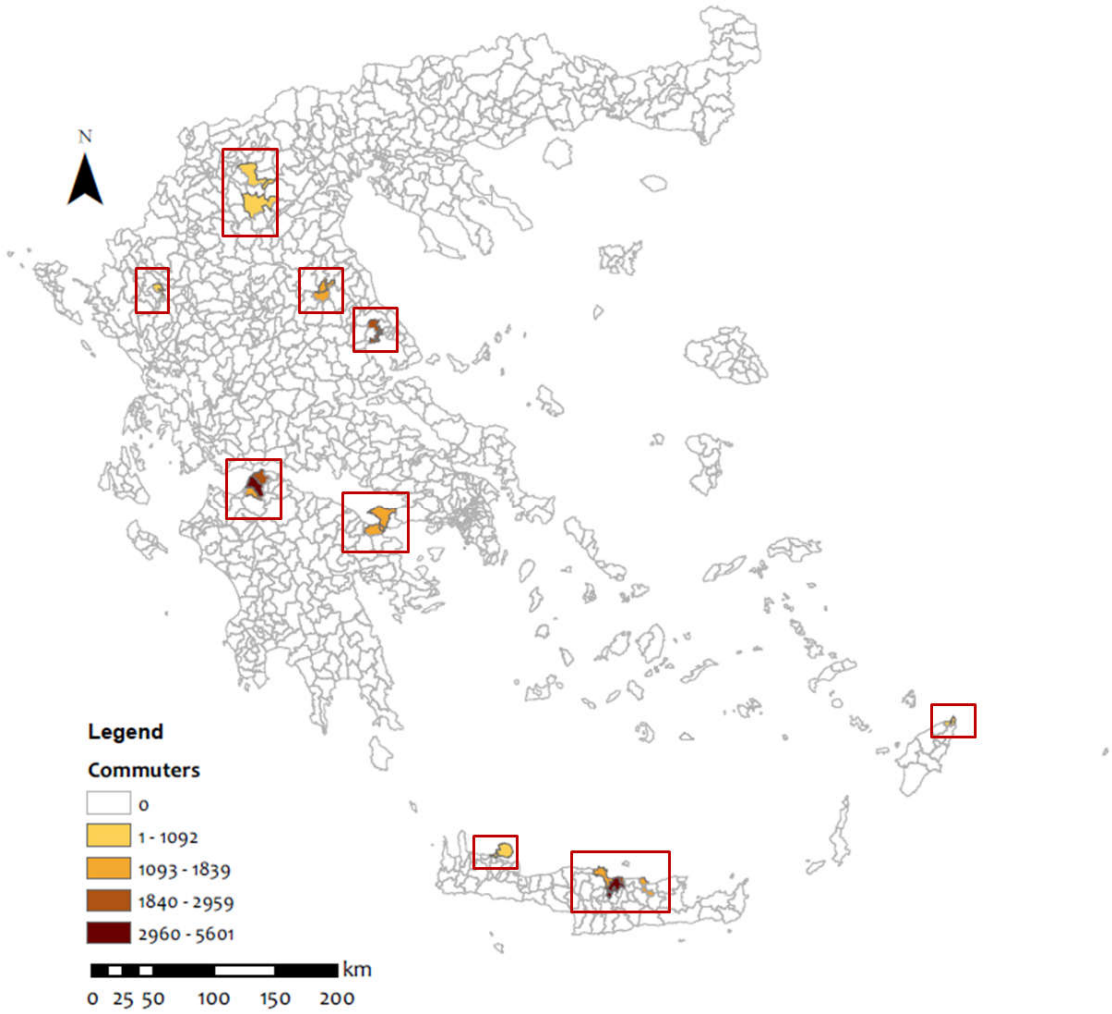
Rank	Origin	Destination	Commuters (people)	Percentile	Distance (km/min.)	Origin Population (people)	Destination Population (people)
1	Nea Ionia (Magnessia)*	Volos (Magnessia)	2'785	P_{100}	2 (8)**	33'578	86'046
2	Gazi (Herakleion)	Herakleion	1'839	$P_{99.9}$	24 (5)	14'640	140'730
3	Patra (Achaia)	Rio (Achaia)	1'767		9 (18)	167'446	5'252
4	Messatida (Achaia)	Patra (Achaia)	1'585		14 (27)	13'852	167'446
5	Korinthos	Loutraki (Korinthos)	1'296		20 (16)	30'176	11'564
6	Giannouli (Larissa)	Larissa	1'285		6 (9)	7'847	144'651
7	Nea Alikarnassos (Herakleion)	Herakleion	1'261		2 (5)	12'925	140'730
8	Herakleion	Nea Alikarnassos (Herakleion)	1'259		2 (5)	140'730	12'925
9	Herakleion	Hersonissos (Herakleion)	1'242		25 (22)	140'730	1'115
10	Rio (Achaia)	Patra (Achaia)	1'192		9 (18)	5'252	167'446
11	Ialyssos (Dodekanessa)	Rhodes (Dodekanessa)	1'092		7 (12)	11'331	50'636
12	Anatoli (Ioannina)	Ioannina	1'084		4 (11)	5'815	65'574
13	Kozani	Ptolemaida (Kozani)	1'020	$P_{99.8}$	34 (29)	41'066	32'127
14	Akrotiri (Chania)	Chania	1'000		12 (24)	13'100	108'642

*. Names inside parenthesis refer to the city regions
**. Numbers in parentheses refer to time-distance measured in minutes.

The location of the functional dipoles of Table 2 is shown in the map of Fig.6, where it can be observed that the spatial distribution of these dipoles is extended throughout the Greek periphery. In particular, 6 out of 14 dipoles belong to the region of Crete, one to the region of Dodecanese, 3 out of 14 to the region of Peloponnese, and the other 4 to the mainland Greece. These dipoles have considerably high commuting flows (≥1'000 commuters) in comparison with the other cases of the distribution (which belong to the $P_{99.8}$ percentile and over), but considerably (over 5.5 times) lower from the commuting flows of the dipoles extracted from the previous analysis (A: including the metropolitan regions). This observation supports the previous discussion about the gravitational configuration of commuting (Van Ommeren and Rietveld, 2005; Liu et al., 2012; Rodrigue et al., 2013; Polyzos, 2019). As far as the spatial distribution is concerned, we can observe in Fig.6 that the spatial arrangement of the functional dipoles configures an "*S-pattern*", oriented toward the west part of Greece but is mainly fitted to the east coastal and Aegean Sea forehead of the country. This arrangement complies with the *S*-pattern ruling the developmental dynamics of the country (Polyzos, 2015, 2019; Tsiotas et al., 2021), which is mainly coordinated along the major highway road network axis, at the east coastal forehead of Greece (where transportation infrastructures, constriction, and economic activity is more intense in comparison with the other country). Next, the regions of Crete and Dodecanese, in which the half of the functional dipoles of Table 2 are included, also concern cases of significant regional development in Greece. In particular, the insular region of Crete is a considerably attractive tourism destination with a significant share in the tourism product of the region of Aegean Island and generally of the country (Tsiotas, 2017; Polyzos, 2019; Tsiotas et al., 2020; Delitheou et al., 2021). The cities

of Chania and Herakleion are within the top populated countries of Greece (Xanthos et al., 2012, 2013; Tsiotas, 2016; Polyzos, 2019), therefore enjoying economies of scale. The island of Rhodes is also a considerable tourism destination of the Dodecanese region, suggesting a core of many economic activities at the south Aegean Sea (Polyzos, 2019).

Fig.6. Map of the functional dipoles extracted according to the second part of the analysis (B: intercity level without metropolitan regions).



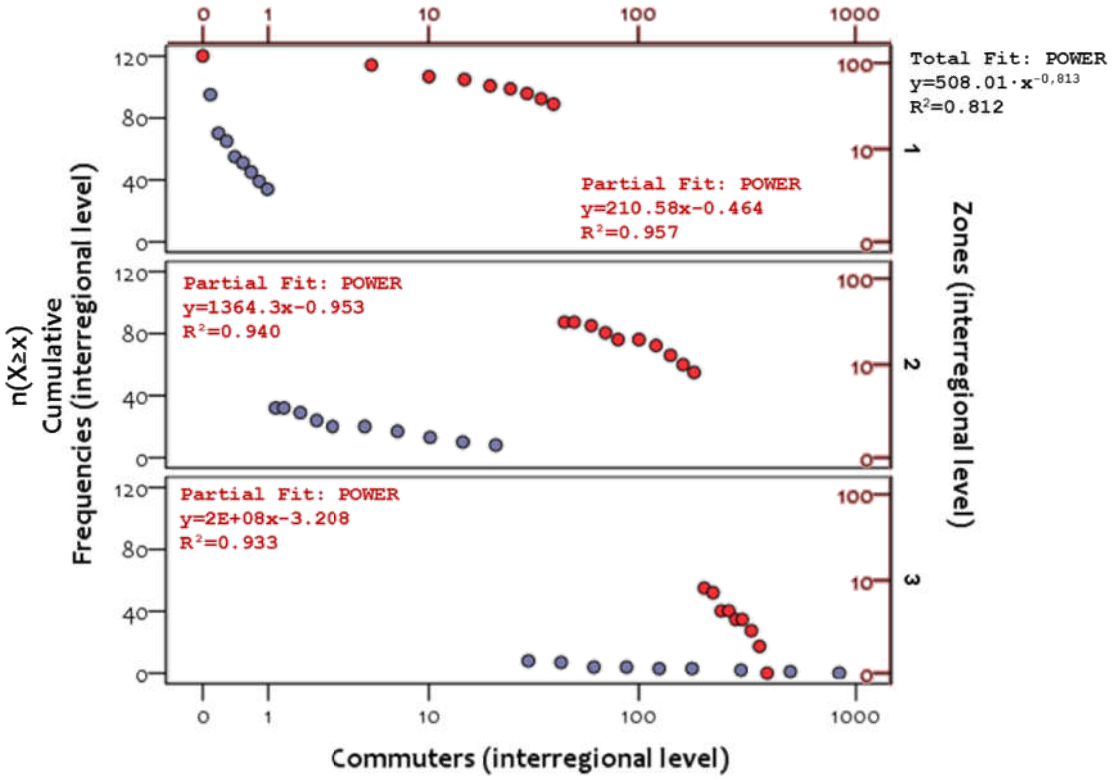
Finally, this part of the analysis also highlights the effect of the spatial proximity to the configuration of the dipoles included in Table 2, since all nodes in these dipole structures are distant within a range of 2-34km, with an average of 12.14km. As is evident, commuting distances are (also in this case) very short, with an average time-distance less than 30min (Google Maps, 2021). In gravitational terms, the cities participating in the functional dipoles of this analysis have a total population of 998’113 people, which refers almost to the 10% of the country’s population. This results also supports the gravity configuration of commuting (Van Ommeren and Rietveld, 2005; Liu et al., 2012; Rodrigue et al., 2013; Polyzos, 2019) and accredits the effectiveness of the method.

3.3. Analysis at the interregional level

The third part of the analysis is implemented to the dataset of interregional connections, including 120 cases of commuting flows between the capital cities of the Greek regions. The results of the analysis are shown in Fig.7, where we can also observe 3 compartments in frequency series. The first one describes a pattern of logarithmic decay (y=–27.81·ln$x$+138.39, R^2=0.9875), whereas the other two describe patterns of exponential decay. All fittings are also of high determination, describing from at least 94.9% of the data variability. The exponent coefficients of the exponential curves are almost equal, namely 0.01

(absolutely) for the second one (y=51.019·e$^{-0.01x}$, R^2=0.9794) and 0.012 (absolutely) for the third curve (y=86.509e$^{-0.012x}$, R^2=0.949), implying that substantial differences in the slope of these curves are due to the term coefficients, where this of the third fitting curve is almost 70% greater than of the second one. In terms of coverage, the first fitting zone includes the 73.33% of commuting flows, the second one the 20% of cases, whereas the third zone includes 8 cases of high flows. The third fitting curve (y=86.509e$^{-0.012x}$, R^2=0.949) is also the candidate of including functional interregional commuting dipoles.

Fig.7. Scatter plot showing the distribution of the Greek interregional cumulative commuting flows (dataset C) that is divided into three compartments (zones), one of logarithmic and two of exponential decay (left: metric; right: log scale).



The dipoles that are included in the final (third) zone are shown in Table 3, where it can be observed that Greek cities composing these dipoles belong to regions of the mainland Greek territory. This result is due to the modeling restriction of considering in this analysis only flows between capital cities, where inter-island or coastal-island commuting flows were by default negligible at the interregional level. Also, the functional dipoles of this analysis have population between 80’419-3’828’434 people, are distant within a range of 50-80km (with an average of 64.13km), and involve 207-372 commuters (with an average of 275 commuters). In comparison with their percentile ranking, these 8 functional dipoles belong to the 93% percentile (P93) and above, which is a broader outlier zone, in comparison with the P95 (which counts 5 cases) and the P99 (which counts just one case) values. This consideration illustrates the potential of the method to discriminate cases with more structural (e.g. the frequency pattern) than numeric (percentage) criteria. In terms of boxplot outlier detection, the mild outliers are defined by the complement of the interval [0, 112] and the extreme outliers are defined by the complement of the interval [0, 169] (both measured in number of commuters). This yields 19 mild outlier values (15.83% of the total cases) and 10 extreme outlier values (8.3% of the total cases), which are greater (although near) in number than the cases resulted by the method.

Table 3. The Greek cities configuring functional dipoles according to the third part of the analysis (C: interregional level).

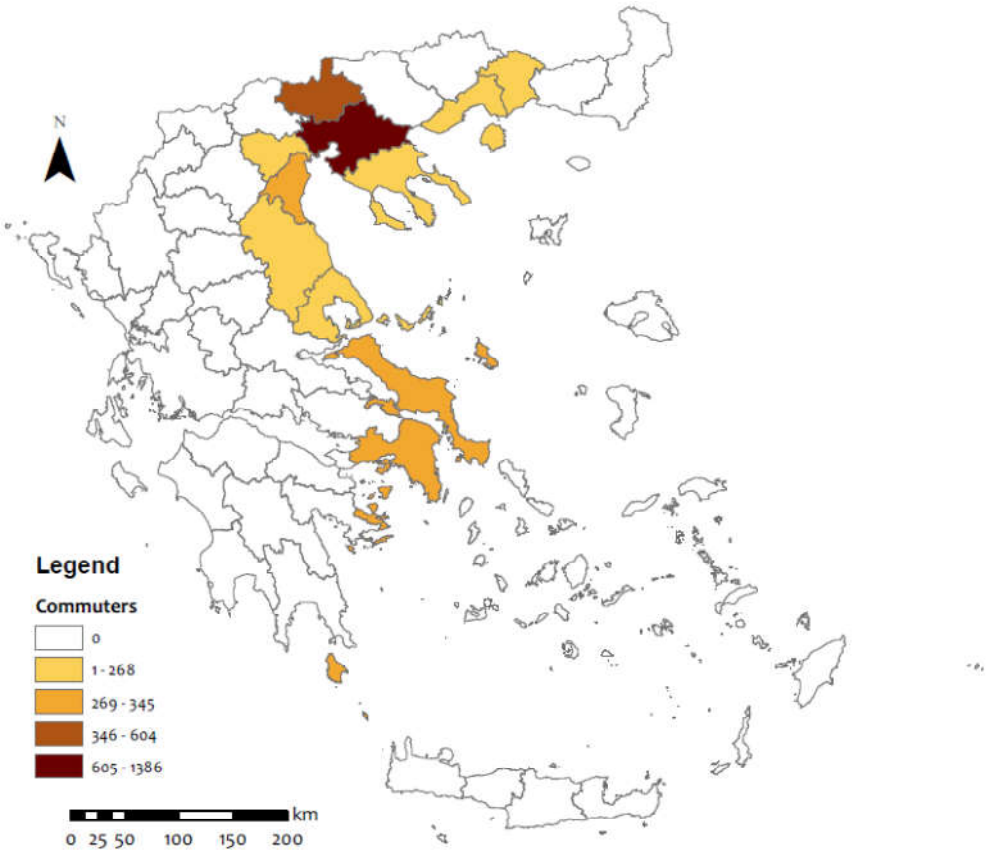
Rank	Origin	Destination	Commuters (people)	Percentile	Distance (km/min.)	Origin Population (people)	Destination Population (people)
1	Thessaloniki	Kilkis	372	P_{100}	50 (58)**	1.110.551	80.419
2	Katerini (Pieria)*	Thessaloniki	345	P_{98}	75 (49)	126.698	1.110.551
3	Chalkida (Euvoia)	Athens	324	P_{97}	80 (56)	210.815	3.828.434
4	Kavala	Xanthi	268		56 (63)	124.917	111.222
5	Kilkis	Thessaloniki	232	P_{96}	50 (58)	80.419	1.110.551
6	Thessaloniki	Polygiros (Chalkidiki)	230	P_{95}	70 (59)	1.110.551	105.908
7	Volos (Magnessia)	Larissa	222	P_{94}	60 (47)	190.010	284.325
8	Veroia (Hemathia)	Thessaloniki	207	P_{93}	72 (57)	140.611	1.110.551

*. Names inside parenthesis refer to the city regions
**. Numbers in parentheses refer to time-distance measured in minutes.

The location of the functional dipoles resulted by this analysis is shown in Fig.8, where it can be observed that the spatial distribution of these dipoles is extended throughout the periphery of the mainland Greece. These dipoles do not have considerably high commuting flows (<400 commuters), compared to the cases of the other parts of the analysis, a fact which supports the previous discussion about the gravitational configuration of commuting (Van Ommeren and Rietveld, 2005; Liu et al., 2012; Rodrigue et al., 2013; Polyzos, 2019). As far as the spatial distribution is concerned, we can observe that (also in this interregional case) the spatial arrangement of the functional dipoles configures an "*S*" pattern, which is oriented toward the east coastal and Aegean Sea foreheads of the Greece. This pattern complies with the developmental dynamics of the country (Polyzos, 2015, 2019; Tsiotas et al., 2021), as it was previously discussed. In terms of spatial proximity, the distance range of the functional dipoles at this (interregional) level is almost 6 times, on average, greater (50-80km) than the cases of the previous two geographical levels. Also, the volume of commuting flows at the interregional level is almost 18 times, on average, decreased comparatively to the previous cases, verifying the gravitation configuration of the commuting phenomenon (Van Ommeren and Rietveld, 2005; Liu et al., 2012; Rodrigue et al., 2013; Polyzos, 2019).

Further, among these 8 functional dipoles of Table 3, the half (4 out of 8) of them belong to the region of Thessaloniki and one to the Attica region, referring together to the 62.5% of the total cases. This observation supports the importance of the metropolitan regions in the configuration of commuting flows in Greece and the gravitational configuration of the phenomenon. In this part of the analysis, we can also observe that the distances where the functional dipoles of commuting emerge are relatively short (50-80km) and the time-distances are on average below 60min (Google Maps, 2021), a fact which also highlights the importance of proximity in the configuration of the commuting phenomenon (Rodrigue et al., 2013; Polyzos, 2019). Finally, in this part of the analysis, we can observe that the region of Thessaloniki and their neighborhood regions configure a polycentric pattern of commuting poles, with a star-like (hub-and-spoke) structure having a hub at the city of Thessaloniki. A similar structure was also detected at the intercity level (first part of the analysis) for the case of Attica region. This result also verifies the gravity configuration of commuting in Greece, outlining that the metropolitan regions of the country are the only sufficing to configure polycentric structures of commuting. In particular, Athens (with a population of almost 4m people) develops a polycentric functional pattern of commuting within its region (at the intercity level), whereas Thessaloniki (with a population over 1m people) does so at the interregional level (a between regions structure).

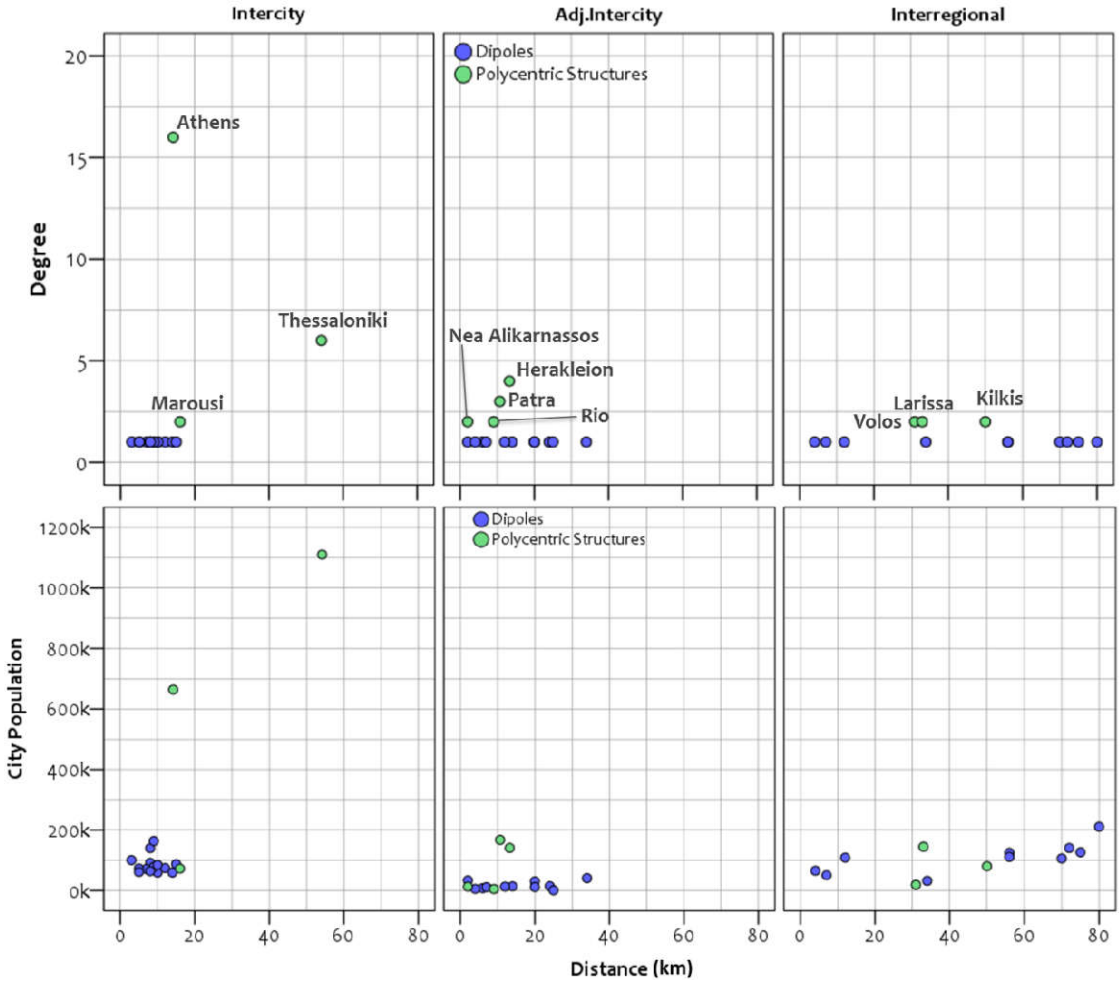
Fig.8. Map of the functional dipoles according to the third part of the analysis (C: interregional level).



3.4. Further analysis

After the detection of the functional dipoles, at the three levels of geographical resolution, we apply a further analysis on the dipoles' dataset consisting of the collection of cases included in Tables 1, 2, and 3. The analysis builds on correlation plots between (*i*) kilometric distance and polycentric structure degree and (*ii*) kilometric distance and city population, distinguishing cases (cities) of dipole structures (node degree =1) and higher order (node degree >1) polycentric structures. The analysis aims to reveal patterns of polycentric configuration in the urban functional dipoles detected for the cases of Greek commuting. To perform the analysis, we define the variable of degree as the number of dipole connections in which each city participates. The results of the analysis are shown in Fig.9, organized into windows of geographical scale (intercity, adjusted intercity, and interregional) and groups of polycentric structure (dipoles, polycentric structures). In terms of degree, we can observe that polycentric structures of commuting in Greece emerge at geographical distances between 2-55km, and particularly between: 15-55km, at the intercity level; 2-15km, at the adjusted (without metropolitan cases) intercity level; and 31-50km, at the interregional level. These kilometric ranges are the same with those shown in the case of distance-population correlation. The concordant intervals in the emergence of dipoles range between: 2-15km, at the intercity level; 2-35km, at the adjusted (without metropolitan cases) intercity level; and 2-80km, at the interregional level. Under a combined consideration, we can observe that (*i*) at the intercity level, polycentric structures emerge at longer distances than dipoles, (*ii*) at the adjusted intercity level, they emerge at shorter distances than dipoles, and (*i*) at the interregional level, they emerge at middle distances than dipoles. As far as intercity and adjusted intercity levels are concerned, we can observe that the effect of the capital cities of Athens and Thessaloniki shifts the polycentric structures' configuration at longer distances, under a gravitational rule. Overall, this approach provides insights into the dynamics describing the spatial emergence of polycentric structures, addressing avenues of further research for further empirical evaluation.

Fig.9. Scatter plots of the (Distance, Degree) and (Distance, City Population) correlations, constructed for the collective cases of functional city dipoles resulted from the analysis.



4. Conclusions

Within the context of the growth poles theory, the areas that lack the critical sizes to develop polycentric structures of socioeconomic functionality (structures composed by core cities and several independent smaller urban units that socioeconomically interact and influence each other) are restricted to the development of special or limited structures proportionally to their characteristic sizes. In the case of Greece (as well as of other countries with similar population and economic sizes), the growth poles development is restricted to the development of urban networks of special structures described by small participation of cities. In the literature, this restriction has led to the emergence of the specialized terms "*urban dipoles*" and "*tripoles*", which are often used within a not well defined and comprehensive context. Aiming to promote the empirical research of urban dipoles, this paper applies a recently introduced method detecting functional dipoles (in respect to an attribute), based on statistical mechanics. The method was applied to data of the Greek commuting and was implemented at three different levels of geographical scale, including intercity, adjusted intercity (without the metropolitan regions of Attica and Thessaloniki), and interregional connections. The first part of the analysis revealed 16 functional dipoles of commuting, including cities with population 1'100-168'000 people, distance within a range of 3-16km (and below 30min time-distance, on average), and flows of 5'700-13'100 commuters. The second part resulted to 14 functional dipoles of commuting, including cities with population 59'000-665'000 people, distance within a range of 2-34km (and below 30min time-distance, on average), and flows of 1'000-2'800 commuters. The third part revealed 8 functional dipoles of commuting, including cities with population 80'000-3'830'000 people, distance within a range of 50-80km (and below 60min time-distance, on average), and flows of 200-400 commuters. In comparison with their percentile ranking, the functional dipoles that were

detected at the first two parts of the analysis (at the intercity level) were exceptionally extreme outliers belonging to the 99.8% percentile ($P_{99.8}$) and above. In these cases, the boxplot outlier analysis yielded thousands of mild and extreme outlier values, illustrating that neither the percentile or boxplot consideration succeeded to highlight the intercity functional dipoles within a realistic context. On the other hand, at the third part of the analysis (at the interregional level), the functional dipoles regarded outliers belonging to the 93% percentile (P_{93}) and above, but were less in number than those emerged by the boxplot outlier analysis. This outcome highlighted the flexibility of the applied method to be adaptable in geographical scale. The intercity analysis revealed dipoles belonging to the two metropolitan regions of Attica and Thessaloniki, where a polycentric structure of a hub-and-spoke (star-like) topology emerged in Attica. The adjusted intercity analysis (without metropolitan regions) revealed dipoles belonging to regions of the whole Greek territory, whereas the analysis at the interregional level resulted to dipoles belonging to regions of the mainland Greek territory, in which a polycentric structure of a hub-and-spoke (star-like) topology emerged in the region of Thessaloniki and their neighborhood regions (with Thessaloniki serving as a hub). In all parts of the analysis, the effect of the spatial proximity were evident to the configuration of the dipoles, where all nodes participating in these structures were considerably near in kilometric and time-distance, a result which complied with the neighborhood criterion of polycentricism in the literature. The analysis also highlighted the gravitational drives in the configuration of the commuting functionality in Greece, where the most populated cities of the country participated in the dipole configurations that covered about 20-60% of the total population. In terms of location, the spatial distribution of the detected functional dipoles illustrated an *S*-pattern configuration, which is the one ruling the developmental dynamics of the country due to its geomorphological, infrastructure, and socioeconomic features. Finally, the analysis revealed the importance of the metropolitan regions of Attica and Thessaloniki in the configuration of commuting, which were only that sufficed to configure polycentric structures, the first at the intercity and the second one at the interregional level. Overall, this paper contributed to the demand of integration in the conceptualization of urban structures, it developed a common vocabulary, and applied a new method for defining and detecting urban dipoles based on a functional attribute, further highlighting its utility.

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DOES EUROPEAN UNION MEMBERSHIP RESULT IN QUALITY-OF-LIFE CONVERGENCE?

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Abstract

This paper employs European Quality-of-life Survey (EQLS) responses from 2003, 2008, 2012, and 2016 to examine whether European Union (EU) enlargement helps meet the objectives of improved living standards and overall quality-of-life across the continent. The data set includes responses to forty questions across nine dimensions for all twenty-eight pre-Brexit EU member states, along with eight non-member states. Insights are captured through the systematic comparison of self-reported perceptions pooled at the country level before and after accession, as well as between member states and non-member states. Special attention is paid to the eleven post-communist countries that joined the EU in 2004, 2007, and 2013, which together represent the addition of one hundred million EU citizens. These include Estonia, Latvia, and Lithuania, Poland, Czech Republic, Slovakia, Hungary, Slovenia, Bulgaria, Romania, and Croatia. Based upon these findings, the paper concludes with speculation upon popular support for further enlargement in the wake of the 2007-08 Global Financial Crisis, the 2016-2020 Brexit process, and ongoing COVID-19 pandemic.

Keywords: European Union, Central and Eastern Europe, economic integration, European convergence

JEL classification: O10, O47, P20, P48, R11

1. Introduction

This paper examines perceived quality-of-life among European countries over time, focusing on "core" (pre-dating 2004 expansion) and "new member states" (NMS) of the European Union (EU). The research question is whether the EU has succeeded in improving the quality-of-life for these eight million new citizens, a fundamental goal of the organization. The founding states[1] of the European Economic Community (EEC), precursor to the EU, signed the Treaty of Rome on March 25, 1957, setting the foundation for a closer union of European states. This treaty's preamble[2] calls for "constant improvement of the living and working conditions" of the people within the member states, as well as collective action to reduce "differences existing between the various regions and the backwardness of the less favored regions."

[1] Belgium, France, the Federal Republic of Germany, Italy, Luxembourg, and the Netherlands.
[2] https://ec.europa.eu/romania/sites/romania/files/tratatul_de_la_roma.pdf

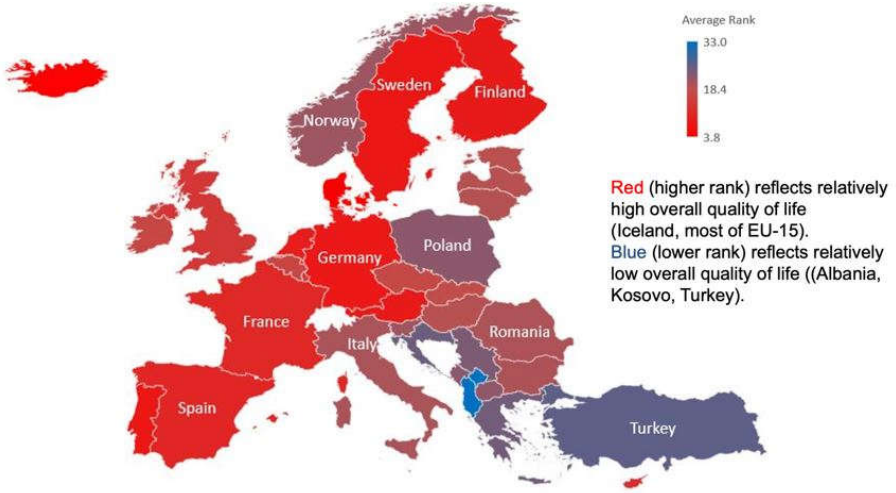
The process of European integration began during the aftermath of World War II, in the wake of unprecedented human suffering and material destruction. While integration appeared to be motivated at its outset by the prevention of future conflict, economic benefits increasingly became a key driving force behind the undertaking (Marti, Mayer & Thoenig, 2012). The founding members of the European Community were relatively homogenous in terms of socio-economic development when they signed the Treaty of Rome. However, since its inception in 1957, the EEC evolved into the EU, comprising 28 states and more than 500 million inhabitants prior to Brexit. While post-1957 enlargement increased the economic and social disparities within the EU to some extent, the 2004, 2007, and 2013 expansions of thirteen new member states, including eleven post-communist[3] Central and Eastern European (CEE) countries, significantly increased the EU's cultural, linguistic, social, and economic diversity.

While a wide range of economic, political, and social goals motivated countries to join the EU, improving the citizenry's quality-of-life has been a key driver of membership in the EU (Delhey, 2001). In a European Commission (2014) study carried out in six EU member states, the benefits of EU membership are summarized by one respondent:

> If we had not joined Europe, we would probably be as miserable as before. We would have remained uneducated and shut in our world, without opening our minds to new technology and to all the breakthroughs that are happening now.
>
> (European Commission 2014, 29).

Membership in the EU has therefore not been driven alone by prospects for an improved standard of living as measured by per capita income, but also by the less-tangible vision of a better life overall. Figure 1 depicts the overall perceived quality-of-life across European states across the four iterations of the EQLS, administered by Eurofound, used elsewhere in the literature (Blanchflower and Oswald, 2011). Substantial spatial differences vary across national boundaries, with the EU-15 core states showing the highest perceived levels in quality-of-life as defined by the methodology (Appendix) and captured by the survey instrument. A cursory review of Figure 1 also further indicates that satisfaction with living standards generally decreases toward Europe's east and south.

Fig 1: Perceived Quality-of-life in Europe (average rank 2003, 2007, 2011, 2016)



Data Source: Eurofound (2019)

This research seeks to answer the question *"to what extent has perceived quality-of-life been realized within the EU-15 core states, and has perceived quality-of-life converged*

[3] The authors fully acknowledge the limitations of the descriptor "post-Communist" three decades after the fall of the Iron Curtain. However, the term remains absolutely relevant in convergence research because of the fundamentally opposed political, economic, and social institutions that divided Europe for much of a century.

between the EU-15 and the post-communist new member states of Central and Eastern Europe?

While the question of human development has been studied extensively and analyzed using the Human Development Index[4] (Bérenger & Verdier-Chouchane, 2006) and through objective income measures (Cieślik and Wciślik, 2020), perceived quality-of-life within the EU and transition states has not received as much attention in the literature. The purpose of the present research is to fill this void by assessing convergence in perceived quality-of-life and provide some policy suggestions for improving wellbeing in countries that lag behind the standards of Europe's core.

The structure of this paper is as follows: First, a review is presented of scholarly research on perceived wellbeing is presented, leading to a compound hypothesis. Second, the methodology is set forth, followed by a discussion of data. Next, the results are analyzed, leading to suggestions for policy. Finally, conclusions are presented, along with further research directions.

2. Literature

In its broadest conceptualization, the notion of quality-of-life refers to "a good life and society" and has been widely used in many disparate fields of research such as medicine, nursing, economics, geography, architecture, visual arts, literature, philosophy, etc. (Barcaccia et al., 2013). Quality-of-life has been studied from both objective and subjective perspectives. Objective quality-of-life is typically measured by a wide range of indicators comprised of "statistics on social or societal reality unfiltered by perceptions and independent from personal evaluations" (Boelhouwer & Noll, 2014). In other words, quality-of-life as an objective construct reflects the "level of wealth, comfort, material goods and necessities available to a certain socioeconomic class, in a certain geographic area" (Boelhouwer & Noll, 2014) and is measured by multiple criteria, chief among them GDP.

While objective standard of living is a key *component* of quality-of-life, it is not a sufficient indicator of overall quality-of-life. In other words, quality-of-life is not just a reflection of objective living conditions, but also how people feel about their life situation. For example, Hayo & Seifert (2003) find empirical evidence indicating that people with good material living conditions could be subjectively dissatisfied, and people living in poor economic conditions can be perfectly happy. This means that quality-of-life is "in the eye of the beholder" as similar living conditions can be evaluated quite differently (Christoph & Noll, 2003). Therefore, subjective feelings about one's living conditions should be considered as an important component of quality-of-life studies.

Empirical evidence is somewhat mixed regarding improvement in the quality-of-life in European countries. For example, Matutinović (1998) investigates the state of six components of quality-of-life including economic (material well-being), social (harmony and justice), political (human rights and dignity), cultural (preservation and fostering of cultural value), ecological (safety and sustainability of natural environment), and human development (meaning systems, symbols and beliefs concerning the ultimate meaning of life and history). His study includes the transition countries of Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Poland, Russia, and Slovenia after the fall of the Iron Curtain. Using the most current data at the time, he concludes that quality-of-life in transition economies improved along several components including political, cultural, ecological, and human development while it deteriorated in economic terms. Overall, however, he concludes that quality-of-life in the selected transition countries improved simply because people had more choices along all six components of t quality of life.

Giannias, Liargovas & Manolas (1999) investigate the issue of convergence/divergence across EU countries between 1970 and 1990. They define convergence not only in terms of economic indicators, but also in terms of social and quality-of-life indicators. Their empirical

[4] Devised in 1990 by the United Nations Human Development Program. For more information, see http://hdr.undp.org/en/content/human-development-index-hdi

test shows that that real convergence was achieved between 1970 -75 for most countries, then stagnated from 1980-85, and subsequently increased again.

Christoph and Noll (2003) examine subjective well-being in the European Union during the 90s and discover that overall life satisfaction tends to be higher in northern European countries (highest in Denmark) and lower in Southern European countries (lowest in Greece). Significant differences are also found between incomes groups across the EU countries (highest among the top income quartiles and lowest in the bottom quartile). Interestingly, while the 20-29 age group exhibit higher life satisfaction than affluent 45-64 age group across EU countries, the evidence with respect to the 65-and-older group is somewhat mixed; the elderly in Southern Europe tend to be less satisfied than those in Northern Europe.

Prospects for new members to catch up with the EU's quality-of-life at the time of its largest expansion of 2004 appeared less than certain. This is because previous enlargements including Ireland in 1973, Greece in 1981, and Spain/Portugal in 1986, helped the new entrants catch up without guaranteeing convergence (Delhey, 2001). Campos Coricelli, & Moretti (2014a) conclude that new members benefit greatly from accession, although they converge at varying rates. Unfortunately, these benefits have not been distributed equally among regions within the CEE countries. The authors find evidence that urban/rural disparities appear to have widened in these countries with highly educated and internationally successful individuals concentrated in metropolitan areas. Urban populations benefit disproportionately from EU membership while people living in rural agricultural regions experience little or no improvements in conditions (Smętkowski, 2013). Because the degree of urbanization in CEE countries ranges from a low of 50 percent in Slovenia to a high of 73 percent in the Czech Republic (World Bank, 2015), it follows the overall benefits of EU membership also vary between the countries.

A large body of empirical research examines convergence across EU economies in general, and in especially between the EU 15 (Austria, Belgium, Germany, Greece, Denmark, Finland, France, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and UK) and CEE 8, which includes Czechia, Estonia, Hungary, Lithuania, Latvia, Poland, Slovenia, and Slovakia. Novak (2011) reviews the most frequently quoted scholarship and finds "no unified view on the past success and future prospects for EU 8 economies to catch-up with the EU 15 economies in terms of real GDP per capita." He attributes these seemingly inconsistent results to different methodological approaches and a wide range of data used in the studies. Using Eurostat data, which contain macroeconomic variables in constant prices in euro, Novak (2011) finds weak evidence on magnitude of convergence between EU 15 and EU8.

In yet another recent study, Campos et al. (2014b) use the synthetic counterfactuals method, finding strong evidence of differential but universal growth in GDP and labor productivity for countries that joined the EU during the successive enlargements of 1973, 1980, 1995, and 2004, with Greece being the only exception.

Fahey (2017) sheds light on the difficulty of EU-wide standards for measuring poverty by pointing out that poverty levels in some core member states might represent above-average incomes in peripheral or new states. The author illustrates the mismatches across European states graphically by plotting household income and other data by country against the EU-25 median. Using data from the 2003 EQLS survey highlighted above, he makes the case for defining poverty relative to four income clusters: EU-12 (high), EU-7 (intermediate), EU-6 (low), and candidate countries of Bulgaria, Romania, and Turkey.

Many quality-of-life variables are also used in research on happiness, a related literature. Blanchflower and Oswald (2011) summarize data used in such studies by scholars across disciplines, which they also review before suggesting directions for future research. Among the data sources they assess is Eurofound's EQLS, which they validate as authoritative for international research, already based upon its second iteration in 2007. They argue that most existing research at the time (2011) is limited to correlations between independent variables and wellbeing, calling for more attention to be paid to experimental and longitudinal approaches, providing additional justification for the present study. They conclude by underscoring the importance of happiness as a multidisciplinary research field given its universal significance for human society.

In their analysis of convergence, Gräbner, Heimberger, Kapeller, and Schütz (2017) focus upon the performance of firms. The authors distinguish between Europe's core and its periphery based upon economic conditions at the time of euro adoption. Examining eurozone countries alone (incongruent to the countries investigated in the present study), they demonstrated that divergence within this zone results from firm- level technology levels and performance. In later papers, Gräbner et al. (2020a, 2020b) extend their research and confirm a core-periphery pattern of divergence that first appeared during the Global Financial Crisis (GFC) due to increasing current account imbalances in some peripheral countries. They link this to structural polarization to export-driven growth in core countries and debt-driven growth in the periphery, attributable at the micro scale to differences in the performance of companies. The authors conclude by recommending better industrial policies, public investment, and more effective redistribution to support aggregate demand.

Laaksonen (2018) uses data from three rounds of the European Social Survey (ESS) to track happiness at different ages across 27 European countries plus Israel. They interrogate a widely accepted U-shape curve that describes overall happiness at its lowest between the ages of 40-50, and more so for males than for females. They find support for the U-shape curve from many countries, with minimum happiness under 50 in the UK, Ireland, and Switzerland. In Norway, Turkey, and Germany, this occurs just above the age of 50. The countries with the oldest age for minimum happiness are France (68), Belgium (64), and the Netherlands (60), with the youngest extreme being Sweden (32). Policy implications include suggestions for making people happier throughout life by providing better education and health services and increasing incomes.

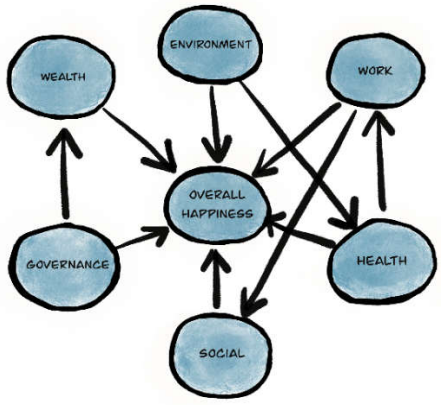
Helliwell, Huang, and Wang (2018) also examine the relationship between happiness and age, confirming that the social context matters. They focus mainly social conditions in the workplace, the home, and the community as determinants of happiness at different life stages, using data from Gallup-Healthways, Statistics Canada, and other international sources. They find that variables impacting subjective wellbeing include workplace congeniality, marriage, time spent living in the same place, sense of community, especially for those in middle and later stages of life. The authors share the extensive data they analyze in a statistical appendix to their paper.

Based on academic research and sponsored initiatives, Eurostat (2019) identifies nine quality-of-life dimensions. These dimensions, defined in the Appendix, include material living conditions, productive activity, health, education, leisure and social activities, economic and physical safety, governance, and basic rights, natural and living environment, and overall life experience. These dimensions are similar to the ones identified earlier by Matutinović (1998), and arguably provide sufficient coverage of important thematic categories in the lives of respondents. As an overarching framework for capturing quality-of-life, the dimensions are interrelated and should therefore not be examined in isolation.

3. Methodology

The purpose of this analysis is to compare perceived quality-of-life in the EU core with that in the new members states and non-member states. In this investigation, quality-of-life is defined as "overall happiness" Figure 1 provides the conceptual framework for this analysis, based upon Eurostat's (2019) definitions of quality-of-life dimensions, the broader literature, and the authors' expectations. For example, intuitively, it makes sense that good governance leads to greater wealth, and better health leads to higher satisfaction with work. Other dimensions are more difficult to link based upon intuition and/or scholarly literature, so no arrows are depicted between those dimensions. The labels in Figure 1 are explained in Appendix A.

Figure 1. Conceptual Framework for Dimensions



Source: Authors' summary based on Eurostat (2019) and reviewed literature. Illustration by Isabela Deichmann

Several names of variables used in this analysis were adapted from their original Eurostat labels as single-word descriptors to assist with the analysis, as clarified in Table 1. The rationale for modifying dimension names is to make them more user-friendly with a single intuitive title.

Table 1: Dimensions in this analysis and their Eurostat (2019) origins

Dimension	Eurostat Dimension	Rationale, or topic reflected by variable
Wealth	material living conditions	household disposable income, consumption, housing
Work	productive or main activity	"work fills up a citizen's life every day" (Eurostat 2019)
Health	Health	no changes
Education	Education	no changes
Social	leisure and social interactions	"networks and social connections" (Eurostat 2019)
Security	economic and physical safety	economic security and protection from physical harm
Governance	governance and basic rights	whether government makes things fair for society
Environment	natural and living environment	concern about air, water, noise pollution
Overall	overall life experience	one word is concise and sufficiently descriptive

Based on our definitions of each dimension, we directly aggregate the responses from each iteration of the survey to obtain the scores for each dimension and each country. To visualize the performance of each country group at each iteration, we compute the average scores for each dimension within each group and demonstrate the results using a radar graph. Then, following Bessler (2003), to discover the structure of the six dimensions relative to overall happiness, we apply a data-driven machine learning method known as "Directed Acyclic Graphs (DAGs)". The software GelNe 3.0 Academic is employed to conduct this analysis. The goal is to compare the causal path structure discovered from the nature of this raw data with the hypothetical structure shown in Figure 1, which is based upon a combination of scholarly literature and intuitive expectations. Ultimately, this will also unveil differences across country groups over time to determine whether perceived quality-of-life in Europe has converged since EU accession, with the eleven post-communist New Member States being the main area of interest.

4. Data

Our country-specific data are from the EQLS, which is administered approximately every four years across Europe. EQLS seeks to assess the "objective circumstances" in the lives of Europeans, paying attention to how they feel about employment, income, education, housing, family, health, and work-life balance. In addition, it provides information about subjective issues such as level of happiness, life satisfaction, and how they perceive the quality of their society.

The EQLS data used in this analysis have been collected at four points in time, with national sample details provided in the Appendix. The samples were collected as follows:

- 2003 (N=26,257) 28 countries are included in the dataset (EU 27 + Turkey)
- 2007-08 (N=35,634) Added to the dataset are Croatia, North Macedonia, and Norway.
- 2011-12: (N=43,636) Added to the dataset are Kosovo, Serbia, Montenegro, Iceland; Norway is removed.
- 2016: (N=36,908) Added to the data is Albania; Iceland and Kosovo are removed.

These years are ideal for our analysis because they represent three important junctures in time for European countries. In 2003, the EU had 15 members, and was on the verge of its 2004 major expansion to ten countries. By 2007, the GFC had begun. The year 2013 is important as the first data point at which many of the EU countries might have emerged from the GFC. Finally, 2016 represents the most recent point for which data are available, following the EU expansion to Bulgaria and Romania (2007), as well as Croatia (2013). The analysis uses nine dimensions of wellbeing based upon the Eurostat (2019) report. Unfortunately, the COVID-19 pandemic has interfered with Eurofound's ability to conduct a fifth iteration of the EQLS, although Eurofound's Ahrendt, Mascherini, Nivakoski, and Sándor (2021) provide an update examining the impact of COVID-19 on perceived quality-of-life with a focus on mental health and trust in institutions. The next full EQLS survey is planned for 2026.

To facilitate analysis, countries in the dataset retain their group membership throughout the period of study. In other words, the group of EU-15 states reflects pre-2004 EU membership plus Cyprus and Malta, non-communist states that joined in 2004. Similarly, the group of NMS-11 countries includes Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. Group membership remains the same throughout the study period because the focus is mainly on whether post-Communist states achieved socio-economic convergence by joining the EU. In addition, the impact of EU accession is a gradual process that is impossible to associate with a single official date of accession. The non-EU "high income" group contains Norway in 2007 and Iceland in 2012. The non-EU group includes North Macedonia, Montenegro, Kosovo, and Albania (all post-communist states) plus Turkey. The availability of data for each country is limited to the years for which the EQLS was administered there (see Appendix B).

The EQLS includes four types of question formats: scale questions, nominal questions, yes/no questions and "enter a number" questions. These required standardization prior to the present analysis. In the end, all the variables represent scores from 0-10. Eurostat's scale answers include ranges from 1 to 5, 1 to 6, and 1 to 10. All scores were rescaled to a range of 1 to 10. For example, if the scale of a question was from 1 to 5 and response is 4, the new score became 8 after rescaling. For yes/no questions, the response "yes" reflects either higher or lower quality-of-life. In this case, the score depends on the nature of the question (higher or lower). For example, if the response "no" presents better quality-of-life the score "10" is used, "yes" yields the score of 0. Nebulous questions were omitted from the new set of variables. Nominal questions and enter-a-number questions are also omitted because they are not applicable to the summary score method. After rescaling the question formats, means of scores were calculated for groups of questions, dimensions, and countries.

To assess each of the iterations, the conceptual framework of causality illustrated in Figure 1 is used. This framework is based upon the literature on quality-of-life, as well as the authors' intuitive expectations. For example, it is expected that a respondent's natural and living environment would impact both their health and overall happiness. Similarly, wealth, governance, and education can be expected to impact economic and physical safety, which in turn plays a role in perceived overall happiness. These examples represent only two of the expected relationships to be tested using DAGs.

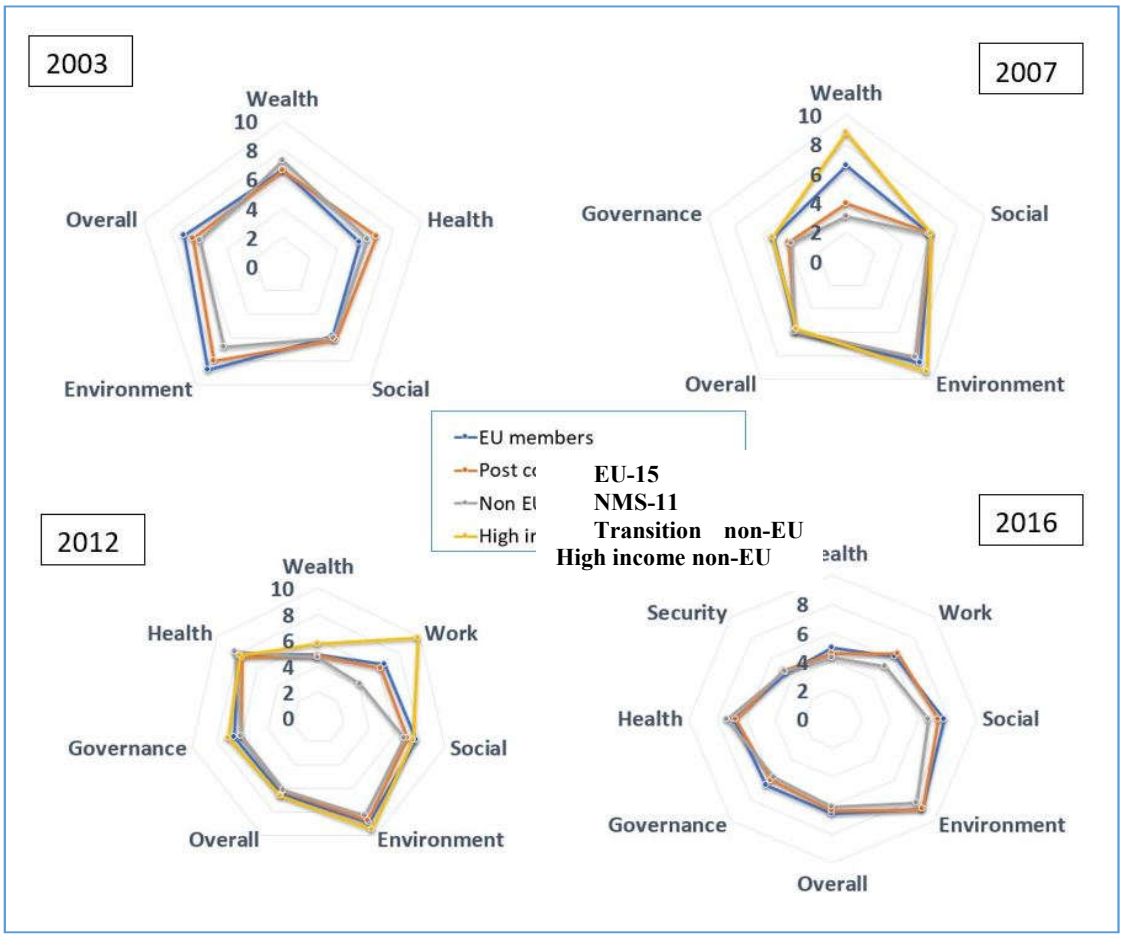
5. Analysis

This section first compares the EQLS overall scores for four groups of European countries during the four EQLS iterations using radar graphs. Next, the conceptual models for 2011 and 2016 are examined with results for the three-country groups (EU-15, NMS-11, and other).

Finally, the DAG models model equations learned from data for each of these groups are discussed.

Figure 2 provides simple radar graphs of each iteration of EQLS. Clearly, satisfaction with each dimension of perceived happiness varies over time and across Europe. In 2003, the EU-15 core countries report the highest satisfaction, especially in their natural and living environment. Ironically, the lowest dimension reported by core EU members in 2003 was material living conditions ("wealth"). The least satisfied were citizens of non-EU countries, with the lowest scores in the overall category. Early in the period under investigation (which reflects the start of political and economic transition in post-socialist countries), citizens of non-EU countries were clearly optimistic about prospects for greater wealth.

Figure 2 Radar Plots of Dimensions for European Country Groups



Data Source: Eurofound (2019)

Figure 2 also indicates that on the eve of the GFC (2007), high income EU members as well as Norway had very positive perceptions of material wellbeing (or "Wealth"), while all four groups expressed even higher satisfaction with the environment. During the entire period under investigation, concerns for environmental awareness remain high in Europe, with widespread support for policies and agreements (Drews, Antal, and Van den Bergh, 2018). Norway, which demonstrates that high overall quality of life does not require EU membership, was removed from the EQLS after 2007.

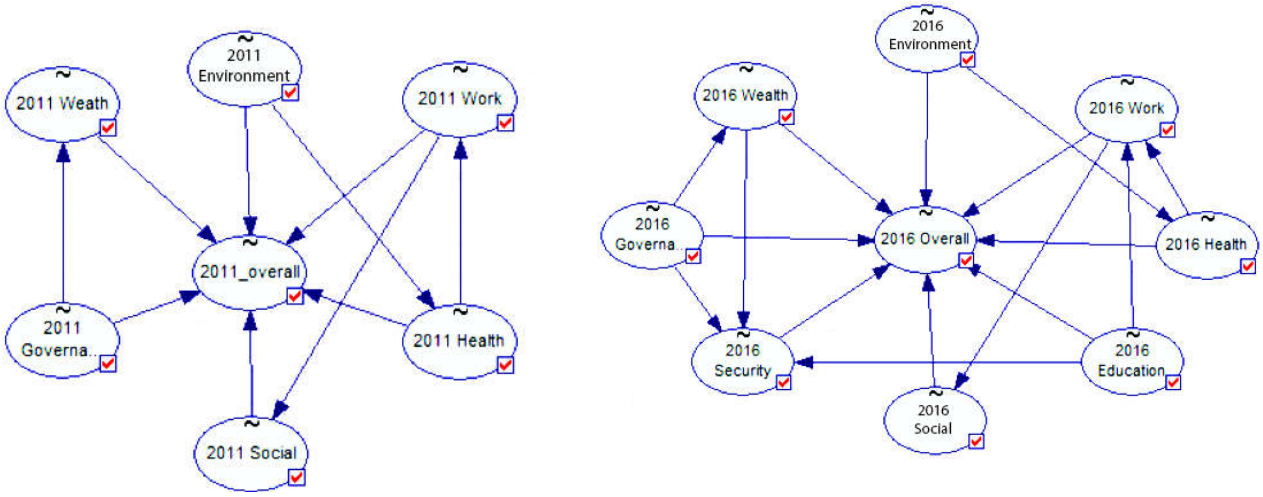
Iceland appears only in 2012, alone showing high perceptions of work in that survey (Figure 2). The 2012 EQLS indicates that satisfaction with health and work dimensions increased even after the GFC, especially in the EU core members and NMS-11. The 2016 EQLS survey shows the greatest similarity across the four country groups, reflecting some measure of convergence in perceived satisfaction across dimensions based upon the EQLS. This also reveals the omission of Norway and Iceland, which are both high income non-EU countries. Finally, it is worth noting that the four radar charts show that over time (as the four iterations progress) a greater number of dimensions becomes perceived positively by

respondents in the entire sample, adding the dimension of governance in 2007 (total of five dimensions), health and work in 2012 (total of seven), and security in 2016 (total of eight).

5.1. Analysis of Conceptual Models

Figure 3 compares the DAGs for the eleven New Member States (NMS-11) in 2011 and 2016, showing increasing complexity in the dimensions that contribute to perceived quality-of-life. These are data learning models, meaning that the illustrated flows are generated by the signficance of variables as opposed to the conceptual model presented in Figure 1. The relationship between variables become increasingly complex in the new member states over time, with the addition of education and security as explanatory variables in 2016. The other two differences include the role of perceived wealth impacting perceived economic and physical security, as well as education contributing to productive activities (work).

Fig 3. DAGs for Conceptual Models 2011 and 2016



Models generated by EQLS results (Eurofound, 2019)

The temporal changes illustrated in Figure 3 between EQLS 3 and 4 seem to reflect convergence of the NMS states toward the living standards of core EU states. For further examination, the three major groups of countries can be compared side-by-side in Tables 2 (2011) and 3 (2016). The rows in each table are based upon the variables in the DAGs of Figure 3.

Table 2 shows more similarity between the drivers of overall happiness between the EU Core and the NMS-11 than is the case with the non-member states. In each of the three groups, the main determinant of perceived happiness is work, or productive activity, followed by social interactions. These can be interpreted as a sense of purpose and community. The significance threshold to include variables in the tables is .05. Across all three groups, it is possible to see from the negative coefficients that in 2011, wealth does not buy happiness. In fact, in each of the three groups, it is perceived to have the opposite effect.

In the wake of the GFC of 2007-08, it is unsurprising to observe skepticism toward the happiness effects of money. Wealth has an even larger negative coefficient in the post-communist states, possibly attributable to deep seated disdain for materialism that was institutionalized under communism. In agreement with Sanfey and Teksoz (2007), evidence is found from the EQLS that satisfaction with life can be explained in part by a country's transition. Unsurprisingly, perceived happiness in the EU Core is associated with good governance, while this does not hold true in the NMS-15 or non-members. Also notably, the EU core diverges from NMS-11 and non-members with the regard to the importance of environment. This confirms Streimikiene's (2015) findings on the influence of environment on quality-of-life.

Table 2: Conceptual Models of Overall Satisfaction 2011 (coefficient magnitudes)

Dimension	EU Core	New Members	Non-Members
Wealth	-.032	-.047	**-.069**
Health	.026	.032	.017
Social	**.051**	**.063**	.039
Work	**1.025**	**.914**	**1.036**
Governance	**.213**	**-.150**	**-.188**
Environment	.018	-.009	-.012

Note: if a variable is not statistically significant, it does not appear. Coefficients of greater than .05 are boldfaced.

In the 2016 model based on EQLS4, the role of governance and basic rights clearly emerged as a determinant of perceived satisfaction in all three groups of countries. This could reflect the instrumental role of policy makers in moving Europe out of the recession that likely impacted EQLS 3 in 2011. Indeed, based on EQLS 4, in 2016 material wealth because a positive and significant predictor of satisfaction across all three groups. Probably reflecting increased attention toward climate change, the condition of the natural and living environment is also associated with perceived happiness. The importance of social interactions remained present.

Table 3: Conceptual Model of Overall Satisfaction 2016 (coefficient magnitudes)

Dimension	EU Core	New Members	Non-Members	
Security	.047	.042	.049	
Governance	**.238**	**.259**	**.282**	
Environment	**.062**	**.073**	**.072**	
Wealth	**.064**	**.057**	**.109**	
Work	.009	.023	.028	
Health	.016	.021	.030	
Education	.006	.028	.007	
Social	**.095**	**.058**	**.076**	

Note: if a variable is not statistically significant, it does not appear. Coefficients of greater than .05 are **boldfaced**.

The fact that governance, wealth, environment, and social all emerged with strong coefficients across the three groups suggestions some evidence for convergence across Europe, if only in terms of perceived happiness and what contributes to it. This is an important observation from the EQLS that is generally in harmony with the socio-economic convergence literature, although some scholars such as Gräbner at al. (2017) argue that institutional changes such as euro adoption can compound divergence, while public (government) industrial and redistributive policies can lead to convergence (Gräbner at al., 2020a, 2020b). What might help reconcile this difference in findings is the fact that some members of the EU core (Sweden, Denmark, and the UK at the time) did not use the euro, while some NMS such as Slovakia and Slovenia did.

5.2. Analysis of Data Learning Models

The Data Learning Models generate Tables 4 (2011) and 5 (2016) and show dramatic changes between the five years 2011-2016 between EQLS 3 and EQLS 4.

Table 4: 2011 Data Learning Model of Overall Satisfaction (coefficient magnitudes)

Dimension	EU Core	New Members	Non-Members
Security			
Governance			
Environment			
Wealth			
Work			
Health			.033
Education			
Social		.214	.204

Note: if a variable is not statistically significant, it does not appear.

Using the data learning model, Table 4 shows no significant variables for the EU core in 2011. Similarly, only a pair of dimensions appear as significant for NMS-11 and non-members. In 2011, the only significant dimension in determining overall quality-of-life for new members is social interactions, while overall life experience is governed by non-members this factor and health in non-member states.

Table 5: 2016 Data Learning Model of Overall Satisfaction (coefficient magnitudes)

Dimension	EU Core	New Members	Non-Members
Security	.042		.037
Governance	**.259**	**.239**	**.267**
Environment	**.073**	.053	**.078**
Wealth	**.057**	**.075**	
Work	.023		
Health	.021	.020	.047
Education	.028		
Social	**.058**	**.093**	**.085**

Note: if a variable is not statistically significant, it does not appear. Coefficients of greater than .05 are boldfaced.

Table 5 shows the models of satisfaction in overall life experience generated by the 2016 responses. These models are much more robust than those from the 2011 data. The predominant role of governance in determining overall happiness is confirmed for all three country groups. It appears to be strongest in non-members (.267), followed by EU core (.259) then new members (.239). Perhaps the slightly lower score for the new member countries is an enduring attitude of suspicion toward government from Communist times.

Gräbner et al. (2017) examine household debt across Europe and find evidence of macroeconomic divergence based on euro adoption. It is plausible that this investigation was confounded because five of the NMS-11 have adopted the euro; specifically, Slovenia (2007), Slovakia (2009), Estonia (2011), Latvia (2014), and Lithuania (2015). Moreover, several EU core members remain outside the eurozone. It is therefore problematic to distinguish between Europe's core and its periphery based on euro adoption.

While this paper illustrates the utility of DAGs in quality-of-life analysis, several limitations should be acknowledged. Administering the EQLS is an enormous undertaking, and it therefore occurred only every 4-5 years even before the most recent planned iteration in 2021 was postponed by COVID-19. Altogether, it has thus far only been administered four times, and the subject countries have changed. For example, Norway was omitted in 2011 and Iceland and Kosovo in 2016. Ideally, scholars would have a complete set of countries to analyze more data points. Moreover, the delay in EQLS 5 due to COVID-19 will complicate a full follow-up to this study. In the meantime, other data sources might help tell the story especially during the pandemic. EQLS questions and formats varied over time, complicating the already daunting task of recoding data. In the present study, variables were recoded to continuous scales of 1-10, which assumes a certain level of comparability across scales, possibly introducing a bias. In addition, the data used here are self-reported and inherently subjective. Satisfaction for a French respondent might be different than for a Romanian respondent. Moreover, it is impossible to determine exactly what biases were introduced to households during reporting.

6. Suggestions

These findings lead to some suggestions for policy and future research. In short, policy makers should focus now upon improving the key determinants of quality-of-life. These include good governance, environment stewardship, improving material living conditions, and enhancing social interactions. Although represented by different dimensions in the EQLS survey, these dimensions can all be fundamentally driven by government policy. Echoing suggestions by Gräbner et al. (2017, 2020a, 2020b) government has several tools at its disposal, including industrial and public investment. In Europe, most governments possess the prerogative to redistribute greater amounts of resources than in some other parts of the world. Based on this study and especially supported by the 2016 EQLS, perceived quality-of-life could be improved by policies protecting the environment, promoting security, and economic

growth, while supporting public health and education. Taken together, the findings here clearly point to the importance of good governance in promoting overall happiness. Governance can also impact other dimensions, which in turn improve overall satisfaction.

The considerable differences across studies of whether socio-economic economic convergence is evident in Europe result from the different time periods and countries considered, as well as different methodologies. It is plausible that all the findings are correct and indeed useful. Findings vary over geographic space. In pursuit of socio-economic convergence, governments of the NMS-11 and other states should mimic the EU core states in their public policies.

To augment this research, one obvious direction to pursue is a replication of this study after the next EQLS. This will capture not only the widespread disenchantment with the EU that culminated in Brexit, but also the effects of the COVID-19 pandemic upon overall life experience across Europe. Unfortunately, the next EQLS is not expected to take place until 2026, with some additional delay in reporting. It will, therefore, be necessary to revisit these issues using data from different sources. Complementary data will help probe into the reason why the determinants of overall quality-of-life vary over time (2003-2016) and across groups of countries. Because the EQLS data are limited to four iterations, some nuances in determinants of overall life satisfaction may have been missed, which is ironic given that the surveys probed into the perceptions of tens of thousands of individuals.

7. Conclusions

This paper makes several contributions to the literature on quality-of-life in Europe. First, it introduces a robust conceptual model to capture the determinants of overall life satisfaction. The model examines the role of wealth, work, health, education, social interactions, security, governance, and environment in influencing perceived overall satisfaction. Other commendable scholarship focuses strictly on one dimension such as environmental indicators (Štreimikienė, 2015) or material wellbeing such as real GDP per capita (Cieślik and Wciślik, 2020).

Second, the research answers the question about whether EU membership contributes to convergence in perceived overall life experience. The answer is a resounding ‘yes’, made clear by the similar role played by governance, wealth, social interactions, and environment in 2016. Evidence of convergence is in harmony with early work by Matutinović (1998) and Giannias et al. (1999).

Third, the authors acknowledge that despite the merits of EQLS data, this research needs to be substantiated with further inquiry using additional data beyond the release of the next EQLS, expected after 2026. The robust data used here to probe for answers to the question of convergence in overall life experience demonstrates progress made by the NMS-11 as well as frustration caused by the GFC (confirming work by Gräbner et al., 2017), followed by further perceived relief associated with recovery in 2016. Because of the onset of pandemic effects in 2020, EQLS 5 has been postponed, leading to a lack of data that would shed insights into respondent uncertainties about European integration following Brexit and COVID-19. As a result, while the present is a vitally important time to revisit the perceived role of government and health in overall wellness, lapsed EQLS data following an entire decade since 2016 will be less useful. Moreover, scholars will need to devise an entirely new research methodology to separate from perceived quality-of-life the socio-economic effects of the Syrian and Ukrainian refugee crises and COVID-19. Published research on effects of the latter, including work by Ahrendt, et al. (2021) has been insightful but largely speculative due to the ongoing nature of the crisis.

The importance of governance in determining perceived quality-of-life across the EU-15 and NMS-11 has been demonstrated here. The present findings confirm research on socio-economic convergence by Gräbner et al. (2020a, 2020b) by employing a very different methodology. Further research using other data sources can shed additional insights on the relationship between governance and health, as well as the direct influence of health upon overall life experience. Moreover, as this research has shown the importance of natural and living environment to satisfaction, the ongoing global dialog surrounding climate change will likely lead to even more discussion about how environmental conditions impact quality-of-life. Remembering that EQLS data are based upon personal perceptions, findings from

follow-up research will be particularly compelling in the wake of the global pandemic and the invasion of Ukraine, both of which will certainly impact European perceptions of wellbeing for the foreseeable future. Assessing the role of these and other current events will require augmented methodologies and new data.

Finally, since the signing of the Treaty of Paris in 1951 brought into effect the European Coal and Steel Community one year later, the European integration project followed a relatively uninterrupted trajectory toward greater depth and breadth through Croatia's 2013 accession as its 28th member and until the United Kingdom became the first to leave with its 2016 Brexit vote. For the most part, shared institutions continued to expand for more than half a century while Schengen and the eurozone enhanced social and economic mobility across much of Europe, facilitating better living standards. Currently, as additional countries continue to pursue EU accession amid growing frustration and Euroscepticism, the EU has reached a crossroads, raising two questions. First, do existing members still have the fortitude to admit new members that generally lag behind their standards of living? Second, do prospective members possess the resolve to continue pursuing accession when benefits remain unclear at best and the timeline for admission is dubious? This paper concludes that EU accession has generally benefitted the NMS-11. However, especially as Europe weathers the social, political, and economic storms of a pandemic and multiple refugee crises, the question of EU expansion remains an open one that must be informed by further inquiry as events continue to unfold.

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Appendix A: Quality-of-life Dimensions (adapted from Eurostat, 2019).

Material living conditions ("Wealth"): This dimension is measured based on three sub-dimensions: income, consumption and material conditions. Income is an important indicator as it has an impact on most of the other indicators. There are several different indicators within this sub dimension, taken from both national accounts and household surveys (net national income, household disposable income).

Productive or main activity ("Work"): The most important activity that fills up a citizen's life every day is work. Indicators measuring both the quantity and the quality of jobs available (working hours, balancing work and non-working life, safety and ethics of employment) are some of the indicators used in Europe to measure this aspect of quality-of-life.

Health ("Health"): This is an essential part of quality-of-life among citizens as poor health can affect the general progress of society. Physical and/or mental problems also have a very detrimental effect on subjective well-being. Health conditions in Europe are mainly measured using objective health outcome indicators such as life expectancy, infant mortality, the number of healthy life years.

Education: In our knowledge-based economies, education plays a pivotal role in the lives of citizens and is an important factor in determining how far they progress in life. Levels of education can determine the job an individual will have.

Leisure and social interactions ("Social"): The power of networks and social connections should not be underestimated when trying to measure the well-being of an individual, as they directly influence life satisfaction. In Europe, this is measured in terms of how often citizens spend time with people at sporting or cultural events or if they volunteer for different types of organizations. In addition, the potential to receive social support and the frequency of social contacts are indicators included in the framework under this dimension.

Economic and physical safety ("Security"): This dimension refers to citizen's ability to plan and overcome any sudden deterioration in their economic and wider environment. Safety is measured in terms of physical safety (e.g., the number of homicides per country) and economic safety. For the latter, wealth indicators should ideally be used, but for the moment there is no comparable data on the topic for all European countries.

Governance and basic rights ("Governance"): An important aspect of quality-of-life is the right to get involved in public debates and influence the shaping of public policies. Moreover, providing the right legislative guarantees for citizens is a fundamental aspect of democratic societies. Good governance depends on the participation of citizens in public and political life (for example, involvement in political parties, trade unions etc.).

Natural and living environment ("Environment"): The protection of the environment has been very high on the European agenda over the last few decades. Most European citizens believe that protecting the environment is important. Exposure to air, water and noise pollution can have a direct impact on the health of individuals and the economic prosperity of societies. Environment-related indicators are very important for assessing quality-of-life in Europe and in general.

Overall life experience: this is measured using three sub-dimensions: life satisfaction (cognitive appreciation), affect (a person's feelings or emotional states, both positive and negative, typically measured with reference to a particular point in time) and eudemonics (a sense of having meaning and purpose in one's life, or good psychological functioning.).

Appendix B: European Quality-of-life Survey Collection Phases

	1st (2003)	2nd (2007)	3rd (2011)	4th (2016)	Total
Austria	1007	1043	1032	1181	4263
Belgium	1005	1010	1013	1017	4045
Bulgaria	1007	1030	1000	1016	4053
Cyprus	598	1003	1006	1009	3616
Czechia	995	1227	1012	1014	4248
Germany	1052	2008	3055	1631	7746
Denmark	999	1004	1024	1020	4047
Estonia	591	1023	1002	1001	3617
Greece	1002	1000	1004	1096	4102
Spain	1005	1015	1512	1005	4537
Finland	997	1002	1020	1052	4071
France	1033	1537	2270	1198	6038
Croatia	0	1000	1001	1011	3012
Hungary	1001	1000	1024	1042	4067
Ireland	990	1000	1051	1011	4052
Italy	1004	1516	2250	2007	6777
Lithuania	1001	1004	1134	1005	4144
Luxembourg	605	1004	1005	1021	3635
Latvia	1004	1002	1009	1000	4015
Malta	603	1000	1001	1000	3604
Netherlands	1050	1011	1008	1010	4079
Poland	1000	1500	2262	1009	5771
Portugal	998	1000	1013	1070	4081
Romania	1030	1000	1542	1004	4576
Sweden	1000	1017	1007	1053	4077
Slovenia	601	1035	1008	1003	3647
Slovakia	1071	1128	1000	1019	4218
United Kingdom	1012	1507	2252	1304	6075
Albania	0	0	0	1011	1011
Iceland	0	0	1000	0	1000
Kosovo	0	0	1076	0	1076
Montenegro	0	0	1000	1000	2000
North Macedonia	0	1008	1006	1013	3027
Norway	0	1000	0	0	1000
Serbia	0	0	1002	1056	2058
Turkey	996	2000	2035	2019	7050
Response Total	**26,257**	**35,634**	**43,636**	**36,908**	**142,435**

DIGITALIZATION OF ECONOMY AND LIVING STANDARDS OF POPULATION IN RUSSIAN REGIONS[1]

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Abstract

The study of territorial inequality in the modern economic space corroborates the relevance of the strategic goals of enhancing the living standards of the population amid digitalization of the economy. Despite the regional disparities in the social and economic development of the Russian regions, favorable factors for the responsiveness to digitalization in various economic and social spheres formed. They include the high quality of human capital, a relatively sufficient level of Internet access among population, modern infrastructure in a significant number of the regions, increased organizational costs for the introduction and use of digital technologies, etc. Therefore, the purpose of the research is to assess the indicators of digitalization in the regions, their territorial disparities and model the indicators of living standards as well as the use of information and communication technologies by the population and in organizations. The research features a typology of regions according to the main indicators of digitalization with the identification of the top regions, where capital territorial entities of the Russian Federation and the northern regions with a high household income, an economy dominated either by processing and knowledge-intensive industries, or with a raw-material focus, stand out. It has been noted that over the past fifteen years, interregional differentiation by digitalization indicators has been decreasing, however, problems persist in the eastern remote and underdeveloped regions in the south of the country. The research is of practical value in terms of economic and mathematical modeling of digitalization and internetization process in relation to living standards of the population.

Keywords: digitalization, region (RF subject), indicators, human capital, internetization, modeling

JEL classification: R23, J610

[1] While drafting the article, the authors used the following materials and research: the results of in-depth interviews with employees of the Ryazan Region employment service, conducted in 2021 as part of the research work entitled "Digitalization of the Labor market and Employment in Russia: Trends and Development Mechanisms", funded by the Federal State Budgetary Educational Institution of Higher Education Plekhanov Russian University of Economics (Order No. 867 dated June 28, 2021); the results of expert discussions and surveys of the heads of employment services of the regions in the central federal district as part of the research entitled "Organizational and Financial Mechanisms for Supporting Employment of the Population in 2021-2023, Aimed at Reducing the Unemployment Rate", carried out by the Research Financial Institute following the state order of the Ministry of Finance of Russia (092-00001-21-00).

1. Introduction

Digitalization of the economic space is becoming an essential part of modern society, where the speed of information dissemination outpaces the established traditional approaches to the perception and performance of professional activity (Kokkinou et al., 2018). In economically developed countries, digital economy is advancing much faster than in developing countries, therefore, many scientists and experts consider it as a new challenge to society (Kudumakis, P. et al., 2019). The objective need for the digital economy development is considered today as one of the priority goals to protect an individual, society and the state from macroeconomic instability (Chistnikova et al., 2017). This way, not only the constitutional rights of a citizen will be exercised, but also decent living standards will be ensured (Belyakova et al., 2017). Moreover, the tasks defined to achieve this goal should have a positive impact on one of the most significant social problems in Russian– reducing the poverty level of the population, as well as achieving sustainable socio-economic development of Russia amid digital economy.

Despite the significant use of new technologies in various economic spheres, the problem of digital inequality between territories is aggravating (Kalybekova et al., 2021). It is connected with a number of reasons of a different nature, to a great extent with the level of socio-economic development, as well as with the characteristics of the location, its remoteness or proximity to large cities. This problem is common for many countries with a relatively large territory, therefore, it is a global problem (Krugman, P.R., 1991, Rusanovsky V., Markov V., 2016).

Nevertheless, Russia saw the development of factors positively affecting the responsiveness to digitalization, especially in the context of improving the living standards in the regions (Larionova et al., 2018). Thus, studying the degree of connection between the main indicators of digitalization and living standards, as well as assessing territorial inequality or digital divide, imbalance in the modern economic space are of scientific and practical interest (Mikhaylova, A., 2021).

The role of digitalization in the economic and social development of the country's territory can be compared with the creation of new added value in the top industries with focus on export (Gribanov Yu.I., Shatrov A.A. 2019). It introduces fundamental changes in the business activities of organizations, their corporate culture, management system, social sphere, and, as a result, in economic growth.

2. Literature Review

According to scientists of the Russian Academy of Sciences, digitalization of the economy opens up a lot of new opportunities for acquiring knowledge, mastering new professions and upgrading your qualifications (Maltseva et al., 2019). At the same time, traditionally, any socio-economic phenomenon, which is in most aspects progressive, is a combination of contradictory factors that also have negative developments (Pessoa, 2013). It is expressed in the reduction of jobs that are no longer required and are no longer functional, changes in the rules of admission to new jobs and requirements for competencies, skills, knowledge of employees (Dudin M., et al. 2021).

In 2020, the World Economic Forum (WEF) published the Future of Jobs Report 2020, which forecasts the disappearance of 85 million jobs by 2025 and the creation of 97 million new ones instead of them thanks to the use of new technologies (RIA News. 2020). However, these new jobs will appear much more slowly than previously expected, while old jobs, on the contrary, will begin to disappear faster. New realities of the labor market associated with the digital transformation of the economy also need to be taken into account, so according to forecasts of human resources experts, already in this decade, such industries as metallurgy, petrochemicals, transport, production of rubber, construction materials may significantly reduce labor resources due to the transition to the digital. Such changes are based on the objective reasons of automation and robotization, the introduction of unmanned production technologies, which help save both on production materials and on technological and managerial operations. Such changes in the market require a flexible approach both in the human resources training system, and in the higher education system in particular (Rossiyskaya Gazeta, 2021).

In early 2021, the Ministry of Economic Development issued an overview of global changes in the labor market, which says that the increased use of digital technologies in work processes during the COVID-19 pandemic accelerated the trends in the global labor market that had started developing even before. The risks of job cuts due to automation have become more real; skills required by employers mismatch those of the labor force; education systems is not effective in preparation of the future workforce. At the same time, the latest research shows that some of the negative forecasts are not materialized, and some of the emerging trends were not predicted earlier.

Theoretical approaches to the research are based on the fundamental works by foreign scholars who studied the problems of socio-economic systems (D. Bell, 1973; Parker G., 2016, Schumpeter J., 1908, M. Friedman, 1994, et al.).

Russian and foreign economists offer various methodological approaches to the analysis and assessment of regional differentiation (Granberg A., 2003, Zubarevich NV, 2014, Nikolaev I., et al. 2011, Porter, 2001, Krugman P., 1994, and etc.).

The situation with the coronavirus pandemic today, combined with the intention of companies to increasingly digitilize their activities, is accelerating the transformation in the labor market not in favor of workers. Thus, digitalization creates a demand for highly qualified IT experts, however, the segment of intermediate-level workers suffers, as automation replaces routine work. During the pandemic in Russia, the demand for couriers increased, while the demand for qualified programmers stayed the same, but the demand for mid-level specialists decreased sharply. This may be a sign of the labor market polarization caused by digitalization (Podtserob M., 2020).

3. Materials and Method

The Digital Economy of the Russian Federation National Program (National Program, 2019), as well as a number of documents containing a program of action, in particular, the Electronic Russia (2002 - 2010) , Information Society (2011 - 2020) state programs, which rely on and are aimed at the implementation of the Strategy of the Information Society Development in the Russian Federation for 2017-2030 (Decree, 2017), are dedicated to the creation of the conditions for the development of digital economy. These strategic documents were used as the main data source, as they allow for a comprehensive analysis and discussion of one of the five basic areas for the development of the digital economy by 2024 – "Personnel and Education". The data of the Federal State Statistics Service (2020) were used as the main information source for the research. Therefore, the paper examines the main aspects that best demonstrate the responsiveness of organizations, the population and regions as a whole to the new realities of digitalization in the regions.

Research approach. Territorial, comprehensive, historical and typological approaches were used as the main ones among the traditional approaches. The use of new approaches is shown based on a system analysis and study of the problems of regional development in modern conditions. A constructive approach is connected with the research of digitalization processes in the regions in terms of the possibility and feasibility of their use in life and economic activity.

The research rests on the key provisions of the comparative analysis methodology, which makes it possible to study the problems of socio-economic development of complex systems in the temporal and spatial aspects, typologization of regions in order to rank them and determine their responsiveness to digitalization.

The statistical method, the method of economic and geographical research, including the regional method, as well as the taxoning method, during which territories comparable in hierarchy – macroregions and regions – are analyzed, are the most important research methods (Granberg A.G., 2009, Minakir P.A., 2010, Nekrasov N.N., 1973, Tatarkin A.I., 2008, Tikhomirov N.P., 2007).

The paper analyzes and assesses socio-economic indicators that illustrate the specific features of informatization and the use of information and communication technologies in the regions. Content analysis, which is a method of collecting data and text analysis with conclusions made based on studying the content of publications of respected researchers on a specific scientific and practical problem was used as the key method for analysis and

comparison. The method allows you to obtain accurate results based on the study of texts available to public using a comparative analysis with the results presented in graphs, diagrams and tables. The study analyzes the following as indicators showing the development level of information and communication technologies and their availability to the population:

- the costs of organizations for the implementation and use of digital technologies;
- the proportion of organizations that used global information networks, by type of economic activity,
- indicators of digitalization and economic development of top regions,
- the share of organizations that used personal computers, by territorial entities of the Russian Federation,
- the composition of the employed population by educational level;
- use of the Internet by the population by type of purpose;
- using the Internet to receive state and municipal services in electronic form;
- provision of uninterrupted broadband Internet access;
- the main indicators of the living standards of the population in the top regions;
- the share of the population using the Internet by type of area,
- using the Internet in households,
- availability of broadband access to the global network for households.

4. Analysis and results

A number of prerequisites have developed in the Russian Federation for the introduction of the digital economy foundations into economic and social practice, which includes the use of new digital technologies in enterprises and organizations, Internet resources, high quality human capital, training of professional experts in IT technologies, advanced training of workers, development of modern infrastructure necessary for progress in the regions, etc.

The digital component in the social and economic life today has increased significantly, including in the regional labor and capital markets (Yalyalieva et al., 2017). This is connected with a change in the operating models of companies aiming at a complete digital transformation and the use of technologies using artificial intelligence, which has an impact not so much on the number of jobs as on the content of professional activities. All data is processed digitally. Today, when digitalization seeks to globally cover countries and their labor markets, information becomes open and accessible, which leads to changes in social life, in business and affects the living standards of the population. The availability of goods and services in the digital economy is becoming easier and faster over time (Baburin et al., 2018) The time spent on document transfer between organizations is decreasing, processes in the labor market are accelerating, with a huge flow of information about job vacancies and career opportunities. One of the aspects of digitalization is remote forms in making decisions about hiring an employee and the operating procedures, which manifested itself during the coronavirus pandemic. One of the positive results of this phenomenon is that workers are not dependent on their place of residence. The negative consequences include a decrease (loss) in demand for some professions or the possibility of replacing vacancies in the field of human resources management, auditing, insurance with new information technologies.

One of the results of these developments is a high demand for employees with digital competencies. However, the modern education and training system often lags behind the needs of the market. Therefore, the importance of informatization is significant, as it is able to change the form and methods of personnel training depending on the needs of companies.

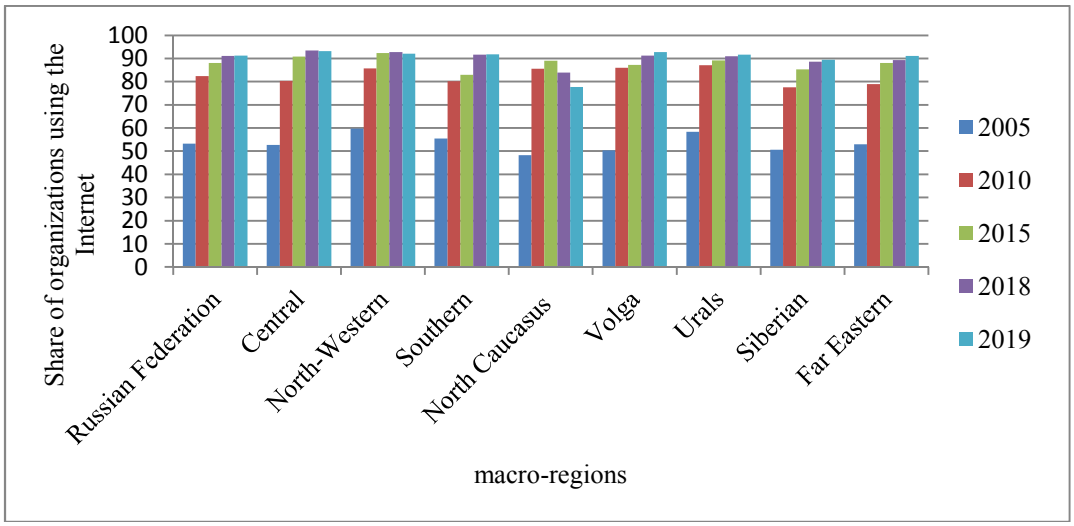
Analyzing the costs of organizations for the introduction and use of digital technologies is of great importance for assessing the digitalization of the economy in the regions and labor markets (Pleshanova et al., 2019). Digital technologies facilitate the development of processes and methods for finding information, collecting and storing it, as well as processing and distributing it. Therefore, the costs of enterprises and organizations for their development are becoming an integral part of modern economic activity. Thus, in the cost structure, the internal costs of organizations first stand out decreasing in the last two years from 78.9% in 2019 to 71.2% in 2020. At the same time, the share of costs for the acquisition of digital technological equipment and its modernization increased, respectively, from 42.9% to 45.5% (Federal state statistics service, 2020). This corresponds to the needs of organizations focusing on digitalizing their activities.

Secondly, more than 20% of the total costs of organizations account for external costs, which grew from 21.1% in 2019 to 28.8% in 2020. The maximum share (59.2% in 2019 and 58.6% in 2020) was spent on development, rental, adaptation, improvement, technical support.

The analysis of internal organizational costs distribution into information and communication technologies by type demonstrates a positive trend for the purchase of software (by 7.1%) and for payment for the services of third-party organizations and experts in information and communication technologies (by 12%). It shows the demand for such experts, as the organizations themselves do not have them. Many types of costs are decreased due to the priority of external costs, which feature a high proportion of payment for the services of third-party organizations or physical persons.

If we study the dynamics of the share of organizations using the Internet in their activities, we can see that in six macro-regions (federal districts) in 2019, the indicator increased, as well as in the country in general (from 53.3% to 91.2%). The Central Federal District (93.1%) stands out, the North Caucasus (77.7%) District lags behind significantly and the Siberian Federal Districts (89.4%) lag behind insignificantly. Moreover, all the macro-regions have a positive dynamics, except for the North Caucasus, where the maximum value of 89.0% was reached in 2015 (Image 1). The decrease is connected with a general decrease in the number of organizations in most subjects of the macro-region in 2010-2019 by 14%.

Image 1. The dynamics of the share of organizations in the regions using the Internet access, %



Source: Authors' calculations based on data from information portals

The analysis of the share of organizations using the Internet across the regions shows significant territorial differentiation. Over the fifteen years, the regions significantly increased access to the Internet and the inequality levelled out. If in 2005 the coefficient of differentiation equaled 3.2 times, and the decile coefficient was 2.0, then by 2019 inequality decreased, respectively, to 1.64 and 1.09 times. However, in the three North Caucasus republics (the Republic of North Ossetia – Alania, the Chechen Republic, the Republic of Dagestan) the figures do not reach 80%. However, it should be mentioned that in 2005 their values ranged between 30-40%. Therefore, there is a significant breakthrough in the internetization of regional organizations.

In the Central Federal District, the maximum number of organizations using the Internet is located in Moscow and the Belgorod Region, in the North-Western Region, the Murmansk and Leningrad Regions are ahead , in the Southern – the Astrakhan and Rostov Regions, in the North Caucasus – the Republic of Ingushetia and Stavropol Krai, in the Volga Region – the Republic of Tatarstan and the Orenburg Region, in the Urals – the Sverdlovsk and Chelyabinsk Regions, in the Siberian Region – the Republic of Altai and Altai Krai, in the Far Eastern Region – Magadan Region and Kamchatka Krai. In these regions, digitalization is intensive, which correlates with the growth of their economic indicators (Table 1).

Table 1. Key indicators of digitalization and economic development of the top regions by the share of organizations using the Internet, 2019, %

Regions	Organizations using the Internet	Investments in fixed capital	Industrial production index	IPPI Index	Index of Gross Regional Product actual volume*	AVT index
Belgorod Region	96.7	116.6	103.6	105.4	102.5	101.8
Republic of Ingushetia	100.0	101.0	109.3	107.5	101.8	100.1
Moscow	98.4	108.9	108.6	110.1	103.0	101.5
Republic of Tatarstan	98.2	**96.3**	102.4	103.5	102.1	100.0
Magadan Region	96.3	**58.1**	112.6	128.3	102.9	100.1
Kamchatka Krai	95.9	110.9	**95.4**	**94.7**	107.1	103.4
Orenburg Region	95.6	96.3	103.2	103.8	102.9	102.3
Tambov Region	95.2	107.0	102.0	102.4	103.3	100.0
Murmansk Region	95.2	101.4	108.0	112.3	100.8	100.0
Vladimir Region	95.0	113.1	111.3	111.4	100.6	100.6

* - Federal State Statistics Service (Rosstat) data for 2018
Abbreviations: IPPI Index – index of industrial production in processing industry; AVT index – index of actual volume of retail turnover.
Source: Authors' calculations based on data from information portals

The regions that are ahead in terms of the internetization of their activities are characterized mainly by increased indicators of economic development: a positive annual increase in the physical volume of GRP, industrial production, including processing industries. They also show high values of the indices of investment in fixed assets and retail trade in the regions. Values below 100% are usually associated with the specific features of regional specialization, task performance in previous years, internal and external market conditions.

The next indicator is *the share of organizations that used personal computers by territorial entities of the Russian Federation*, which is calculated as a percentage of the total number of surveyed organizations of the corresponding territorial entity of the country. The analysis of this indicator demonstrates that since 2005 the gap between the regions has been decreasing, but in 2020 the disproportions increased due to a decrease in the indicator in certain entities, mostly in the North Caucasus republics (Table 2).

The digitalization of the economy depends significantly on human capital quality. Therefore, in Russia there is a high share of the population with secondary vocational and higher education. It is corroborated by the analysis of such an indicator as *the composition of the working population by level of education*. In 2019, a group of population with secondary vocational education was ahead (45%) with the second place held by the population with higher education (34%), and the third place occupied by those with secondary general education – 16.9%. The first group is leading in such macro-regions (federal districts) as the Urals (48.5%) and the Volga (47.4%) Districts.

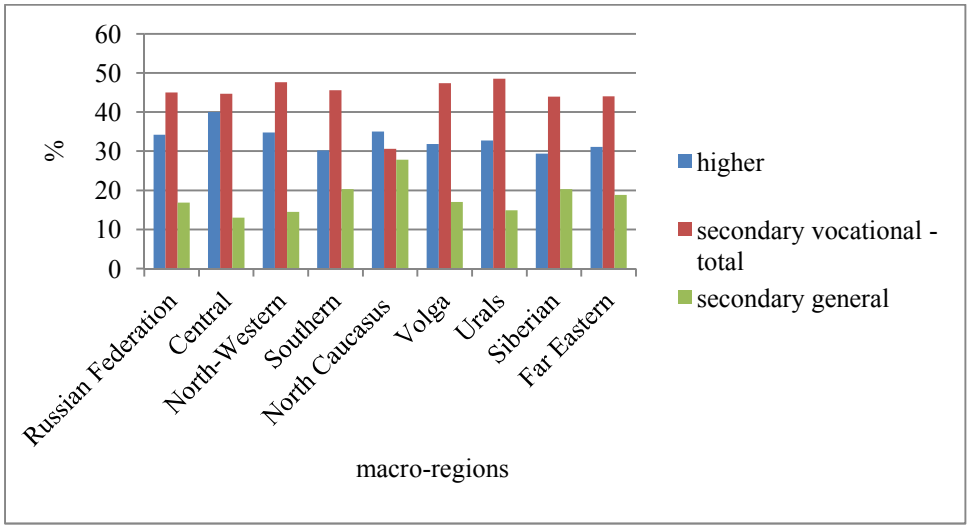
Table 2. The dynamics of differentiation of the Russian territorial entities by the share of organizations that used personal computers, %

Regions	2005	2010	2015	2020
Top regions	Voronezh Region	Tver Region	Moscow	Belgorod Region
	Moscow Region	Moscow	Republic of Ingushetia	Altai Republic
	Ryazan Region	Kabardino-Balkar Republic	Republic of Crimea	Zabaykalsky Krai
Outsider regions	Smolensk Region	Republic of Komi	Volgograd Region	Volgograd Region
	Republic of North Ossetia - Alania	Tambov Region	Samara Region	Sevastopol
	Karachay-Cherkess Republic	Karachay-Cherkess Republic	Kurgan Region	Republic of Dagestan
		Dynamics of inequality		
Coefficient of range	1.35	1.31	1.32	2.03
Decile coefficient	1.25	1.14	1.15	1.22

Source: Authors' calculations based on data from information portals

The second place is occupied by the Central (40%) District and the third place – by the North Caucasian (27.8%) District. The territorial distribution of the population according to the education level corresponds to the historical economic specialization in these entities, the demand for experts of certain qualifications on the labor market (Image 2).

Image 2. Structure of working population in the Russian Federation by education level, %



Source: Authors' calculations based on data from information portals

Russian regions differ by the share of the working population, depending on the level of education. It is worth mentioning that the regions of the top ten across all groups are significantly ahead of the indicator for Russia in general. A high share of the employed with higher education are in cities of federal significance, where the top Russian universities are located, in the North Caucasus republics, which are characterized by a high demand for higher education. Secondary vocational education prevails in the Central and North-Western Russia. A high level of secondary general education is in the regions of the southern part of the country with a developed agro-industrial sector and a high demand for low-skilled labor (Table 3).

Table 3. Top regions by the share of the working population depending on education level, %

Regions	Higher	Regions	SV	Regions	SG
Russian Federation	34.2	Russian Federation	45.0	Russian Federation	16.9
Moscow	50.4	Kostroma Region	54.4	Chechen Rep.	34.8
Rep. of North Ossetia Alania	48.1	Rep. of Bashkortostan	54.4	Rep. of Dagestan	33.8
Yamalo-Nenets AD	46.4	Rep. of Komi	54.1	Kabardino-Balkarian Rep.	30.3
Sevastopol	43.0	Arkhangelsk Region	54.1	Republic of Ingushetia	26.6
Moscow Region	42.7	Tver Region	53.9	Ulyanovsk Region	26
St. Petersburg	41.7	Rep. Karelia	53.7	Voronezh Region	25.2
Magadan Region	41.3	Orenburg Region	52.5	Karachay-Cherkess Republic	25
Rep. of Ingushetia	41.0	Ryazan Region	52.4	Zabaykalsky Krai	24.9
Rep. of Kalmykia	40.7	Chelyabinsk Region	52.2	Republic of Crimea	24.1
Karachay-Cherkess Republic	40.0	Udmurt Republic	52.1	Krasnodar Krai	23.3
		Coefficient of differentiation			
2.18		2.65		6.69	

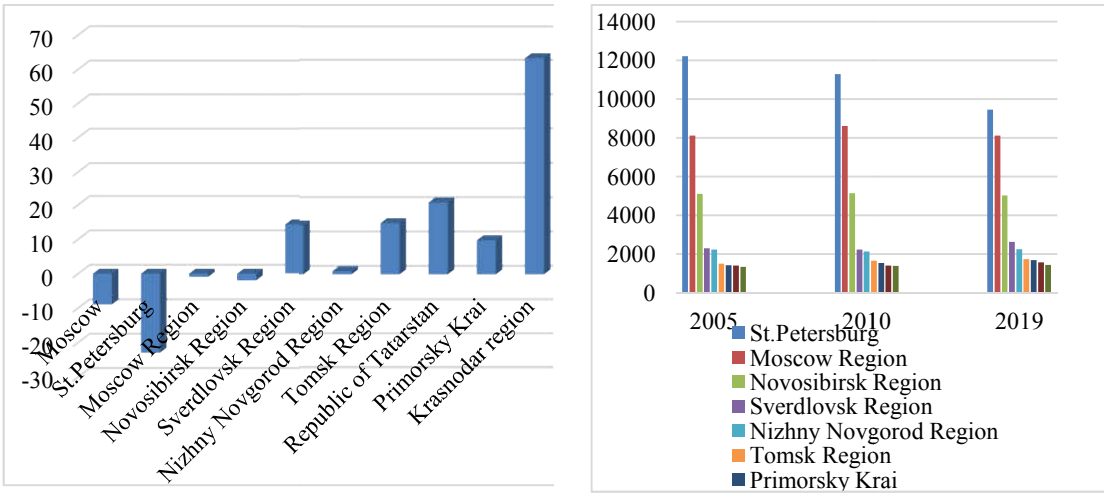
Abbreviations hereinafter: SV – secondary vocational education

SG – secondary general education
AD– Autonomous District
Rep. – Republic
Reg. – region

Source: Authors' calculations based on data from information portals

One of the indicators characterizing the human capital quality is the number of *researchers with advanced academic degrees*. In the Russian Federation, it reaches 100 thousand people, with 40% of scientists concentrated in the capital city of Moscow. Figure 3 demonstrates the dynamics of the number of scientists in the top regions which suggests a decreasing indicator in four entities and an increasing indicator in six entities, which is considered as a positive trend facilitating the research and development in various fields, including digitalization. Data on Moscow are derived from Figure 3 to improve visualization of the process dynamics.

Image 3. Dynamics in the number of researchers holding academic degrees in the top regions, persons. Change over 2005 – 2019, %



Source: compiled by the authors according to the calculation results

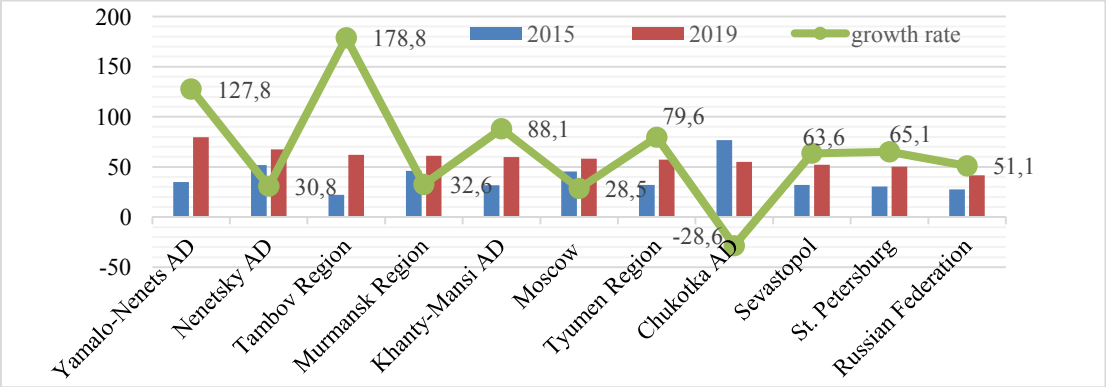
Overall, in the Russian Federation, the share of regions where the number of researchers with an academic degree increased over the past 15 years is 84% (68 entities). This is connected with the growth of funding for the scientific sector and its attractiveness for young

experts. The decrease in the indicator in the regions is due to various reasons, including moving to other territorial entities of the Russian Federation with higher level of remuneration in the research sphere and international migration.

The regions that are ahead in the number of scientists have stable financial budgets, a diversified economy, a developed scientific sector in innovative economy, and thus are attractive to researchers.

The next indicator is *the use of the Internet by the population by type of purpose*. People use the Internet resources for various purposes, including ordering services and goods, which is becoming a characteristic feature of a modern society that has the ability to improve the life quality. In Russia overall, 41.7% of the population use such services. In 32 territorial entities, this indicator is higher than the national average, with the top ten leaders (Image 4).

Image 4. Dynamics of the share of population using the Internet to order goods and services in the top regions, %*



Source: Authors' calculations based on data from information portals

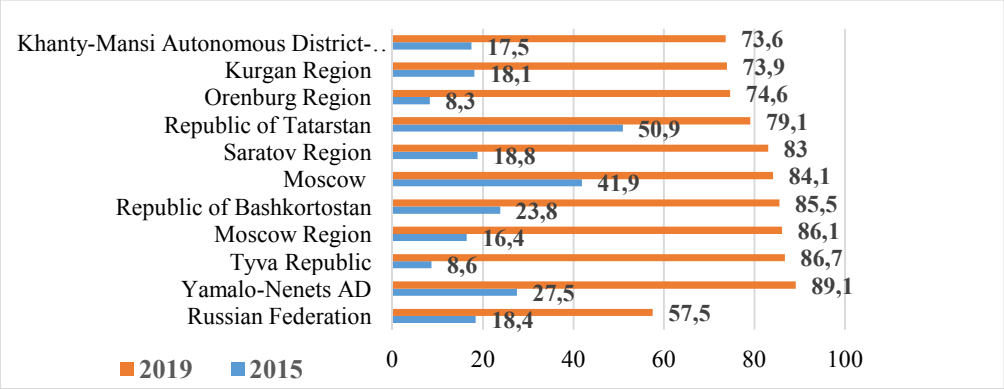
Among the regions that are ahead by the use of the Internet for shopping, those located in the north of the country, having, on the one hand, harsh natural and climatic conditions and the rotational shiftwork making it difficult to access all the amenities, on the other hand, with high incomes making remote orders more attractive as opposed to physical contact with certain organizations or shopping centers, stand out. Moreover, the top ten include three federal cities with relatively high living standards, where the income level makes it possible to order services and goods remotely.

An essential part of the modern life is *the use of the Internet to receive state and municipal services in electronic form*. In 2019, 57.5% of the population used official websites and portals (in 2015 – 18.4%), including in cities where this level reached 61.7% (in 2015 – 21.8%), in rural areas 44.6% (in 2015 – 8.0%). The majority of the population using this method of services provision has a higher or postgraduate education (88.6%). They are followed by the second group of the population with secondary vocational education who completed the training program for mid-level experts (78%). The third place is occupied by the group of the population with secondary education (70.1%) and the fourth – by those with secondary vocational education who completed the training program for skilled workers and employees (69.6%). In 2015, the share of these population groups was 57.6%, respectively; 36.4%; 27.8% and 27%. Such dynamics suggests rapid informatization both in cities and beyond their boundaries as well as the wish of citizens to improve the quality of life. Among the most popular services received by the population via the Internet are healthcare and medicine (53.4%), payment of taxes and fees (39%), and services of the Ministry of Internal Affairs and the Road Service (30.5%).

Across the regions, the following trend has emerged: in 26 territorial entities, the use of the Internet to receive state and municipal services exceeds the national indicator, in 59 entities it is lower. Among the top ten regions, not only the most prosperous regions with the high income level stand out (Yamalo-Nenets Autonomous District, the Republic of Tatarstan, Moscow and the Moscow Region), but also the Republic of Tyva and the Kurgan Region, which are lagging behind in economic development. These entities of the Federation are

characterized by a unique geopolitical border position, where one of the strategic national objectives is to provide a high level of modern means of information communication (Image 5).

Image 5. Dynamics of the share of population using the Internet to receive state and municipal services (in % from total population)



Source: Authors' calculations based on data from information portals

The current situation is characterized by overcoming the problem of digital inequality in relation to the Russian Federation entities due to vast disparities in their socio-economic development. This inequality is related not so much to differences in basic indicators but to different levels of broadband Internet access.

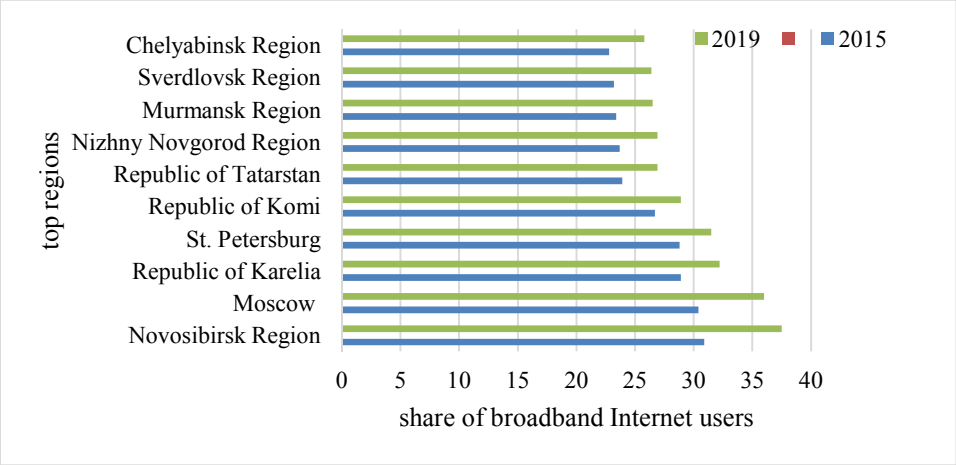
An indicator showing the digital inequality of regions is *the provision of uninterrupted broadband Internet access* for citizens and organizations. It is provided using wired, fiber-optic and wireless communication lines. Fixed access is provided through wired connections, while mobile access is based on data transmission over wireless connections. The specifics of broadband Internet access development across the Russian territory is connected with the uneven nature of the population distribution and, therefore, large cities that are economic, scientific, and cultural hubs.

In the group of regions leading in the number of active users of fixed broadband Internet access (Image 6), the Russian territorial entities characterized by certain features and role in the country's economy stand out, for example:

- the cities of Moscow and St. Petersburg – big shares in the Russian Federation by the population (respectively, 8.64% and 3.68%), gross regional product (21% and 4.9%), etc.;
- the Republic of Tatarstan and the Nizhny Novgorod Region are large hubs of the processing industry (4.1% and 3.2%), science, construction business and commerce are developing;
- the Sverdlovsk and Chelyabinsk Regions are characterized by a relatively high concentration of the population (3% and 2.4%, respectively), the processing industry, including metallurgy (4.3% and 3.1%), energy (4.4% and 2.2%), etc.;
- the Novosibirsk region is one of the largest scientific hubs in the Russian Federation with a developed mechanical engineering, construction industry, and a home to 2% of the population of Russia;
- the Republic of Karelia and the Murmansk Region have an important geopolitical position, neighboring with the EU countries, with which the annual growth of export-import operations is increasing.

The regions that are among the leaders are characterized by a significant share of the population with higher and secondary vocational education, the number of research organizations, cultural facilities, industries with high added value of goods and services. Six entities kept their presence in the top ten, while losing their places. They were replaced by regions that have improved access to broadband Internet.

Image 6. Dynamics of active users of fixed broadband Internet access per 100 people (units)



Source: compiled by the authors according to the calculation results

Digitalization affects such indicators of *the living standards* as the level of poverty, the ratio of salaries and the subsistence level, etc. This is connected with the fact that the time spent on finding a job is reduced, remote work becomes more efficient thanks to the possibility of using a huge database in a short period of time. There is an option of online payment for services, including state and municipal ones, as well as the availability of a wide range of goods and services. The conversion of organizational databases into digital format has decreased the time previously included in the cost of production.

The lowest poverty rate in the Russian Federation is registered in successful regions with economies based on competitive extractive and processing industries. The capitals and neighboring regions specialize in high-tech spheres of economic activity, therefore, the monetary incomes of those employed in these regions are one of the highest in the country (Table 4).

Table 4. The main indicators of the living standards in the top regions over 2019

Poverty level, %		Ratio of salaries and the subsistence level, %		Average per capita monetary income, place in Russia	
Yamalo-Nenets Autonomous District	5.6	*Yamalo-Nenets Autonomous District*	6.1	*Chukotka Autonomous District*	1
St. Petersburg	6.5	*Sakhalin Region*	6.0	*Yamalo-Nenets Autonomous District*	2
Moscow	6.6	*St. Petersburg*	5.4	Nenets Aut. District	3
Republic of Tatarstan	6.9	*Moscow*	5.4	*Moscow*	4
Moscow region	7.3	Magadan Region	5.1	Magadan Region	5
Belgorod region	7.8	*Chukotka Autonomous District*	5.1	*Sakhalin Region*	6
Sakhalin Region	8.2	Khanty-Mansi Autonomous District	4.9	Khanty-Mansi Autonomous District	7
Chukotka Autonomous District	8.5	Republic of Sakha (Yakutia)	4.5	Kamchatka Krai	8
Lipetsk region	8.7	*Moscow Region*	4.4	*Moscow region*	9
Leningrad region	8.8	Kemerovo Region	4.3	*St. Petersburg*	10

Source: Authors' calculations based on data from information portals

The ratio of salaries and the subsistence level also correlates with the level of economic development in the regions, their high profitability and a high supply of jobs. Six out of ten regions of the top ten are included in three groups, both by low poverty level, the ratio of monetary incomes to the subsistence level, and in terms of place in the Russian Federation by average per capita monetary income.

The next indicator is the *population using the Internet by type of location*. Urbanization, being an essential part of life today, accelerates many socio-economic processes, including digitalization. In the Russian Federation, the share of the urban population is about 75%, reaching a maximum in the Khanty-Mansi Autonomous District (92.5%) and a minimum in the Chechen Republic (36.9%). According to the Federal State Statistics Service in 2019, 91% of the population living in cities used the Internet (in 2014 – 81.7%). In rural areas, the indicator is lower – 81.2% (in 2015 – 65.5%). The share of the population in cities and rural areas that does not use the Internet dropped significantly: by 2.0 and 1.8 times, respectively. These trends have a positive impact on the process of digitalization of social life and economy (Table 5).

Table 5. Dynamics of the share of population using the Internet in the top regions, %

Regions	2014	Regions	2017	Regions	2019
Yamalo-Nenets Autonomous District	90.0	Yamalo-Nenets Autonomous District	95.5	Yamalo-Nenets Autonomous District	96.8
Khanty-Mansi Autonomous District	87.7	Republic of Tatarstan	91.2	Chukotka Autonomous District	96.5
St. Petersburg	83.3	Moscow Region	90.4	Moscow Region	95.5
		Khanty-Mansi		Khanty-Mansi	
Tyumen Region	81.3	Autonomous District	88.5	Autonomous District	93.5
Murmansk Region	80.8	St. Petersburg	86.5	Sevastopol	93.2
Moscow	79.8	Tyumen Region	86.3	Moscow	92.5
Kaliningrad Region	78.8	Murmansk Region	85.6	Rep. of Tyva	92.3
Sverdlovsk Region	77.8	Sevastopol	84.4	Tula Region	91.7
Chukotka Autonomous District	77.1	Magadan Region	84.3	Rep. of Bashkortostan	91.3
		Chukotka Autonomous			
Chechen Republic	76.3	District	84.2	Rep. of Tatarstan	91.2
		Interregional differentiation			
Coefficient of differentiation	1.64	1.52		1.37	
Decile coefficient	1.28	1.34		1.19	

Source: Authors' calculations based on data from information portals

Across the regions, over a five-year period, this indicator increased by 15%, reaching maximum values in the regions of the northern part of the country (the Yamalo-Nenets and Khanty-Mansi Autonomous Districts), cities of federal significance and economically developed entities (with the exception of the Republic of Tyva, which is classified by the GRP per capita as an outsider). Apart from the growth in the share of the population using the Internet, another positive trend is developing – a decrease in interregional differentiation for this indicator, which is corroborated by calculations of the coefficients of differentiation (Table 5).

The next indicator is the *Internet use in households*. Households, being institutional units in the economy, reflect the existing situation of the availability and use of the Internet, which provides various services from online shopping to financial transactions, as well as remote work. Therefore, the analysis of the territorial differentiation of the share of households with Internet access can show the trend towards the readiness for further digitalization. Considerable changes took place over the five-year period (Table 6).

In the top ten regions in 2014, the Russian territorial entities having powerful economic potential stood out. They feature the regions with a raw materials-based economy (the Yamalo-Nenets, Khanty-Mansi, Chukotka Autonomous Districts and the Magadan Region), two federal cities (Moscow and St. Petersburg) and three entities with a developed processing sector (the Kaliningrad, Murmansk and Tula Regions).

Table 6. Dynamics of the Internet use in households, %

Regions	2014	Regions	2017	Regions	2019
Yamalo-Nenets Autonomous District	91.4	Yamalo-Nenets Autonomous District	95.3	Yamalo-Nenets Autonomous District	95.0
Magadan Region	86.4	Khanty-Mansi Autonomous District	90.5	Chukotka Autonomous District	93.4
Khanty-Mansi Autonomous District	86.3	Rep. of North Ossetia – Alania	88.1	Magadan Region	91.0
St. Petersburg	84.9	St. Petersburg	87.6	Tula Region	88.4
Kaliningrad Region	81.6	Magadan Region	86.4	Orenburg Region	87.9
Moscow	80.7	Rep. of Ingushetia	86.3	Rep. of Sakha (Yakutia)	87.6
Murmansk Region	80.4	Rep. of Tyva	86.2	Rep. of Tyva	87.5
Chukotka Autonomous District	78.5	Moscow Region	84.5	Moscow	86.9
Rep. of Tatarstan	76.6	Rep. of Tatarstan	84.2	Khanty-Mansi Autonomous District	86.2
Tula region	76.0	Moscow	82.1	St. Petersburg	85.3
		Interregional differentiation			
Coefficient of differentiation	1.75		1.53		1.47
Decile coefficient	1.32		1.26		1.31

Source: Authors' calculations based on data from information portals

In 2017, the number of raw materials-based regions decreased to two. Both capitals kept their positions and entities lagging behind by gross regional product per capita (the Republic of North Ossetia – Alania, Republic of Ingushetia, Republic of Tyva) were also included. In 2019, the raw materials-based regions returned to the top ten, while among the regions lagging behind, the Republic of Tyva was included. Of the new regions in the group of leaders, the Republic of Sakha (Yakutia) and the Orenburg Region stand out with the share of mineral extraction reaching 51.5% and 41.0%, respectively. The top positions are held by the northern raw materials-based regions, where Internet access is a part of everyday life and work. Overall, in 2019, in 43 territorial entities of the Russian Federation, households had access to the Internet above the country value in general and in 42 territorial entities – below, therefore, the distribution is approximately 50:50%.

The digitalization of households is also reflected in the indicator of *the broadband Internet access*. Overall across Russia, 73.6% of households have such access (2.5% lower than the general network access). Over the five years, the indicator increased by almost 10%. Among the top regions, the northern regions stand out, where the demand for high-quality Internet is most urgent: the Yamalo-Nenets and Khanty-Mansi Autonomous Districts, the Magadan and Murmansk Regions, the capital cities of Moscow and St. Petersburg (Table 7).

Interregional differentiation by broadband Internet access to households is more significant compared to its general accessibility. At the same time, the dynamics of the decline is more significant: over the five years, inequality between the Russian territorial entities approximately halved. The decile coefficient also dropped, which confirms significant positive changes.

The assessment of territorial inequality using the coefficients of the range and the decile coefficient of differentiation are of great importance for the analysis of the changes. The calculations presented in the tables indicate a significant decrease in inequality, however, the decile coefficient, which is more objective, remained almost at the same level. It is explained by the fact that in the group of the top regions, the indicator increased by approximately the same value as in the group of the outsider regions. Therefore, in general, the interregional differentiation of households with access to the Internet, despite the decline, is preserved and remains significant. The main reasons why the Internet is not used by households in the Russian Federation, in general, are no need for it (66.3% of the total number of households with no access to the Internet), high subscription costs (18.6%) and a lack of Internet skills (16.8%). The regional aspect of this problem makes it possible to identify the following regions according to the main reasons for not using the Internet: the Vologda and Tambov

Regions (83%) – no need for this resource; the Ulyanovsk Region (43.3%) – the highest subscription costs; the Khanty-Mansiysk Autonomous District (34%) – the lack of Internet skills (Information Society, 2020).

Table 7. Dynamics of the share of households having broadband Internet access in the top regions, %

2014		2017		2019	
Russia	64.1	Russia	72.6	Russia	73.6
Yamalo-Nenets Autonomous District	87.0	Yamalo-Nenets Autonomous District	93.3	Yamalo-Nenets Autonomous District	93.9
Khanty-Mansi Autonomous District	84.2	Khanty-Mansi Autonomous District	87.0	Magadan Region	86.7
St. Petersburg	84.1	Rep. of Tatarstan	83.1	Moscow	86.6
Moscow	80.4	Tyumen Region	82.9	Orenburg Region	86.1
Murmansk Region	79.5	St. Petersburg	82.7	Tula Region	85.2
Leningrad Region	73.9	Sevastopol	82.5	St. Petersburg	83.9
Kaliningrad Region	72.7	Rep. of Tyva	81.7	Murmansk Region	83.6
Volgograd Region	72.1	Karachay-Cherkess Rep.	81.5	Rep. of Crimea	83.2
		Rep. Crimea			
Rep. of Mordovia	71.9		81.3	Khanty-Mansi Autonomous District	83.2
Primorsky Krai	71.0	Orenburg Region	80.7	Sevastopol	83.0
		Interregional differentiation			
Coefficient of differentiation	3.35		2.84		1.86
Decile coefficient	1.56		1.33		1.40

Source: Authors' calculations based on data from information portals

To confirm the results of the research, a correlation-regression analysis of the dependence of the living standards main indicators with the indicators of the use of information and communication technologies by the population and in organizations was carried out. The regression model was built based on the open data from the Federal State Statistics Service for 2019 using MS Excel tools. The impact of 10 factors (Xj) on the average per capita money income of the population (Y) in all territorial entities of the Russian Federation is analyzed.

The analyzed factors characterizing the living standards included:

X_1 - actual accrued salaries of employees, in % against the previous year;

X_2 - average monthly nominal accrued salaries of employees, rubles;

X_3 – the real volume of assigned pensions (as of 01.01.2020) in % against the previous year;

X_4 – average volume of assigned pensions (as of 01.01.20), rubles;

X_5 - consumer spending on average per capita (per month), rubles.

The analyzed factors connected with the digitalization of society included:

X_6 - the number of personal computers per 100 employees with Internet access, pieces;

X_7 - the number of personal computers per 100 employees – total, pieces;

X_8 - Internet use by the population,% of the total;

X_9 – use of information and communication technologies in organizations, %;

X_{10} - the number of connected subscriber mobile devices per 1000 people, pieces.

A statistically significant regression model:

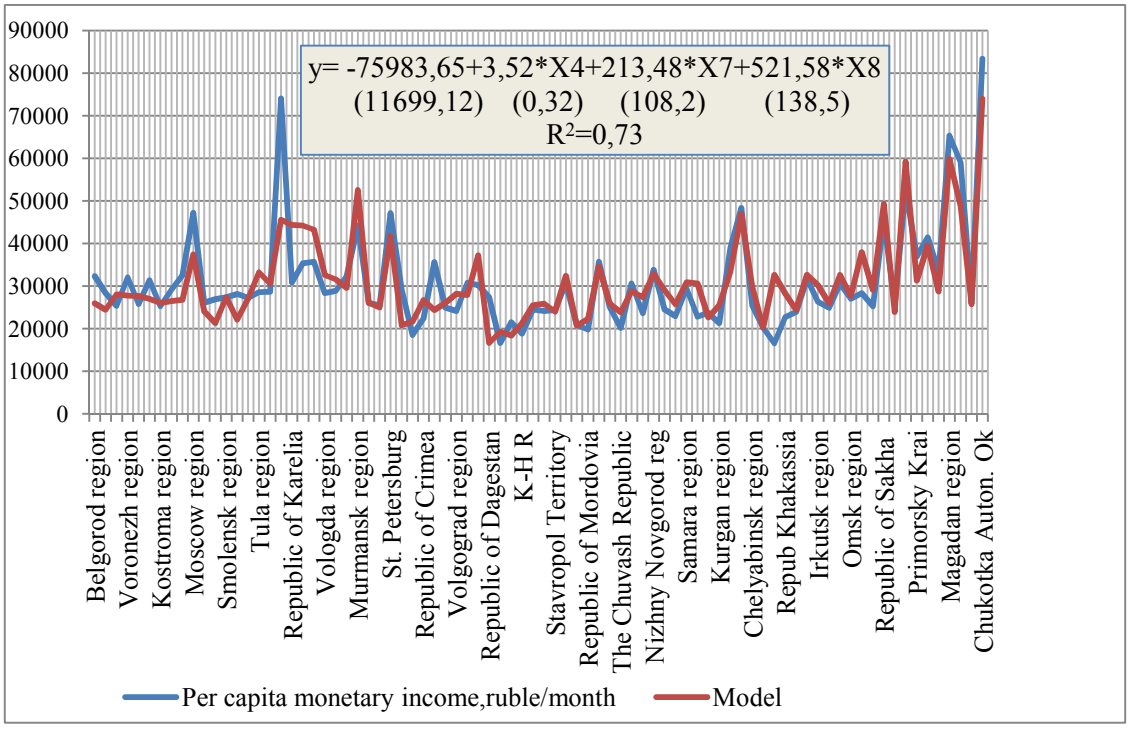
$$Y = -75983{,}65 + 3{,}52 * X4 + 213{,}48 * X7 + 521{,}58 * X8 \qquad (1)$$

A graphical interpretation of the model is shown in Figure 7.

The coefficient of determination R^2, equal to 0.73, shows that the variability of the dependent variable Y (average per capita money income) is explained by 73% by the factors included in the model. It is worth mentioning that two of the factors included in the model

belong to the block associated with social digitalization (X_7 and X_8). In the figure, the standard errors of the model parameters are specified in brackets. All the discovered parameters of the model are significant according to the Student's t-test and reflect the following revealed dependence. With an increase in the average volume of assigned pensions (X_4) in the regions of the Russian Federation per ruble, the average per capita income of the population (Y) will grow by an average of 3.52 rubles; with an increase in the number of personal computers per 100 employees (X_7) per unit, the average per capita income will increase by an average of 213.48 rubles; with an increase in the use of the Internet by the population by 1% (X_8), the average per capita income will grow on average by 521.58 rubles.

Image 7. Graphical interpretation of the regression model for assessing the average per capita money income by region.

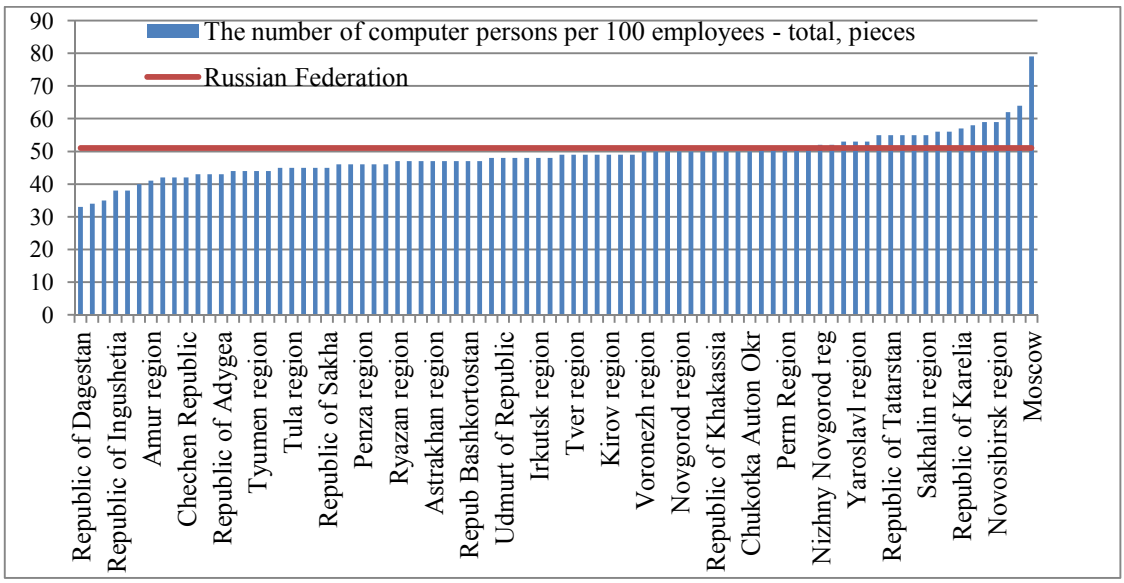


*Abbreviations:*K-HR - Karachay-Cherkess Republic;
Source: compiled by the authors according to the calculation results

As a result of the regression modeling, it was concluded that the increase in the population's living standards is significantly influenced by the increase in factors associated with social digitalization. The introduction of digitalization tools in various spheres of economic activity, together with effective management and use of communication infrastructure, are processes that have a positive impact on the quality of life and reduce interregional differentiation.

Figures 8 and 9 show the results of ranking the regions according to the identified factors of social digitalization included in the regression model. It should be noted that the graphical interpretation of the results features data for all regions of the Russian Federation, however, a sample number has been automatically recorded for the purpose of better visualization.

Image 8. Ranking of regions by the number of personal computers per 100 employees, pieces.

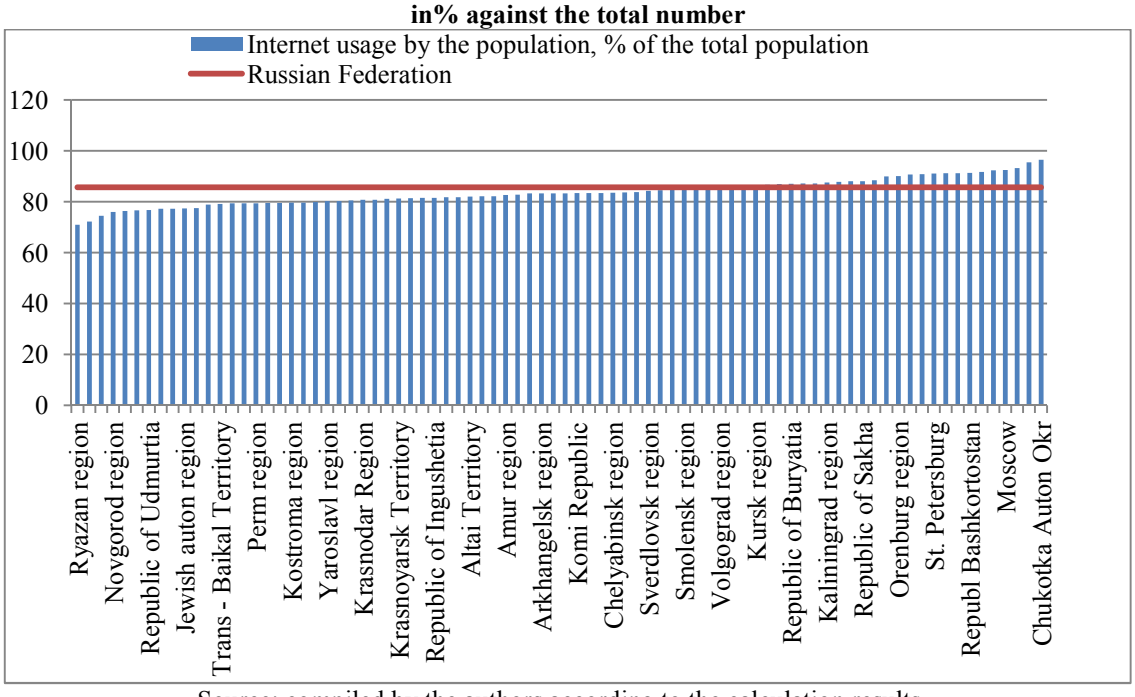


Source: compiled by the authors according to the calculation results

The biggest number of computers is owned by employees of organizations in the North-Western and Central Federal Districts, and the smallest – in the republics of the North-Caucasian Federal District.

Figure 9 suggest that regions are significantly scattered in terms of the Internet use. Thus, in the Central Federal District there is a representative of both the lowest provision of the Internet network – the Ryazan Region, which has 70.9% with 87.7% in the district overall and 85.6% in the Russian Federation, and the highest – Moscow, which has 92.5%. Interregional differentiation in this case is associated with the difference in incomes, professional employment of the population, and the structure of the regional economy.

Image 9. Ranking of the regions according to the use of the Internet by population, in% against the total number



Source: compiled by the authors according to the calculation results

5. Conclusion

The conducted research of the territorial aspects of digitalization across the Russian regions showed that amid digitalization, the problem of digital inequality in relation to a number of regions is aggravated due to different levels of socio-economic development, urbanization, historical conditions for economic activity, remoteness from large economic hubs and cities. But the level of readiness to accept new technologies is high in most regions.

The assessment of disbalances in the development of the digital economy in the regions of the Russian Federation helped identify a group of top regions by indicators reflecting the level of information and communication technologies development and their availability to the population. These regions include the entities in the northern part of the country with high incomes – the Yamalo-Nenets and Khanty-Mansiysk Autonomous Districts, the cities of federal significance and economically developed entities of the European Center – the Kaluga, Moscow Regions, the Republic of Tatarstan, the cities of Moscow and St. Petersburg, the peripheral regions of the North-Caucasian Federal District – the Republic of Ingushetia, Kabardino-Balkaria, that were included most likely due to the initially low statistical base. Among the outsiders are the republics of North Ossetia – Alania and Dagestan, Karachay-Cherkess and Chechen Republics, which is caused by infrastructural restrictions.

The remaining interregional differentiation, both in terms of living standards of the population and the responsiveness of regions to digitalization, results in unequal access of the population to modern resources and benefits. Nevertheless, there is a trend of reducing inequality. Thus, decile coefficients decreased by the share of organizations that used personal computers in the regions, the share of the Russian population using the Internet in the top regions, and the use of the Internet in households, including those with broadband Internet access.

The quality of human capital is improving in regions with developed economies. More than 2/3 of the entities in the Russian Federation show an increase in the number of researchers with academic degrees. The share of the population using the Internet to order goods and services, as well as to receive state and municipal services, is increasing.

The graphic interpretation of the regression model confirmed the dependence of one of the main living standards indicators – the average per capita money income – on most of the studied factors. At the same time, two of the factors included in the model belong to the block associated with social digitalization – the use of the Internet by the population and information and communication technologies in organizations. Thus, the responsiveness of regions to digitalization is one of the most important factors in improving the living standards. At the same time, reducing the digital inequality between regions is one of the strategic goals of the state and regional heads, being an essential part of economic sovereignty.

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MAPPING CLUSTERS IN CENTRAL AND EASTERN EUROPEAN REGIONS BASED ON FDI, REMITTANCES AND EMPLOYMENT – A SPATIAL STATISTICS GROUPING ANALYSIS

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Abstract

Central and Eastern European (CEE) and Visegrad countries transform and develop in different spatial patterns in a global economy. Host labour markets benefit directly from Foreign Direct Investment (FDI) inward flows through jobs creation or increased productivity. On the other side, the labour force rises its geographical mobility and benefits from jobs in FDI's source countries, sending personal remittances. Global integration marks that the "receipts of remittances have become an important and stable source of funds that exceeds FDI" (indexmundi.com). Are the CEE /Visegrad countries similar concerning their spatiotemporal pattern of FDI inflows? These countries are identical in their development model, described by the coordinates of FDI, remittances and Employment? We applied for 35 European countries from 2013-to 2019 the Similarity check –Grouping Analysis ARC GIS-tool from the Spatially Constrained Multivariate Clustering (Spatial Statistics) family. The FDI inflow as input proves to be more inertial, according to the categories set by EuroVoc. Simultaneously, the FDI inward as output (employment growth or labour productivity growth) differentiate CEE countries next to labour/ human capital mobility as personnel remittances in more heterogeneous categories.

In conclusion, for CEE countries, capital mobility and labour & human capital mobility create different development patterns globally. Therefore, it is not enough to build policies to attract capital (FDI) and attract high human capital.

Keywords: CEE, inward FDI rates, personal remittances receipt as GDP rate, employment rate, Similarity check –Grouping Analysis, spatial statistics

JEL classification: C23, F21, F22, F24, J21, J24, O52

1. Introduction

Central and Eastern European (CEE) countries are *Moldova, Hungary, Czechia, Romania, Slovakia, Poland, Belarus, Ukraine, Russian Federation and Bulgaria*, and Visegrad countries are Hungary and Czechia, Slovakia and Poland. Both groups of countries transform and develop in different patterns in a global economy. Host labour markets benefit directly from FDI inward flows through jobs creation or increased productivity. On the other side, the labour force rises its geographical mobility and benefits from jobs in FDI's source countries, sending personal remittances. Global integration marks that the "receipts of remittances have become an important and stable source of funds that exceeds FDI"(Indexmundi 2019). At the world level, the receipt of remittances presents a slow but upgrowing tendency from 0.319% GDP in 1995 to 0.762% GDP in 2019 (World Bank 2020), accelerated after 2000. FDI and net inflows (% of GDP) after 1997 start to oscillate following a decreasing tendency. It decreased from the last peak of 5.357% GDP in 2007 to the recent minim of 1.227% in 2018, reaching 1.817% in 2019 (World Bank 2020).

FDI (Inward Flow, Percentage of Gross Domestic Product %, UNCTAD), Personal remittances (Receipts, Percentage of Gross Domestic Product %, UNCTAD) and Employment to population ratio (15+, female (%), World Bank based on ILO)) are the three

features to distinct the clusters among 39 countries, mainly from Europe. These characteristics generate different Spatio-temporal patterns and illustrate territorial heterogeneity, described by the various development models (depicted by different combinations of their intensity). In this background, our research questions are: Are the CEE /Visegrad countries similar in their spatiotemporal pattern of FDI inflows? These countries are similar in their development model, described by the coordinates IFDI, remittances and Employment?

2. Theoretical framework

Gál and Sass launched in the 60th ERSA Congress edition the debate regarding the "Geoeconomic challenges: the role of FDI revisited in the Central and Eastern European regions"(Gal and Sass 2021). The hosts identify three main research topics regarding the FDI in CEE/V4 "the outstanding importance in the transition process, the impact on the host economy and the territorial dimension". The last is the most miniature explored theme, especially in CEE/V4 countries "although they attract more FDI than Mediterranean countries of the EU". (Gal&Saas, 2021)

Our Paper focuses on improving the knowledge regarding the territorial dimension of the FDI at the national level. The importance of FDI attractiveness at a national level is a prerequisite for FDI attractiveness at the regional level, initiating a path dependence trajectory. Basile et al. launched this idea in 2008. Authors conclude that national boundaries still play some role in choices made by non-European multinationals. Casi and Resmini (2014) prove, through spatial econometrics techniques, that next to the between-country effect of FDI, there is a within-country effect. On the other side, Stilianos and Ladias (2011) found that ”optimality allocation of investment across regions may lead to increasing inequalities at the spatial level”.

Gal (2013) emphasize some specific characteristics of FDI in CEE countries:

- the foreign direct investment is the primary investment mechanism and "not the stock market as in Liberal Market Economies (LMEs) or domestic credit as in Coordinated Market Economies (CMEs)" (Gal, 2013, p.3);
- the high FDI flows change the ownership structure (Gal 2013) reflected in the economic structural change. Table 1 illustrate the significant dissimilarity in terms of ownership. The share of Employment in foreign controlled enterprise in total Employment, EU in average, increased from 14.9% in 2013 for EU 28 to 15.6% in 2018 for EU 27. Except for Poland and Hungary, the share of Employment in FATS enterprises (Foreign Affiliates Statistics) is almost double the EU average: in 2019, Romania has 29.2%, Slovakia 28.4%, Czechia 28.3%). In terms of structural change by the ownership, Slovakia, Romania, and Poland register significant trends, respectively increasing the employment share in FATS by 6pp, 3.2pp and 2.9pp.

Table 1. The share of persons employed in foreign-controlled enterprise in total Employment in the entire business economy (including repair of computers, personal and household goods, except financial and insurance activities)

Region /Country	**2013**	**2018**	2018-2013
European Union - 27 countries (from 2020)		15.6	0.7
European Union - 28 countries (2013-2020)	14.9		
Romania	**26.0**	**29.2**	**3.2**
Slovakia	22.4	28.4	6.0
Czechia	26.7	28.3	1.6
Hungary	26.4	26.0	-0.5
Poland	17.0	19.9	2.9

Source: data calculated by authors using the EUROSTAT indicators.
Foreign control of enterprises by economic activity and a selection of controlling countries (from 2008 onwards) [FATS_G1A_08__custom_1161967]
Annual enterprise statistics for special aggregates of activities (NACE Rev. 2) [SBS_NA_SCA_R2__custom_1161997]

Promote economic growth "in the short run and a growth environment, but this is not true in the long run and crisis times," as was the 2008 crisis. During the post-2008 economic crisis, the CEE future becomes uncertain. (Gal, 2013, p.7)

Crescenzi, Luca, and Milio (2016) Identify core-periphery patterns in the post-2008 economic crises landscape analysis, supplementary to the "traditional North-South divide". These result advocates for a more complex spatial heterogeneity. Important to note the presence of 3 countries from the V4 –"most of Poland, and partly stretches to neighbouring regions (such as most regions of Slovakia and the Czech Republic) in the core-continental area, around Germany." The core countries prove to have a low or moderately low impact of the crises.

Ernst (2005) sees FDI as the employment link to globalization. The author shows that in the case of developing countries Argentina, Brazil and Mexico, the impact of large FDI inflows on Employment fails to create jobs according to expectations. The sectoral pattern of FDI allocation, mostly in services, in "already existing companies due to privatization, deregulation and increased merger & acquisition" (Ernst 2005) does not create new jobs. Still, more than that, it releases the labour force following the restructuring. A negative impact of FDI on Employment is signalled by (Messerlin 1995) in the case of France, "inward FDI is small in relation with gross domestic investment, especially for those where employment is declining". Cechella (2013) analyses the internationalization of the Portuguese economy, particularly foreign investment in Portugal, and find similarities in the determinants of investments between investors. The decrease in the investment attractiveness of Russian companies on the increasing importance of FDI for firms' development is analysed by (Khryseva, Akimova, and Savchenko 2018)

(Saurav, Liu, and Sinha 2020) shows that the increases in FDI directly contribute to job growth. FDI's Markets tracks cross border greenfield investment globally and estimate that in 2018 greenfield FDI projects created approximately 2.3 million new jobs.

Carp (2012) find for CEE a strong correlation between FDI and unemployment rate dynamic in the host country due to econometric analysis. Moretti (2012) finds that rich capital locations attract high human capital. Agglomeration of talents acts as a job multiplier and produces positive externalities (Moretti 2003). This spatial structure has a high propensity to employ low human capital.

Crescenzi, Luca, and Milio (2016) Identify the human capital as "the single most important regional factor associated with a better resistance to economic shocks". Lincaru, Pîrciog, and Atanasiu (2016) remarks the growing "competitive environment's "demand for Public Employment Services (PES) in unemployment management. PES, have to "react efficiently and effectively to unceasingly changing public and political demand. Lincaru et al. (2012) make a quantitative estimation of the non-citizen worker flows at European aggregate level as a measure of European single market development.

Jones and Wren (2006) research "the generation, theory and location of FDI and its implications for regional and national development. The analysis is related to investment, Employment, and firm survival at the project and plant levels." Lincaru et al. (2010) conclude that the regions "profile" by diversity/variety of the firms could offer an image of the structural transformation of economic development as a prerequisite for growth.

The FDI development model changed dramatically post crises in two steps. First, in 2019, except in Chine, at the global level, the remittance overpass the FDI. (Rhata 2019)

The Corona Pandemic crisis marks the second step. It includes the lockdown decision followed by the decrease in labour mobility globally. Although the downturn projection for the remittance (Ernst & Capal, 2021) showed for 12 Asia Pacific countries that "the remittances demonstrated incredible resiliency as has been the case during the previous crisis".

The remittance flows proved to be resilient in 2020 (Rhata et al., 2021, p.22), but remittance to Europe and Central Asia fell sharply. Among the CEE countries, there are data only about:

- "Ukraine, the region's largest recipient of remit¬tances, received $15 billion in 2020, 4.6 per cent less than the previous year.
- The Russian Federation, the second-largest remittance recipient of the region, received about $10 billion in remittances with a negative growth rate of about 6 per cent." (Rhata et al., 2021, p.22)

In the background of the recent crises **financial (2008)** and human: **health (2019+),** the geoeconomics map changes the role of FDI. The mobility in time and space of the two

production factors, human capital, and financial capital, reached new barriers and trends globally and locally.

Mapping Clusters in the CEE/V4 region, under dimensions of FDI, remittances and Employment, could better understand the new models of development post Pandemic crises.

3. Method and data

3.1. Method

Lincaru et al. (2020) apply in the case of tourism the multivariate clustering analysis. Lincaru et al. (2013) apply ICA method on unemployment monthly data in the case of for finding underlying factors or components from multivariate in the case of components that are both statistically independent and non-Gaussian.

Method: We applied the Similarity check –Grouping Analysis ARC GIS-tool from the Spatially Constrained Multivariate Clustering (Spatial Statistics) family. (Box1) Based on Calinski-Harabasz pseudo-F-statistic involved in ArcGIS Desktop, we evaluate the optimal number of groups. The spatial Euclidian distance constraint uses spatial relationships' conceptualization by contiguity (continuous neighbourhood) edges corners. K Nearest Neighbours algorithm is a supervised machine learning algorithm used to solve the classification problem.

Box 1

Grouping Analysis Tool

"look for a solution where all the features within each group are as similar as possible, and all the groups themselves are as different as possible…. It is most appropriate, therefore, to think of Grouping Analysis as an exploratory tool that can help you learn more about underlying structures in your data.

Inputs

This tool takes:

1. point, polyline, or polygon **Input Features**, a unique ID field,
2. a path for the **Output Feature Class**,
3. one or more **Analysis Fields,**
4. an integer value representing the **Number of Groups to create**, and
5. the type of **Spatial Constraint**—if any—that should be applied within the grouping algorithm.

There are also a number of optional parameters including one that allows you to create a PDF **Output Report File**.

Analysis fields

Select fields that are numeric, reflecting ratio, interval, or ordinal measurement systems. While Nominal data can be represented using dummy (binary) variables, these generally do not work as well as other numeric variable types.

Note: *The values in the Analysis Fields are standardized by the tool because variables with large variances (where data values are very spread out around the mean) tend to have a larger influence on the clusters than variables with small variances. Standardization of the attribute values involves a z-transform where the mean for all values is subtracted from each value and divided by the standard deviation for all values. Standardization puts all of the attributes on the same scale even when they are represented by very different types of numbers: rates (numbers from 0 to 1.0),*

"Performance Evaluation: Sum of Squared Differences

We can evaluate how our algorithm is performing by calculating the sum of squared differences between our data points and centroids. We calculate the SSD using:

$$\sum_{i=0}^{n}(X_i - \overline{X})^2$$

Where X_i represents a data point and $\overline{X}$ represents the centroid that data point belongs to. To an extent, the lower the value we get the better;[1]"

R^2 = (TSS - ESS) / TSS
where *TSS is the total sum of squares and*
ESS is the explained sum of squares.
TSS is calculated by squaring and then summing deviations from the global mean value for a variable. ESS is calculated the same way, except deviations are group by group: every value is subtracted from the mean value for the group it belongs to and is then squared and summed."

- ***the larger the R2 value is for a particular variable, the better that variable is at discriminating among your features***

Number of groups

Number of groups is the result of Grouping Analysis tool evaluation following the Evaluate Optimal Number of Groups parameter and let the Grouping Analysis tool assess the effectiveness of dividing your features into 2, 3, 4, and up to 15 groups.

Calinski-Harabasz pseudo-F-statistic,

which is a ratio reflecting within-group similarity and between-group difference (Jain 2010):

$$\frac{(\frac{R^2}{n_c-1})}{(\frac{1-R^2}{n-n_c})}$$

where:

$$R^2 = \frac{SST - SSE}{SST}$$

and SST is a reflection of between-cluster differences and SSE reflects within-cluster similarity:

$$SST = \sum_{i=1}^{n_c}\sum_{j=1}^{n_i}\sum_{k=1}^{n_v}(V_{ij}^k - \overline{V^k})^2$$

$$SSE = \sum_{i=1}^{n_c}\sum_{j=1}^{n_i}\sum_{k=1}^{n_v}(V_{ij}^k - \overline{V_i^k})^2$$

n = the number of features

n_i = the number of features in cluster i

n_c = the number of classes (clusters)

n_v = the number of variables used to cluster features

V_{ij}^k = the value of the k^{th} variable of the j^{th} feature in the i^{th} cluster

$\overline{V^k}$ = the mean value of the k^{th} variable

$\overline{V_i^k}$ = the mean value of the k^{th} variable in cluster i

* the tool will create a minimum spanning tree (AssunÇão et al. 2006) reflecting both the spatial structure of your features and their associated analysis field values. The tool then determines the best place to cut the tree to create two separate groupings. Next, it decides which one of the two resultant groups should be divided to yield the best three group solution.

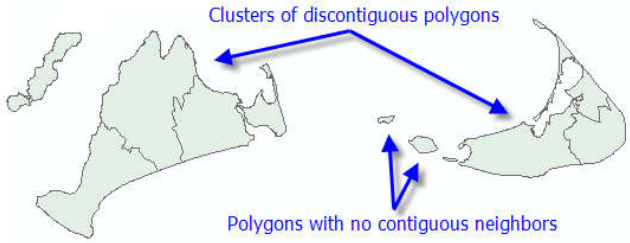
1https://ukdevguy.com/k-means-algorithm-for-clustering/#Performance_Evaluation_Sum_of_Squared_Differences

One of the two groups will be divided, the other group remains intact. Finally, it determines which of the resultant three groupings should be divided in order to provide the best four group solutions. For each division, the best solution is the one that maximizes both within-group similarity and between-group difference. A group can no longer be divided (except arbitrarily) when the analysis field values for all the features within that group are identical. In the case where all resultant groups have features within them that are identical, the Grouping Analysis tool stops creating new groups even if it has not yet reached the Number of Groups you have specified. There is no basis for dividing a group when all of the Analysis Fields have identical values.

Spatial constraint

If you want the resultant groups to be spatially proximal, specify a spatial constraint. The Contiguity options are enabled for polygon feature classes and indicate that features can only be part of the same group if they share an edge (Contiguity edges only) or if they share either an edge or a vertex (Contiguity edges corners) with another member of the group. The polygon contiguity options are not good choices, however, if your dataset includes clusters of discontinuous polygons or polygons with no contiguous neighbours at all.

Image 1. Clusters examples of discontiguous polygons or polygons with no contiguous neighbors at all



Source: Arc.GisPro 2.8, How grouping analysis works. https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/how-grouping-analysis-works.htm

If you want the resultant groups to be both spatially and temporally proximal, create a spatial weights matrix file (SWM) using the Generate Spatial Weights Matrix tool and select **Space time window** for the **Conceptualization of Spatial Relationships** parameter. You can then specify the SWM file you created with the *Generate Spatial Weights Matrix* tool for the **Weights Matrix File** parameter when you run Grouping Analysis. (The SWM file is only used to keep track of which features can and cannot be included in the same group.)

Minimum spanning tree

When you specify a spatial constraint to limit group membership to contiguous or proximal features, the tool first constructs a connectivity graph representing the neighbourhood relationships among features. From the connectivity graph, a minimum spanning tree is devised that summarizes both feature spatial relationships and feature data similarity. Features become nodes in the minimum spanning tree connected by weighted edges. The weight for each edge is proportional to the similarity of the objects it connects. After building the minimum spanning tree, a branch (edge) in the tree is pruned, creating two minimum spanning trees. The edge to be pruned is selected so that it minimizes dissimilarity in the resultant groups, while avoiding (if possible) singletons (groups with only one feature). At each iteration, one of the minimum spanning trees is divided by this pruning process until the **Number of Groups** specified is obtained. The published method employed is called SKATER (Spatial "X_i"luster Analysis by Tree Edge Removal). While the branch that optimizes group similarity is selected for pruning at each iteration, there is no guarantee that the final result will be optimal.

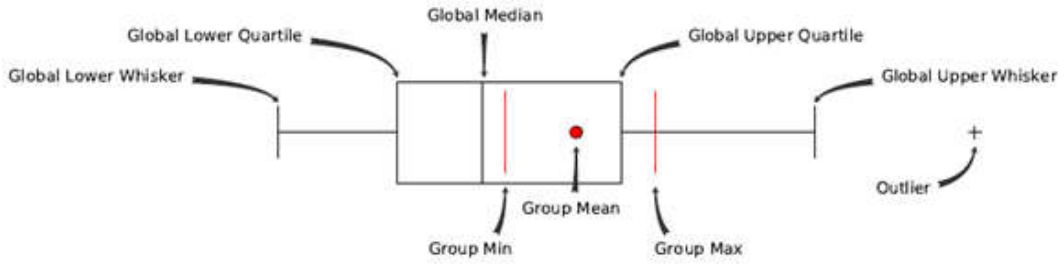
Outputs

The default output for the Grouping Analysis tool is a new Output Feature Class containing the fields used in the analysis plus a new Integer field named SS_GROUP identifying which group each feature belongs to. This output feature class is added to the table of contents with a unique colour rendering scheme applied to the SS_GROUP field. Hollow rendering indicates features that could not be added to any group, usually because they have no neighbouring features.

Grouping analysis report file

**Grouping Analysis could create a report for maximum 15 variables and maxium 15 groups;* Box plots are included throughout the report, so the first element in the report is a graphic showing you how to interpret them (see below):

Image 2. Group-Wise Summary



Source: Arc.GisPro 2.8, How grouping analysis works. https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/how-grouping-analysis-works.htm

The **box plots in the Grouping Analysis** report graphically depict nine summary values for each analysis field and group: minimum data value, lower quartile, median, upper quartile, maximum data value, data outliers (values smaller or larger than 1.5 times the interquartile range), group minimum, group mean, and group maximum. Any + marks falling outside the upper or lower whisker represent data outliers.

*The interquartile range (IQR) is the upper quartile minus the lower quartile. Low outliers would be values less than 1.5*IQR (Q1-1.5*IQR), and high outliers would be values more significant than 1.5*IQR (Q3+1.5*IQR). Outliers appear in the box plots as + symbols.*

Source: Arc.GisPro 2.8, How grouping analysis works. https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-statistics/how-grouping-analysis-works.htm

3.2. Data

Our analysis explores the Spatio-temporal patterns for the variables FDI, remittances and Employment as rates. The spatial area is contiguous. Our analysis area includes the European geographical location for 39 countries (Albania; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Latvia; Lithuania; Luxembourg; Moldova; Montenegro; Netherlands; Norway; Poland; Portugal; Romania; Russian Federation; Serbia; Slovakia; Slovenia; Spain; Sweden; Switzerland; The Former Yugoslav Republic of Macedonia; Turkey, Ukraine and the United Kingdom). The time dimension is generated yearly for the most recent seven years 2013, 2014, 2015, 2016, 2017, 2018 and 2019. The variables data are from the sources:

a) United Nations Conference on Trade and Development UNCTADSTAT for the FDI and remittances, with the indicators:

- Foreign direct investment (codified as IFDI -Inward Foreign direct investment) Inward Flow, Percentage of Gross Domestic Product [%],
- Personal remittances (Receipts, Percentage of Gross Domestic Product %)

"Remittances are usually understood as financial or in-kind transfers made by migrants to friends and relatives back in communities of origin. However, the statistical definition of international remittances only partially reflects this common understanding."

b) World Bank based on ILO for Employment, with the indicator: Employment to population ratio (15+, female (%), codifies ER) with the WB code SL.EMP.TOTL.SP.FE.ZS.

The diversity of European countries in terms of performance to attract capital IFDI, remittance, and create jobs is visible in Table 2. In 2019, the mean IFDI rate was 2.8% for 39 European selected countries. This level is very close to the mean of Visegrad countries of 2.7% and both above the CEE of 2.6%. The CEE non-Visegrad countries register the lowest level of the mean of 2.5. Remittances rates as a share in GDP is on average 1.8% in V4, the lowest level, almost half of Europe's 39 mean of 3.3. Non-Visegrad countries present the highest average of remittances of 6%, above the CEE average of 4.3%. V4 countries offer the highest employment rates of 48.6%, higher by 0.2pp than the 39 Europe, higher by 1.2pp than the CEE rate and higher by 2pp than the CEE non V4 countries.

Table 2. CEE and Visegrad counties on the background of 39 selected countries' performance in 2019 by IFDI, remittances and employment rates (%)

CEE countries	***IFDI 2019***	**FRM2019**	**ER2019**
Moldova	***5.0***	16.3	36.54
Hungary (VC)	***3.3***	2.7	46.76
Czechia (VC)	***3.1***	1.6	51.54
Romania	***2.5***	3.0	44.06
Slovakia (VC)	***2.3***	1.9	49.22
Poland (VC)	***2.3***	1.0	46.84
Belarus	***2.1***	2.3	55.63
Ukraine	***2.0***	10.3	43.18
Russian Federation	***1.9***	0.6	52.17
Bulgaria	***1.8***	3.5	48.45
N CEE non Visegrad	**6**	**6**	**6**
Minimum	1.8	0.6	36.5
Maximum	5.0	16.3	55.6
Std. Deviation	1.231	6.033	6.860
Mean	***2.545***	***5.991***	***46.672***
N Visegrad	**4**	**4**	**4**
Minimum	2.3	1.0	46.8
Maximum	3.3	2.7	51.5
Std. Deviation	0.521	0.715	2.274
Mean	***2.734***	***1.796***	***48.590***
N CEE	**10**	**10**	**10**
Minimum	1.8	0.6	36.5
Maximum	5.0	16.3	55.6
Std. Deviation	0.970	5.008	5.371
Mean	***2.621***	***4.313***	***47.439***
N39 Europe	**39**	**39**	**39**
Minimum	-16.3217	0.1062	25.3504
Maximum	20.244	25.3504	68.02
Std. Deviation	4.9044	5.1042	8.3013
Mean	***2.765***	***3.341***	***48.4267***

Data sources: UNCTADSTAT for the IFDI and FRM; World Bank for ER
Legend: VC Visegrad Country

We intend to Mapp the Clusters CEE regions based on FDI, remittances and Employment – a spatial statistics grouping analysis, ignoring any classification. The CEE countries exceed the UE area, and, given applying this spatial analysis tool, we select 39 countries (see Images 1 to 4) that assure the contiguity condition. If the CEE/ V4 are similar, we shall obtain the

clusters with the same pattern in terms of IFDI and secondly in terms of IFDI, remittances and Employment.

4. Findings

The detailed results are in the Appendices. in four sections presented before:

In 2013 the V4 countries were split into two groups from the 15 clusters resulted: Hungary in the Dark mouve group (G12), Poland and Slovakia, as well as Romania are in the light green group (G13), and Czechia in the Brown Group (G14) (Table 3, selected from Appendix 1. Image 3) Each group (G12, G13 and G14) present in comparison with other groups the following most distinctive characteristics:

Image 3. The 2013 clusters build on rates of inward FDI, remittances receipts rates and employment rates

Source: graphic made by authors in Arc Gis Pro

Table 3. Means of variables by groups in 2013 (Image 1 & Appendices 9.1). Selection from the 15 groups checked with the maximum Pseudo-Statistic F of 31.5122 of the groups that contains the V4 countries

Variable \ Groups	Group 12 (Dark Mouve) – Hungary next to Croatia and Yugoslav Republic of Macedonia, count 3	Share	Group 13 (light green) – Poland, Slovakia next to Romania	Share	Group 14 (Brown) - Czech Republic, next to Austria and Slovenia, count 9	Share	Global mean	R2
FRM2013	3.4311	0.0294	2.0126	0.0477	0.7086	0.0186	3.0965	0.9815
IFDI2013	2.4404	0.0572	0.5987	0.0941	0.8629	0.0773	3.4234	0.954
ER2013	36.2633	0.2054	43.33	0.0130	48.4320	0.1308	45.1318	0.944

Source: data calculated by authors

Note *Group 12, 13 and 14 do not contain outliers for the analysed variables /features*

1. *The FRM has the largest R2 and therefore is the best discriminant compared with IFDI and ER. All variables have high level of R2.*
   - *In the Group 12 the highest share of the range is 20.54% for the ER2013 variable, the second share is 5.72% for the IFDI2013 and the lowest share is for the variable FRM 2013 of 2.94%.*
   - *In the Group 13 the highest share of the range is 9.41% for the IFDI2013 variable, the second share is 4.77% for the FRM 2013 and the lowest share is for the ER2013 variable of 1.3%.*
   - *In the Group 14 the highest share of the range is 13.08% for the ER2013 variable, the second share is 7.73% for the IFDI2013 and the lowest share is for the variable FRM 2013 of 1.86%.*

2. *FRM2013: G12>G13>G14*
IFDI2013: G12>G14>G13
ER2013: G12<G13<G14

Group means above the global mean

- G12 has the highest remittance & IFDI and the lowest level of employment rate. The IFDI acts in sectors that increase productivity and improve the technology level of innovation, followed by labour force dismissal. The released labour force becomes mobile for work and sustains the remittances flows.
- G13 have the lowest level of IFDI and medium level for remittances and employment rates. The lack of IFDI does not support the job creation or technology & innovation transfer, and in consequence, the national level of Employment is under potential, part of the human capital is spatially mobile.
- G14 has the highest level of national Employment and the lowest remittance level of remittance. IFDI is at the medium level compared to G12 and G13. The IFDI is complementary to other investments mechanisms. The economy creates enough new jobs and supports the employment growth; therefore, the interest in labour mobility is low, and the level of remittances.

In 2019 the V4 countries were split into two groups from the 15 clusters resulting: Hungary moved into the red group, G10 with Poland, Slovakia, next to Romania and Bulgaria. The other group is G14, the brown one. (Table 4, selected from Appendices 2. Image 4) Each group (G10 and G14) presents in comparison with other groups the following most distinctive characteristics:

Image 4. The 2019 clusters build on rates of inward FDI, remittances receipts rates and employment rates

Source: graphic made by authors in Arc Gis Pro

Table 4. Means of variables by groups in 2019 (Image 2 & Appendices 9.2).

Selection from the 15 groups checked with the maximum Pseudo-Statistic F of 41.0691 of the groups that contains the V4 countries

Groups / Variable	Group 10 (Red)– Poland, Slovakia, Hungary next to Romania and Bulgaria	Share	Group 14 (Brown) - Czech Republic, next to Austria and Slovenia	Share	Global mean	R2
FRM2019	2.4190	0.0964	1.4581	0.1280	3.3431	0.972
IFDI2019	2.4308	0.0395	2.3172	0.0783	2.7650	0.9456
ER2019	47.07	0.1314	53.2078	0.1593	48.4267	0.9276

Source: data calculated by authors

Note Group 10, and 14 do not contain outliers for the analysed variables /features

1. The FRM has the largest R2 and therefore is the best discriminant compared with IFDI and ER. All variables have high level of R2.

- *In the Group 10 the highest share of the range is 13.14% for the ER2019 variable, the second share is 9.64% for the FRM 2019 and the lowest share is for the variable IFDI2019 of 3.95%.*

- *In the Group 14 the highest share of the range is 15.9% for the ER2019 variable, the second share is 12.8% for the FRM2019 and the lowest share is for the variable IFDI2019 of 1.86%.*

2. *FRM2019: G10>G14*

IFDI2019: G10>G14

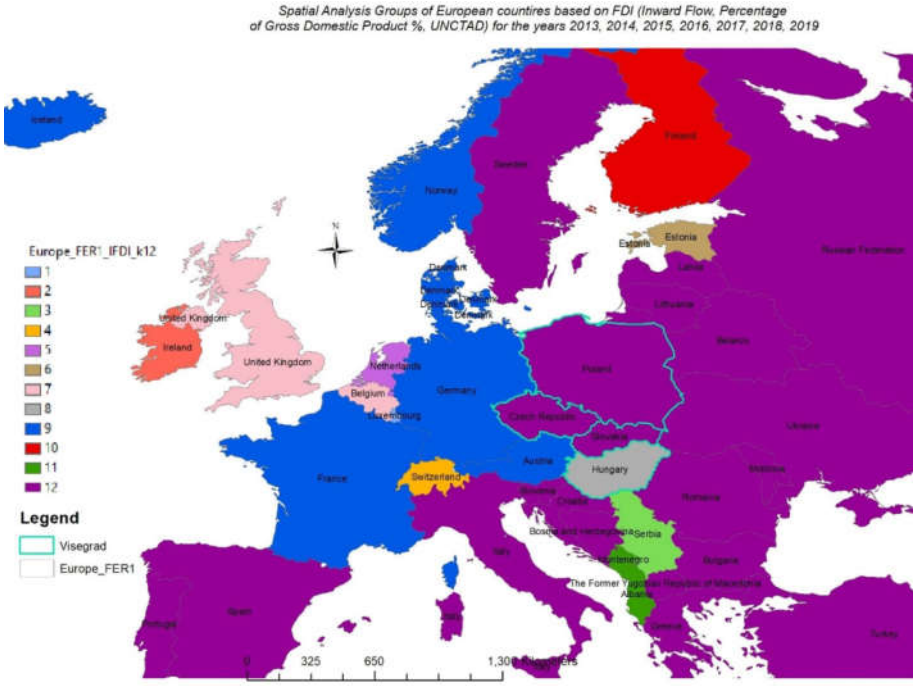
ER2019: G10<G14

Group means above the global mean

- G10 have the highest level of remittance & IFDI and the lowest level of employment rate. The IFDI acts in sectors that increase productivity and improve the technology level of innovation, followed by labour force dismissal. The released labour force becomes mobile for work and sustains the remittances flows.
- G14 has the highest level of national Employment and the lowest remittance level of remittance. IFDI is comparable to G10. The IFDI is complementary to other investments mechanisms, i.e., the case of Czechia[2] , with the venture capital innovation subindex increasing from 13.7 in 2014 to 37.5 in 2021 (European Innovation Scoreboard 2021). The economy creates enough new jobs and supports employment growth; therefore, the interest in labour mobility is low, and the level of remittances.

The Grouping analysis report results for IFDI rate (% in GDP), 2013, 2014, 2016, 2017, 2018 and 2019 (Table 5, selected from Appendices 9.3 and illustrated in Image 5), differentiate 12 clusters. Hungary is alone in the grey group G8, and all other V4 countries are in the dark mauve group G12. The FIDI provides a distinctive character of attractiveness in all years for Hungary except 2015 and 2016, years that give the best discriminant profile. In 2018 for the G12, the share in GDP of IFDI is 5.2982%, more than double the average for the G8 of 5.3%.

Image 5. The clusters build on Spatial Statistics Grouping Analysis for Inward FDI rates during the period 2013-2019



Source: graphic made by authors in Arc Gis Pro

Among the three variables, FDI, ER and FRM, in both years 2013 and 2019, the remittance has the highest discriminant contribution and the lowest by the ER.

[2] https://ec.europa.eu/docsroom/documents/45910

Table 5. The Spatial Statistics Grouping Analysis for IFDI in the years 2013-2019 (Image 3 and Appendices 9.3) are 12 groups with the maximum Pseudo-Statistic F of 82.3765. The V4 countries are distributed among the following groups:

Groups / Variable	Group 8 (Grey) Hungary – isolated island in CEE, count 1	Share	Group 12 (Dark Mauve)- Poland, Czech Republic and Slovakia next to areas of southern Europe, CEE and mainly Northern Europe (and Romania). Count 21	Share	Global mean	R2
IFDI2015	-11.6739	0.0000	2.1106	0.0494	5.4249	0.9845
IFDI2016	-4.2653	0.0000	2.2839	0.0792	4.4179	0.9837
IFDI2019	3.2701	0.0000	2.3636	0.1125	2.7650	0.9769
IFDI2018	5.2982	0.0000	2.3511	0.1397	1.6924	0.9704
IFDI2013	2.6473	0.0000	1.7727	0.1637	3.4234	0.9686
IFDI2014	5.6685	0.0000	1.8021	0.1892	3.5025	0.9617
IFDI2017	2.475	0.0000	2.3183	0.1293	3.2115	0.9517

Source: data calculated by authors

1. The IFDI2015 has the largest R2 and therefore is the best discriminant compared with IFDI for the other years;

	G12-G8	G12		G8
IFDI2013	-0.8746	G12	<	G8
IFDI2014	-3.8664	G12	<	G8
IFDI2015	13.7845	G12	>	G8
IFDI2016	6.5492	G12	>	G8
IFDI2017	-0.1567	G12	<	G8
IFDI2018	-2.9471	G12	<	G8
IFDI2019	-0.9065	G12	<	G8

Group means above the global mean

The development model presents the tendency to change from FDI inflow to increasing the importance of remittances. The capital investment in another country changes its pattern from

FDI model: usually from a large amount traditionally made by a company in a business economic sector, in the production scope, associated with management or technology but also with "effective control of or at least substantial influence over the decision-making of a foreign business" (Investopedia) towards the

Remittance model: towards micro amounts made by (in our case by essential groups of) individuals active labour persons that work abroad, towards their families/households in their origin countries, in the **consume scope**, associated with high demographic unbalances. (Table 3&4)

The temporal tendency of IFDI confirms the trend of changing the capital investment model. IFDI in 2016 presents the highest contribution in worldly terms with an R2 of 0.806907, followed by 2018 with 0.57645. In the most recent available year, 2019, the rank deteriorated to 5 from the seven years analysed.

The FDI inflow as input is highly similar: The similarity in FDI Spatio-temporal inflows pattern 2013-2019 points that the CEE (under the definition of EuroVoc, Image 6) has the same regime for all countries in this class, except Hungary and the Balkan countries block (Serbia, Montenegro, Albania, and the Former Republic of Macedonia). More than this, the CEE regime of FDI expand to the Southern Europe regions and partially to the Northern Regions (Sweden, Lithuania, Latvia). The western block is shrinking (looking at the FDI inflow similarity criteria), accelerated by the Brexit and different patterns for Belgium, Netherland, Luxembourg, and Switzerland. Also, Norway, Denmark, and Iceland (the second part of the Northern region) are under our Western area criteria.

Image 6. A map of European sub-regions and their boundaries, according to the categories set by EuroVoc (the European Union's official multilingual thesaurus)

Source: Samotny Wędrowiec - A map of European sub-regions and their boundaries, according to the categories set by EuroVoc (the European Union's official multilingual thesaurus). The regions in the image are colour-coded in the following manner: Blue - Northern Europe. Green - Western Europe. Red - Central and Eastern Europe. Yellow - Southern Europe. Grey - Territories not considered part of Europe. Before June 2018, the countries in red (Central and Eastern Europe) were classified simply as Eastern Europe. For reference: http://eurovoc.europa.eu/drupal/?q=request&uri=http://eurovoc.europa.eu/100277

The FDI inflow as an outcome regime is spatially dissimilar in the development model (mainly focusing on the CEE /Visegrad countries) illustrated by the clusters built on inward FDI, remittances receipts rates, and employment rates in Image 1 for 2013 and in Image 2 for 2019. There is a high similarity convergence for Poland, Slovakia, Hungary, Romania, and Bulgaria in this time frame. If Hungary converges to the Northeast – Southeast band, the Czech Republic is dissimilar but like Austria and Slovenia.

Limits of the model: countries analysed set include Turkey but not Armenia & Azerbaijan**.**

5. Discussion

V4 countries increased the similarity tendency regarding **their development model, described by the coordinates FDI, remittances and Employment** from 2013 to 2019. In Image 1 for 2013, Poland and Slovakia are like Romania, and the other 2 V2 countries are in different clusters. Czechia is in the Western group, and Hungary is comparable to Croatia and Bosnia Herzegovina. In 2019 according to Image 2, the pattern of the V3 countries (Slovakia, Poland and Hungary) to join the same practice with Romania and Bulgaria, shaping "**a 'buffer zone' situated between German and Russian spheres of interest**". (Gal and Andrea 2017) The 4th V4 country, the Czech Republic, is comparable Austria and Slovenia. The spatiotemporal pattern change of development in terms of IFDI, Remittances, and Employment confirms the conclusion (Phillips, 2000, p.185) "Germany's apparent power advantage and presence did not translate into influence". The two maps prove to **announce a new core-periphery relationship** from 2013 to 2019:

- France moved toward the Latin/Mediterranean countries cluster Span and Italy, next to Belgium,

- Germany joins back the western block (according to Wędrowiec classification) becomes similar to the UK and partially to Northern countries (Norway and Denmark). There are signs that the tandem of France and Germany drives apart;
- Austria is similar to the Czech Republic and Slovenia in 2019, members in the largest[3] cluster (brown colour), presenting a tendency to differentiate from Germany.

Long term inward rates of FDI spatiotemporal (2013-2019) pattern shape, in general, a map convergent to European sub-regions and their boundaries, according to the categories set by EuroVoc Wędrowiec. Southern Europe is like CEE, including V4 countries except for Hungary. Germany is like France, and Austria from the cluster of Western Europe, enlarged with Norway and Island from Nordic Europe. UK and Belgium are dissimilar to the Western block. Netherlands, Ireland, Switzerland, Estonia, Serbia, and Hungary are countries different to the previous generated geopolitical blocks.

Constantin (2021) points that the" territorial inequalities that are better captured at deeper disaggregation" levels, especially in the case of CEE. Xanthos, Ladias, and Genitsaropoulos (2012) contribute to methodologies to depict the regional inequalities in Greece at NUTS2 and NUTS3 level. On this background, our analysis is at NUTS0 only level, driven by the data.

Another direction to further research is create tools to support the precise selection of the proper public policy instruments. Our result could improve the understanding to shape innovative policy tools to wide range implemented instruments of research, technology, and innovation policy, as emphasis by (Kokkinou et al. 2018)

6. Conclusions

The answer for the Q1: Are the CEE /Visegrad countries similar in their spatiotemporal pattern of FDI inflows? Is that both CEE and V4, with the Hungary exception countries present a similar design on the background of the enlarged European area during the period 2013-2019. Hungary is an attractive destination for FDI compared to CEE and the V3 countries. Except for Hungary, the CEE investment model tends to move towards the remittance investment model. The remittance model expresses the location's incapacity to provide endogenous growth directly. The human capital is mobile and supports growth in a place abroad, with the remittance as positive externalities. The perennial lack of local development increases the number of mobile workers globally. This fact supports the action model based on consumption for the origin locations. Individuals make the capital investment at the household level and not in the economy. The areas with remittance development levels are more vulnerable to global risks, and therefore their populations, usually inactive ones, are more exposed to poverty and marginalization risks.

This conclusion is in line with the findings of (Gal & Andrea, 2017):

> "The economic transition fuelled by a neoliberal approach through economic liberalization, marketization, privatization overlapping with excessive 'foreignization' which created the legal and structural frameworks for the dependent mode of re-integration into the EU and into the global division of labour. Dependencies and semi-peripheral situation are the direct consequences of relative scarcities in capital and technology. The roots of these scarcities lie in the unfavourable conditions of specialization in the international division of labour. This is characterized by the limited access to resources in the process of capital accumulation, and, semi peripheral regions experiencing significant outflows of resources making them unable to pursue autonomo us growth." (Gal and Andrea 2017)

[3] Group 14: Sweden, Finland, Russian Federation, Latvia, Lithuania, Belarus, Austria, Czech Republic and Slovenia

The answer for the Q1: These countries are similar regarding their model of development, described by the coordinates IFDI, remittances and Employment?

In terms of development, it looks like space matters. V3 countries (Slovakia, Poland and Hungary) to join the same pattern with Romania and Bulgaria shaping "**a 'buffer zone' situated between German and Russian spheres of interest**". (Gal and Andrea 2017) The 4th V4 country, the Czech Republic, is comparable to Austria and Slovenia.

Our contribution is regarding the visual exploration of the territorial dimension of FDI in connection to remittance and employment creation on one side and on FDI territorial patterns changes in the long term across the European Territory,

Capital mobility and labour & human capital mobility create different development patterns in a global world**. Therefore, it is not enough to build policies to attract capital (FDI) and attract high human capital.** (Moretti, 2012)

But not the least, the existing technological gaps across regions (Stylianos, Ladias, and Polo 2010), more than ever, put in question the European territorial convergence policy success.

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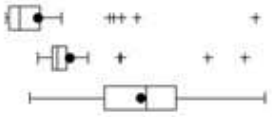
9. Appendices

9.1. The Grouping analysis report results for IFDI rate (% in GDP), Employment Rate and Remittance Rate in GDP in 2013 [FRE 2013 k15]

FRE 2013 k15 Section1 of the Output Report: Group-Wise Summary. Comparing the variables (the Analysis Fields) within each group to each other

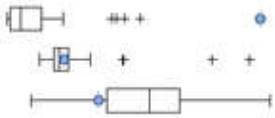
Overall Variable Statistics: Count = 39, Std. Distance = 11.5404, SSD = 4.6881

Variable	Mean	Std. Dev.	Min	Max	R2
FRM2013	3.0965	4.4807	0.1514	23.0768	0.9815
IFDI2013	3.4234	5.2199	-0.6121	25.9279	0.9540
ER2013	45.1318	9.2659	24.6700	67.8500	0.9443



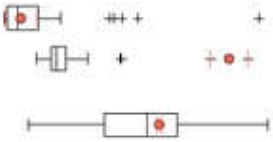
Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	23.0768	0.0000	23.0768	23.0768	0.0000
IFDI2013	2.4557	0.0000	2.4557	2.4557	0.0000
ER2013	36.9000	0.0000	36.9000	36.9000	0.0000



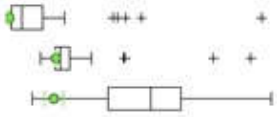
Group 2: Count = 2, Std. Distance = 2.7642, SSD = 0.5998

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	1.6734	1.3722	0.3012	3.0456	0.1197
IFDI2013	23.5718	2.3560	21.2158	25.9279	0.1775
ER2013	48.3050	0.4550	47.8500	48.7600	0.0211



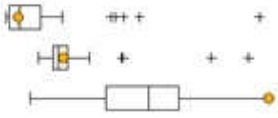
Group 3: Count = 2, Std. Distance = 1.6807, SSD = 0.0669

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	0.2677	0.0678	0.2000	0.3355	0.0059
IFDI2013	1.2955	0.1206	1.1749	1.4161	0.0091
ER2013	28.5950	1.6750	26.9200	30.2700	0.0776



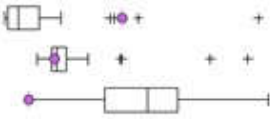
Group 4: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	1.2639	0.0000	1.2639	1.2639	0.0000
IFDI2013	2.4749	0.0000	2.4749	2.4749	0.0000
ER2013	67.8500	0.0000	67.8500	67.8500	0.0000



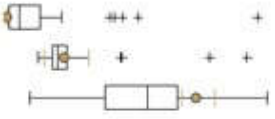
Group 5: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	10.7705	0.0000	10.7705	10.7705	0.0000
IFDI2013	1.5202	0.0000	1.5202	1.5202	0.0000
ER2013	24.6700	0.0000	24.6700	24.6700	0.0000



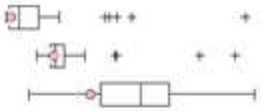
Group 6: Count = 3, Std. Distance = 3.4393, SSD = 0.8377

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	0.2359	0.0813	0.1724	0.3507	0.0078
IFDI2013	2.6168	2.3739	0.1662	5.8294	0.2134
ER2013	54.9333	2.4873	52.2800	58.2600	0.1385



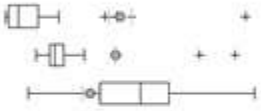
Group 7: Count = 2, Std. Distance = 2.3071, SSD = 0.1378

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	0.6140	0.2733	0.4407	0.7873	0.0151
IFDI2013	1.6134	0.4796	1.1239	2.0830	0.0161
ER2013	36.5000	2.2500	34.2500	38.7500	0.1042



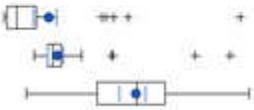
Group 8: Count = 2, Std. Distance = 1.8879, SSD = 0.1740

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	11.1236	1.0906	10.0330	12.2142	0.0951
IFDI2013	9.9655	0.0573	9.9082	10.0229	0.0043
ER2013	36.5100	1.5400	34.9700	38.0500	0.0713



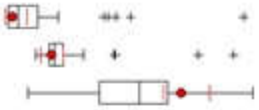
Group 9: Count = 4, Std. Distance = 2.3968, SSD = 0.4709

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	4.5019	0.9350	2.9985	5.3000	0.1004
IFDI2013	2.4641	0.8347	1.1173	3.3057	0.0825
ER2013	45.9200	2.0429	42.7800	47.7900	0.1160



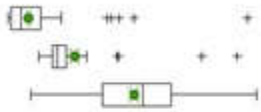
Group 10: Count = 7, Std. Distance = 3.1391, SSD = 1.1998

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	0.8329	0.7304	0.1514	2.2349	0.0909
IFDI2013	1.4439	1.2033	-0.0391	3.0511	0.1164
ER2013	54.1414	2.8058	50.8300	59.5700	0.2024



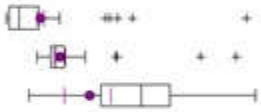
Group 11: Count = 2, Std. Distance = 0.8900, SSD = 0.0289

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	2.1050	0.1370	1.9680	2.2420	0.0119
IFDI2013	4.1564	0.4249	3.7315	4.5813	0.0320
ER2013	44.4800	0.7700	43.7100	45.2500	0.0357



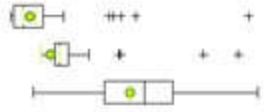
Group 12: Count = 3, Std. Distance = 3.7163, SSD = 0.5218

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	3.4311	0.2766	3.0719	3.7449	0.0294
IFDI2013	2.4404	0.6371	1.5775	3.0964	0.0572
ER2013	36.2633	3.6508	31.5000	40.3700	0.2054



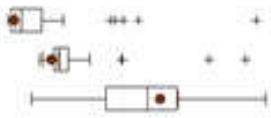
Group 13: Count = 3, Std. Distance = 1.1419, SSD = 0.1473

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	2.0126	0.4509	1.4235	2.3168	0.0477
IFDI2013	0.5587	1.0215	-0.6121	1.8868	0.0641
ER2013	43.3300	0.2393	43.1000	43.6000	0.0136



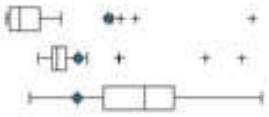
Group 14: Count = 5, Std. Distance = 2.7154, SSD = 0.5031

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	0.7086	0.1538	0.4392	0.8664	0.0186
IFDI2013	0.8629	0.7432	-0.3124	1.7379	0.0773
ER2013	48.4320	2.6072	46.0600	51.7100	0.1308



Group 15: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

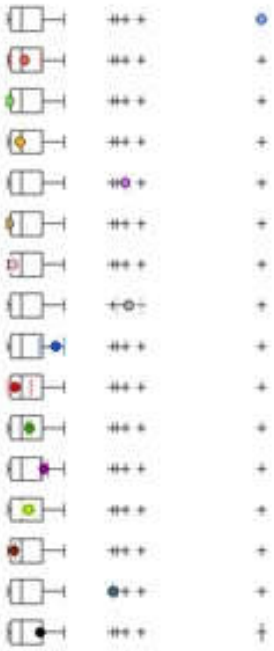
Variable	Mean	Std. Dev.	Min	Max	Share
FRM2013	9.6653	0.0000	9.6653	9.6653	0.0000
IFDI2013	4.6115	0.0000	4.6115	4.6115	0.0000
ER2013	33.5300	0.0000	33.5300	33.5300	0.0000



FRE 2013 k15 Section 2 of the Output Report: Variable Wise-Summary. Comparing the variables (the Analysis Fields) ranges for each group, one analysis field (variable) at a time

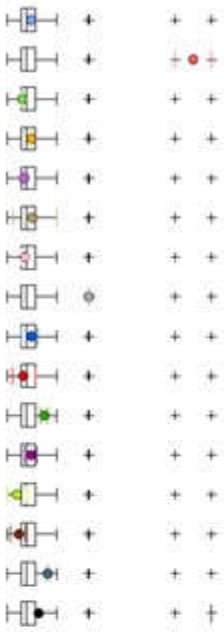
FRM2013: R2 = 0.98

Group	Mean	Std. Dev.	Min	Max	Share
1	23.0768	0.0000	23.0768	23.0768	0.0000
2	1.6734	1.3722	0.3012	3.0456	0.1197
3	0.2677	0.0678	0.2000	0.3355	0.0059
4	1.2639	0.0000	1.2639	1.2639	0.0000
5	10.7705	0.0000	10.7705	10.7705	0.0000
6	0.2359	0.0813	0.1724	0.3507	0.0078
7	0.6140	0.1733	0.4407	0.7873	0.0151
8	11.1236	1.0906	10.0330	12.2142	0.0951
9	4.5019	0.9350	2.9985	5.3000	0.1004
10	0.8329	0.7304	0.1514	2.2349	0.0909
11	2.1050	0.1370	1.9680	2.2420	0.0119
12	3.4311	0.2766	3.0719	3.7449	0.0294
13	2.0118	0.4509	1.4725	2.5168	0.0477
14	0.7086	0.1538	0.4392	0.8664	0.0186
15	9.6653	0.0000	9.6653	9.6653	0.0000
Total	3.0965	4.4807	0.1514	23.0768	1.0000



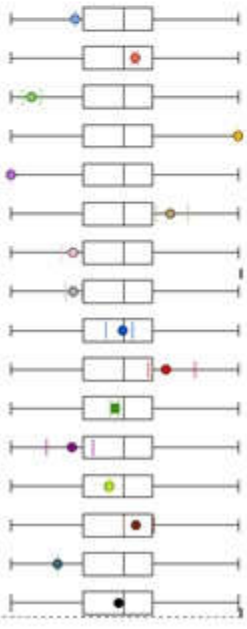
IFDI2013: R2 = 0.95

Group	Mean	Std. Dev.	Min	Max	Share
1	2.4557	0.0000	2.4557	2.4557	0.0000
2	23.5718	2.3560	21.2158	25.9279	0.1775
3	1.2955	0.1206	1.1749	1.4161	0.0091
4	2.4749	0.0000	2.4749	2.4749	0.0000
5	1.5202	0.0000	1.5202	1.5202	0.0000
6	2.6168	2.3739	0.1662	5.8294	0.2134
7	1.6134	0.4786	1.1339	2.0930	0.0361
8	9.9655	0.0573	9.9082	10.0229	0.0043
9	2.4641	0.8347	1.1173	3.3057	0.0825
10	1.4439	1.2033	-0.0391	3.0511	0.1164
11	4.1564	0.4249	3.7315	4.5813	0.0320
12	2.4404	0.6371	1.5775	3.0964	0.0572
13	0.5987	1.0215	-0.6121	1.8866	0.0941
14	0.8629	0.7432	-0.3124	1.7379	0.0773
15	4.6115	0.0000	4.6115	4.6115	0.0000
Total	3.4234	5.2199	-0.6121	25.9279	1.0000

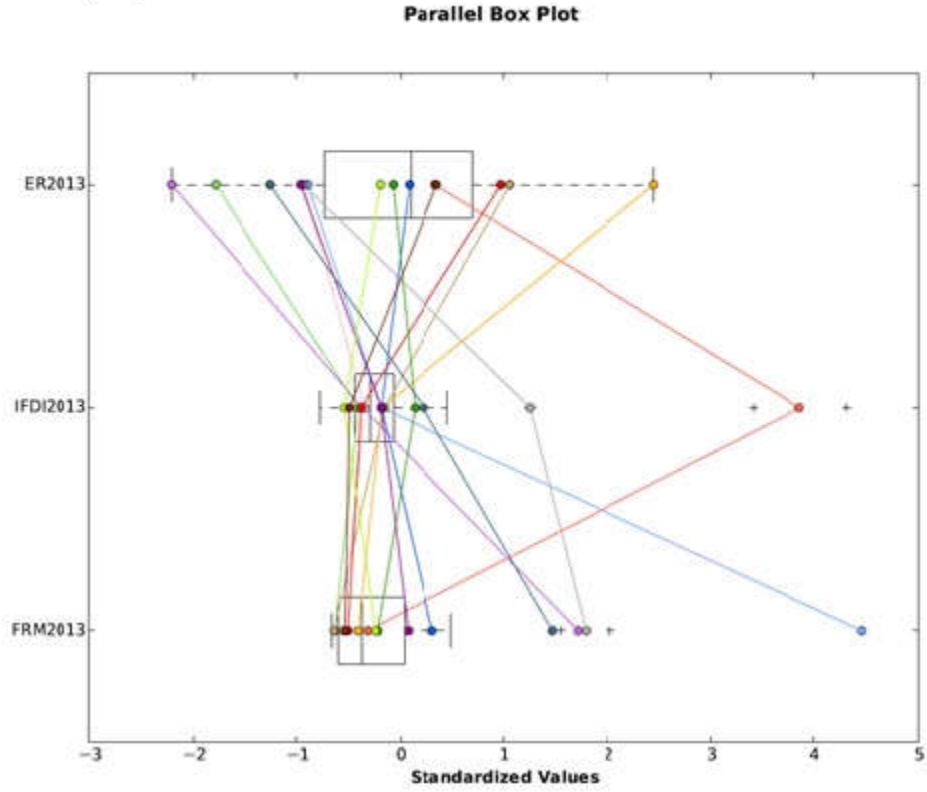


ER2013: R2 = 0.94

Group	Mean	Std. Dev.	Min	Max	Share
1	36.9000	0.0000	36.9000	36.9000	0.0000
2	48.3050	0.4550	47.8500	48.7600	0.0211
3	28.5950	1.6750	26.9200	30.2700	0.0776
4	67.8500	0.0000	67.8500	67.8500	0.0000
5	24.6700	0.0000	24.6700	24.6700	0.0000
6	54.9333	2.4873	52.2800	58.2600	0.1385
7	36.5000	2.3500	34.2500	38.7500	0.1042
8	36.5100	1.5400	34.9700	38.0500	0.0713
9	45.9200	2.0429	42.7800	47.7900	0.1160
10	54.1414	2.8058	50.8300	59.5700	0.2024
11	44.4800	0.7700	43.7100	45.2500	0.0357
12	36.2633	3.6508	31.5000	40.3700	0.2054
13	43.3300	0.3393	43.1000	43.6600	0.0130
14	48.4320	2.6072	46.0600	51.7100	0.1308
15	33.5300	0.0000	33.5300	33.5300	0.0000
Total	45.1318	9.2659	24.6700	67.8500	1.0000



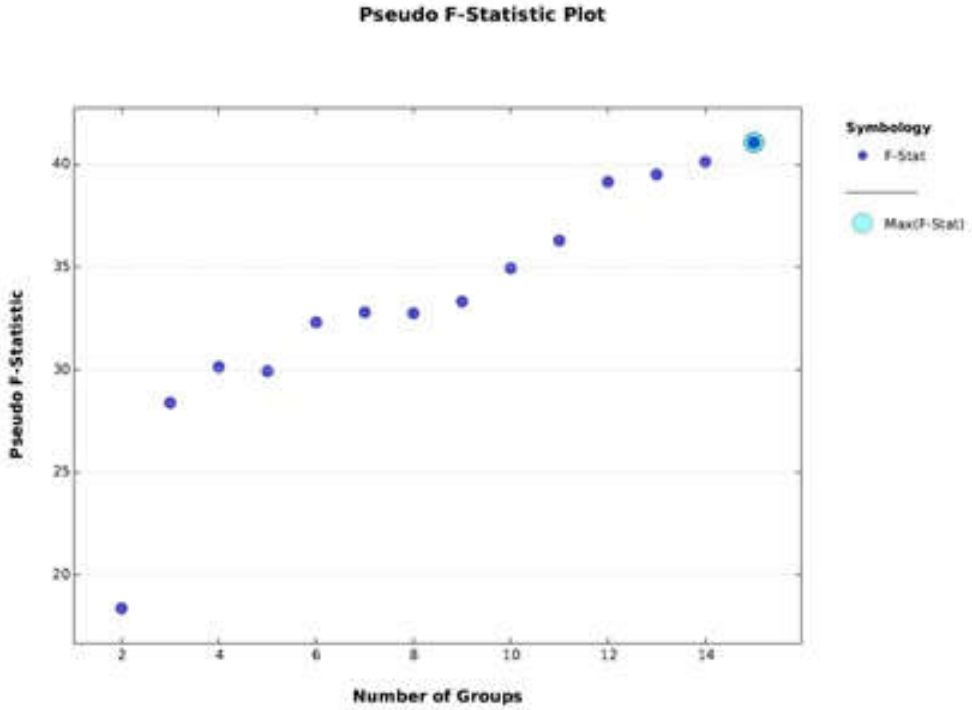
FRE 2013 k15 *Section 3 of the Output Report: The parallel box plot graph - summarizes both the groups and the variables within them*



FRE 2013 k15 *Section 4 of the Output Report: check on the Evaluate Optimal Number of Groups parameter based on Pseudo F-statistic values*

Grouping Analysis Parameters

Parameter Name	Input Value
Input Features	Europe_FER1
Unique ID Field	OBJECTID
Output Feature Class	None
Analysis Fields	IFDI2013
	FRM2013
	ER2013
Spatial Constraints	GET_SPATIAL_WEIGHTS_FROM_FILE
Distance Method	EUCLIDEAN
Number of Neighbors	None
Weights Matrix File	D:\cristina_29_07_2014acasa\an2021\diseminare\todo\Bolzano\GIS\Europe_FER.swm
Initialization Method	FIND_SEED_LOCATIONS
Initialization Field	None
Selection Set	False

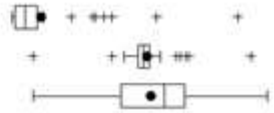


Pseudo F-Statistic Summary

Number of Groups	Pseudo F-Statistic
2	18.3766
3	28.3916
4	30.1349
5	29.9258
6	32.3114
7	32.7965
8	32.7474
9	33.3199
10	34.9423
11	36.2942
12	39.1538
13	39.5063
14	40.1251
15	41.0691

Overall Variable Statistics: Count = 39, Std. Distance = 10.9095, SSD = 6.0365

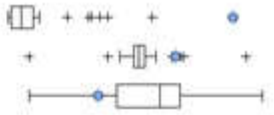
Variable	Mean	Std. Dev.	Min	Max	R2
FRM2019	3.3431	5.1042	0.1062	25.3504	0.9720
IFDI2019	2.7650	4.9044	-16.3217	20.2440	0.9456
ER2019	48.4267	8.3013	28.6600	68.0200	0.9276



Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

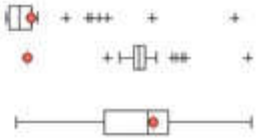
Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	25.3504	0.0000	25.3504	25.3504	0.0000
IFDI2019	8.3411	0.0000	8.3411	8.3411	0.0000
ER2019	40.3100	0.0000	40.3100	40.3100	0.0000



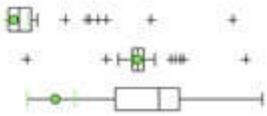
Group 2: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	2.8600	0.0000	2.8600	2.8600	0.0000
IFDI2019	-16.3217	0.0000	-16.3217	-16.3217	0.0000
ER2019	51.6000	0.0000	51.6000	51.6000	0.0000



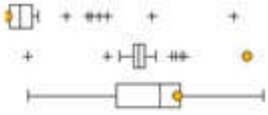
Group 3: Count = 3, Std. Distance = 3.6902, SSD = 0.7267

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.9675	1.1127	0.1062	2.5387	0.0964
IFDI2019	2.0739	0.7465	1.1059	2.9228	0.0497
ER2019	33.4200	3.4383	28.6600	36.6600	0.2033



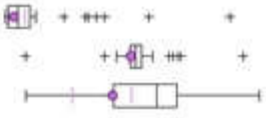
Group 4: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.1504	0.0000	0.1504	0.1504	0.0000
IFDI2019	20.2440	0.0000	20.2440	20.2440	0.0000
ER2019	53.6500	0.0000	53.6500	53.6500	0.0000



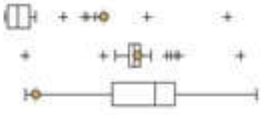
Group 5: Count = 4, Std. Distance = 4.1805, SSD = 1.0784

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	1.1472	0.7371	0.5195	2.3962	0.0743
IFDI2019	1.3298	0.3340	0.8979	1.8339	0.0256
ER2019	43.3000	4.1015	36.4500	46.5300	0.2561



Group 6: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	11.3219	0.0000	11.3219	11.3219	0.0000
IFDI2019	2.7294	0.0000	2.7294	2.7294	0.0000
ER2019	30.4300	0.0000	30.4300	30.4300	0.0000

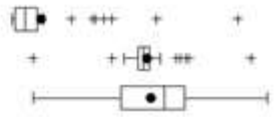


9.2. The Grouping analysis report results for IFDI rate (% in GDP), Employment Rate and Remitance Rate in GDP in 2019 [FRE 2019 k15]

FRE 2019 k15 Section1 of the Output Report: Group-Wise Summary. Comparing the variables (the Analysis Fields) within each group to each other

Overall Variable Statistics: Count = 39, Std. Distance = 10.9095, SSD = 6.0365

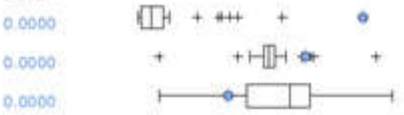
Variable	Mean	Std. Dev.	Min	Max	R2
FRM2019	3.3431	5.1042	0.1062	25.3504	0.9720
IFDI2019	2.7650	4.9044	-16.3217	20.2440	0.9456
ER2019	48.4267	8.3013	28.6600	68.0200	0.9276



Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

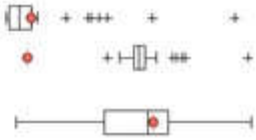
Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	25.3504	0.0000	25.3504	25.3504	0.0000
IFDI2019	8.3411	0.0000	8.3411	8.3411	0.0000
ER2019	40.3100	0.0000	40.3100	40.3100	0.0000



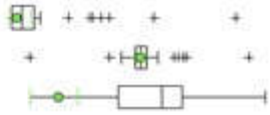
Group 2: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	2.8600	0.0000	2.8600	2.8600	0.0000
IFDI2019	-16.3217	0.0000	-16.3217	-16.3217	0.0000
ER2019	51.6000	0.0000	51.6000	51.6000	0.0000



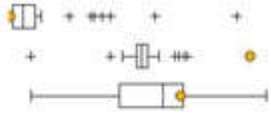
Group 3: Count = 3, Std. Distance = 3.6902, SSD = 0.7267

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.9675	1.1127	0.1062	2.5387	0.0964
IFDI2019	2.0739	0.7465	1.1059	2.9228	0.0497
ER2019	33.4200	3.4383	28.6600	36.6600	0.2033



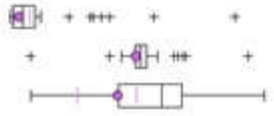
Group 4: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.1504	0.0000	0.1504	0.1504	0.0000
IFDI2019	20.2440	0.0000	20.2440	20.2440	0.0000
ER2019	53.6500	0.0000	53.6500	53.6500	0.0000



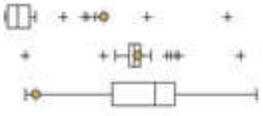
Group 5: Count = 4, Std. Distance = 4.1805, SSD = 1.0784

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	1.1472	0.7371	0.5195	2.3962	0.0743
IFDI2019	1.3298	0.3340	0.8979	1.8339	0.0256
ER2019	43.3000	4.1015	36.4500	46.5300	0.2561



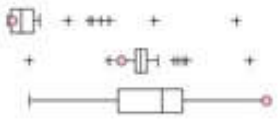
Group 6: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	11.3219	0.0000	11.3219	11.3219	0.0000
IFDI2019	2.7294	0.0000	2.7294	2.7294	0.0000
ER2019	30.4300	0.0000	30.4300	30.4300	0.0000



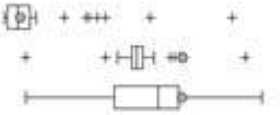
Group 7: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.6397	0.0000	0.6397	0.6397	0.0000
IFDI2019	-1.0038	0.0000	-1.0038	-1.0038	0.0000
ER2019	68.0200	0.0000	68.0200	68.0200	0.0000



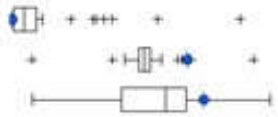
Group 8: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	1.8488	0.0000	1.8488	1.8488	0.0000
IFDI2019	9.7690	0.0000	9.7690	9.7690	0.0000
ER2019	54.6700	0.0000	54.6700	54.6700	0.0000



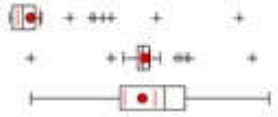
Group 9: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.2598	0.0000	0.2598	0.2598	0.0000
IFDI2019	9.3011	0.0000	9.3011	9.3011	0.0000
ER2019	57.0200	0.0000	57.0200	57.0200	0.0000



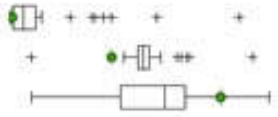
Group 10: Count = 5, Std. Distance = 2.0343, SSD = 0.4204

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	2.4190	0.8682	1.0287	3.4614	0.0964
IFDI2019	2.4308	0.4720	1.8274	3.2701	0.0395
ER2019	47.0700	1.7781	44.0600	49.2300	0.1314



Group 11: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

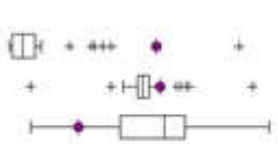
Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.3532	0.0000	0.3532	0.3532	0.0000
IFDI2019	-3.0633	0.0000	-3.0633	-3.0633	0.0000
ER2019	59.9400	0.0000	59.9400	59.9400	0.0000



Group 12: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

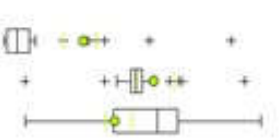
Group 12: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	16.2577	0.0000	16.2577	16.2577	0.0000
IFDI2019	5.0121	0.0000	5.0121	5.0121	0.0000
ER2019	36.5500	0.0000	36.5500	36.5500	0.0000



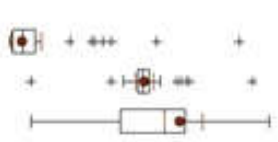
Group 13: Count = 4, Std. Distance = 3.6862, SSD = 1.9139

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	8.9051	1.5447	6.7041	10.3195	0.3431
IFDI2019	5.0860	2.9663	2.0029	8.3558	0.1736
ER2019	43.6125	1.7285	42.1200	46.5300	0.1120



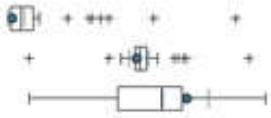
Group 14: Count = 9, Std. Distance = 2.3038, SSD = 1.0872

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	1.4581	1.0276	0.3337	3.5654	0.1280
IFDI2019	2.3172	0.8284	1.0425	3.9059	0.0783
ER2019	53.2078	1.8882	50.6600	56.9300	0.1593



Group 15: Count = 5, Std. Distance = 2.8437, SSD = 0.8099

Variable	Mean	Std. Dev.	Min	Max	Share
FRM2019	0.5936	0.6400	0.1374	1.8493	0.0678
IFDI2019	1.5748	1.1350	0.2678	3.5194	0.0889
ER2019	54.8640	2.5276	50.8000	58.5400	0.1966



FRE 2019 k15 Section 2 of the Output Report: Variable Wise-Summary. Comparing the variables (the Analysis Fields) ranges for each group, one analysis field (variable) at a time

FRM2019: R2 = 0.97

Group	Mean	Std. Dev.	Min	Max	Share
1	25.3504	0.0000	25.3504	25.3504	0.0000
2	2.8600	0.0000	2.8600	2.8600	0.0000
3	0.9675	1.1127	0.1062	2.5387	0.0964
4	0.1504	0.0000	0.1504	0.1504	0.0000
5	1.1472	0.7371	0.5195	2.3962	0.0743
6	11.3219	0.0000	11.3219	11.3219	0.0000
7	0.6197	0.0000	0.6197	0.6197	0.0000
8	1.8488	0.0000	1.8488	1.8488	0.0000
9	0.2598	0.0000	0.2598	0.2598	0.0000
10	2.4190	0.8682	1.0287	3.4614	0.0964
11	0.3532	0.0000	0.3532	0.3532	0.0000
12	16.2577	0.0000	16.2577	16.2577	0.0000
13	8.9151	1.3447	6.7041	10.3155	0.3431
14	1.4581	1.0276	0.3337	3.5654	0.1280
15	0.5936	0.6400	0.1374	1.8493	0.0678
Total	3.3431	5.1042	0.1062	25.3504	1.0000

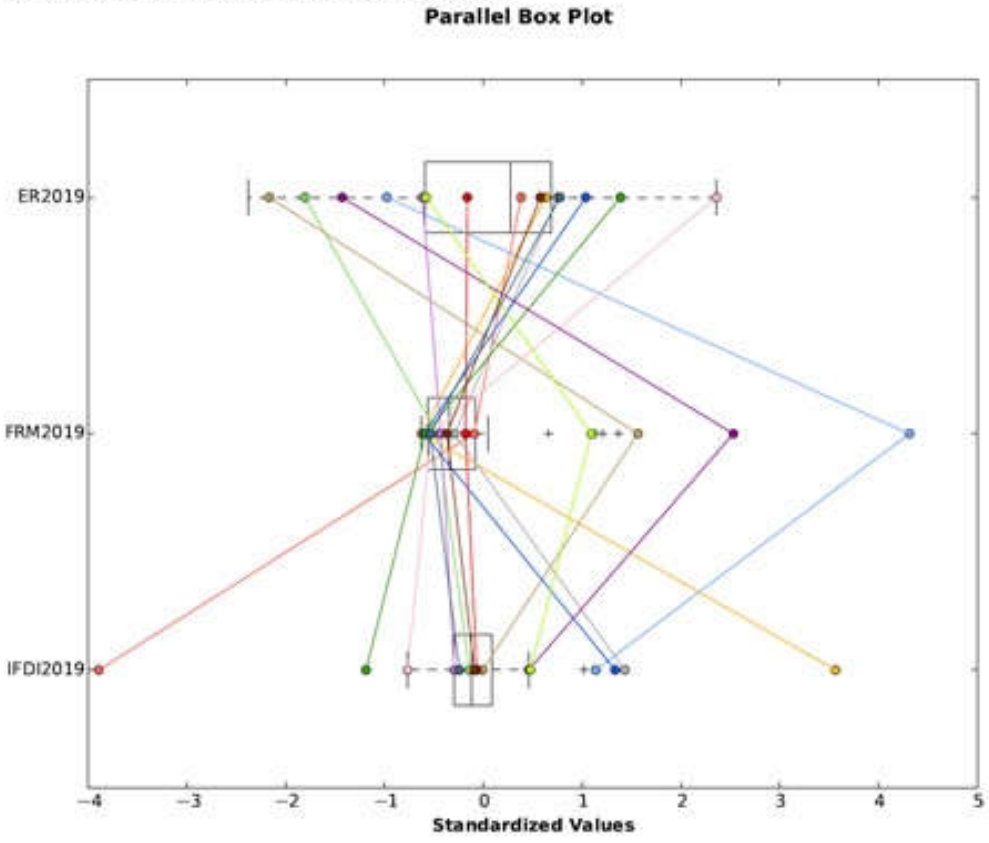
IFDI2019: R2 = 0.95

Group	Mean	Std. Dev.	Min	Max	Share
1	8.3411	0.0000	8.3411	8.3411	0.0000
2	-16.3217	0.0000	-16.3217	-16.3217	0.0000
3	2.0739	0.7465	1.1059	2.9228	0.0497
4	20.2440	0.0000	20.2440	20.2440	0.0000
5	1.3298	0.3340	0.8979	1.8339	0.0256
6	2.7294	0.0000	2.7294	2.7294	0.0000
7	-1.0038	0.0000	-1.0038	-1.0038	0.0000
8	9.7890	0.0000	9.7890	9.7890	0.0000
9	9.3011	0.0000	9.3011	9.3011	0.0000
10	2.4308	0.4720	1.8274	3.2701	0.0395
11	-3.0633	0.0000	-3.0633	-3.0633	0.0000
12	5.0121	0.0000	5.0121	5.0121	0.0000
13	5.0960	2.9663	2.8026	8.3508	0.1736
14	2.3172	0.8284	1.0425	3.9059	0.0783
15	1.5748	1.1350	0.2678	3.5194	0.0889
Total	2.7650	4.9044	-16.3217	20.2440	1.0000

ER2019: R2 = 0.93

Group	Mean	Std. Dev.	Min	Max	Share
1	40.3100	0.0000	40.3100	40.3100	0.0000
2	51.6000	0.0000	51.6000	51.6000	0.0000
3	33.4200	3.4383	28.6600	36.6600	0.2033
4	53.6500	0.0000	53.6500	53.6500	0.0000
5	43.3000	4.1015	36.4500	46.5300	0.2561
6	30.4300	0.0000	30.4300	30.4300	0.0000
7	68.0100	0.0000	68.0200	68.0100	0.0000
8	54.6700	0.0000	54.6700	54.6700	0.0000
9	57.0200	0.0000	57.0200	57.0200	0.0000
10	47.0700	1.7781	44.0600	49.2300	0.1314
11	59.9400	0.0000	59.9400	59.9400	0.0000
12	36.5500	0.0000	36.5500	36.5500	0.0000
13	43.6129	1.7265	42.1200	46.5300	0.1130
14	53.2078	1.8882	50.6600	56.9300	0.1593
15	54.8640	2.5276	50.8000	58.5400	0.1966
Total	48.4267	8.3013	28.6600	68.0200	1.0000

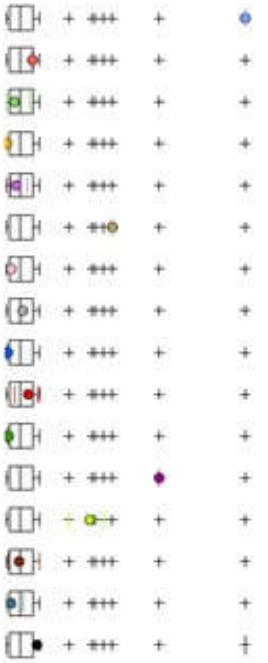
FRE 2019 k15 *Section 3 of the Output Report: The parallel box plot graph - summarizes both the groups and the variables within them*



FRE 2019 k15 Section 2 of the Output Report: Variable Wise-Summary. Comparing the variables (the Analysis Fields) ranges for each group, one analysis field (variable) at a time

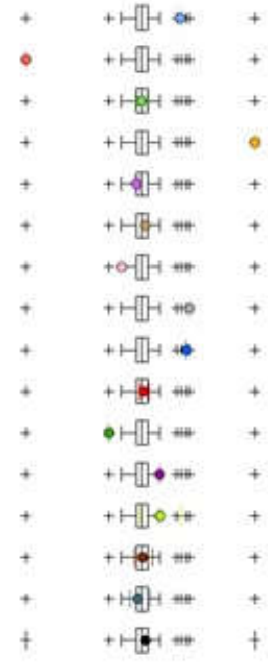
FRM2019: R2 = 0.97

Group	Mean	Std. Dev.	Min	Max	Share
1	25.3504	0.0000	25.3504	25.3504	0.0000
2	2.8600	0.0000	2.8600	2.8600	0.0000
3	0.9675	1.1127	0.1062	2.5387	0.0964
4	0.1504	0.0000	0.1504	0.1504	0.0000
5	1.1472	0.7371	0.5195	2.3962	0.0743
6	11.3219	0.0000	11.3219	11.3219	0.0000
7	0.6397	0.0000	0.6397	0.6397	0.0000
8	1.8488	0.0000	1.8488	1.8488	0.0000
9	0.2598	0.0000	0.2598	0.2598	0.0000
10	2.4190	0.8682	1.0287	3.4614	0.0964
11	0.3532	0.0000	0.3532	0.3532	0.0000
12	16.2577	0.0000	16.2577	16.2577	0.0000
13	8.9151	1.3447	6.7041	10.3155	0.1431
14	1.4581	1.0276	0.3337	3.5654	0.1280
15	0.5936	0.6400	0.1374	1.8493	0.0678
Total	3.3431	5.1042	0.1062	25.3504	1.0000



IFDI2019: R2 = 0.95

Group	Mean	Std. Dev.	Min	Max	Share
1	8.3411	0.0000	8.3411	8.3411	0.0000
2	-16.3217	0.0000	-16.3217	-16.3217	0.0000
3	2.0739	0.7465	1.1059	2.9228	0.0497
4	20.2440	0.0000	20.2440	20.2440	0.0000
5	1.3298	0.3340	0.8979	1.8339	0.0256
6	2.7294	0.0000	2.7294	2.7294	0.0000
7	-1.0038	0.0000	-1.0038	-1.0038	0.0000
8	9.7890	0.0000	9.7890	9.7890	0.0000
9	9.3011	0.0000	9.3011	9.3011	0.0000
10	2.4308	0.4720	1.8274	3.2701	0.0395
11	-3.0633	0.0000	-3.0633	-3.0633	0.0000
12	5.0121	0.0000	5.0121	5.0121	0.0000
13	5.0660	2.9683	2.0026	8.3508	0.1738
14	2.3172	0.8284	1.0425	3.9059	0.0783
15	1.5748	1.1350	0.2678	3.5194	0.0889
Total	2.7650	4.9044	-16.3217	20.2440	1.0000

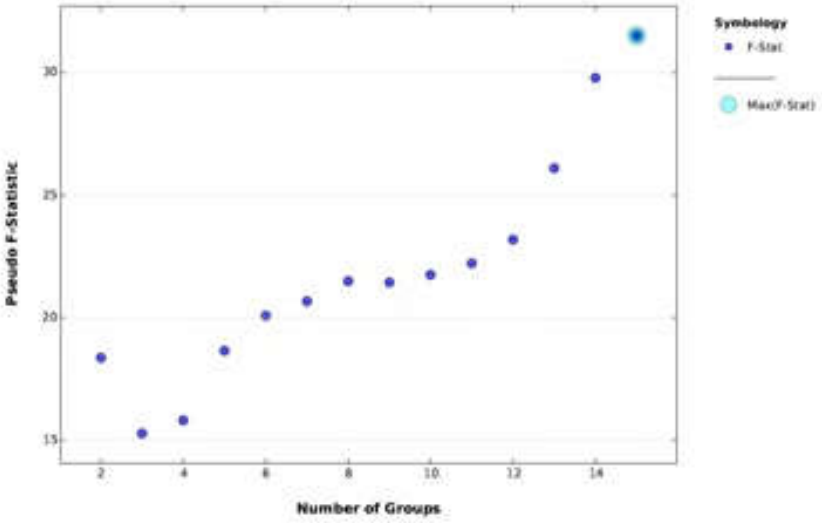


FRE 2019 k15 ***Section 4 of the Output Report: check on the Evaluate Optimal Number of Groups parameter based on pseudo-F-statistic values***

Grouping Analysis Parameters

Parameter Name	Input Value
Input Features	Europe_FER1
Unique ID Field	OBJECTID
Output Feature Class	None
Analysis Fields	IFDI2019
	FRM2019
	IER2019
Spatial Constraints	GET_SPATIAL_WEIGHTS_FROM_FILE
Distance Method	EUCLIDEAN
Number of Neighbors	None
Weights Matrix File	D:\cristina_29_07_2014acasa\an2021\diseminare\codoiBolzano\GIS\Europe_FER.swm
Initialization Method	FIND_SEED_LOCATIONS
Initialization Field	None
Selection Set	False

Pseudo F-Statistic Plot



Pseudo F-Statistic Summary

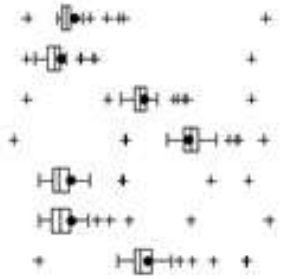
Number of Groups	Pseudo F-Statistic
2	18.3568
3	15.2665
4	15.8018
5	18.6421
6	20.0752
7	20.6625
8	21.4859
9	21.4329
10	21.7466
11	22.2123
12	23.1802
13	26.1005
14	29.7886
15	31.5122

9.3. The Grouping analysis report results for IFDI rate (% in GDP), 2013, 2014, 2016, 2017, 2018 and 2019 [IFDI k12]

IFDI k12 Section1 of the Output Report: Group-Wise Summary. Comparing the variables (the Analysis Fields) within each group to each other

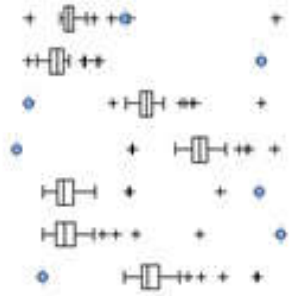
Overall Variable Statistics: Count = 39, Std. Distance = 19.1090, SSD = 7.8991

Variable	Mean	Std. Dev.	Min	Max	R2
IFDI2015	5.4249	12.7159	-11.6739	74.7406	0.9845
IFDI2016	4.4179	8.6942	-4.2653	52.5607	0.9837
IFDI2019	2.7650	4.9044	-16.3217	20.2440	0.9769
IFDI2018	1.6924	5.4099	-23.6275	12.5047	0.9704
IFDI2013	3.4234	5.2199	-0.6121	25.9279	0.9686
IFDI2014	3.5025	5.3591	-0.6557	28.5801	0.9617
IFDI2017	3.2115	4.3111	-10.6188	15.7405	0.9517



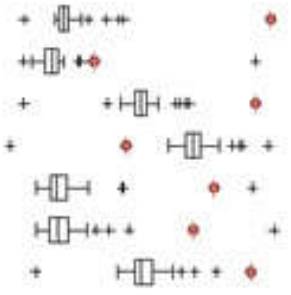
Group 1: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	21.6466	0.0000	21.6466	21.6466	0.0000
IFDI2016	52.5607	0.0000	52.5607	52.5607	0.0000
IFDI2019	-16.3217	0.0000	-16.3217	-16.3217	0.0000
IFDI2018	-23.6275	0.0000	-23.6275	-23.6275	0.0000
IFDI2013	25.9279	0.0000	25.9279	25.9279	0.0000
IFDI2014	28.5801	0.0000	28.5801	28.5801	0.0000
IFDI2017	-10.6188	0.0000	-10.6188	-10.6188	0.0000



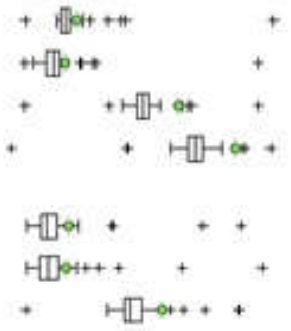
Group 2:

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	74.7406	0.0000	74.7406	74.7406	0.0000
IFDI2016	13.1150	0.0000	13.1150	13.1150	0.0000
IFDI2019	20.2440	0.0000	20.2440	20.2440	0.0000
IFDI2018	-7.3402	0.0000	-7.3402	-7.3402	0.0000
IFDI2013	21.2158	0.0000	21.2158	21.2158	0.0000
IFDI2014	18.6668	0.0000	18.6668	18.6668	0.0000
IFDI2017	15.7405	0.0000	15.7405	15.7405	0.0000



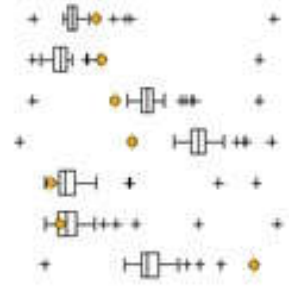
Group 3: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	6.1702	0.0000	6.1702	6.1702	0.0000
IFDI2016	5.4821	0.0000	5.4821	5.4821	0.0000
IFDI2019	7.7558	0.0000	7.7558	7.7558	0.0000
IFDI2018	7.5998	0.0000	7.5998	7.5998	0.0000
IFDI2013	4.6115	0.0000	4.6115	4.6115	0.0000
IFDI2014	4.2631	0.0000	4.2631	4.2631	0.0000
IFDI2017	6.1652	0.0000	6.1652	6.1652	0.0000



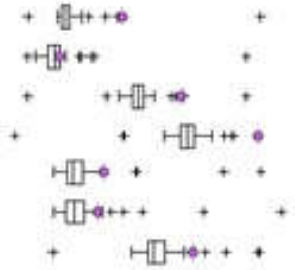
Group 4: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	10.9725	0.0000	10.9725	10.9725	0.0000
IFDI2016	13.0755	0.0000	13.0755	13.0755	0.0000
IFDI2019	-3.0633	0.0000	-3.0633	-3.0633	0.0000
IFDI2018	-7.4657	0.0000	-7.4657	-7.4657	0.0000
IFDI2013	0.1662	0.0000	0.1662	0.1662	0.0000
IFDI2014	1.3048	0.0000	1.3048	1.3048	0.0000
IFDI2017	15.6332	0.0000	15.6332	15.6332	0.0000



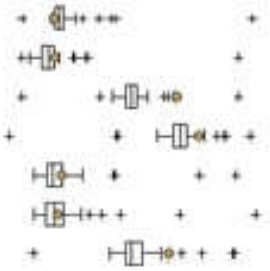
Group 5: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	23.3893	0.0000	23.3893	23.3893	0.0000
IFDI2016	3.9179	0.0000	3.9179	3.9179	0.0000
IFDI2019	9.3011	0.0000	9.3011	9.3011	0.0000
IFDI2018	12.5047	0.0000	12.5047	12.5047	0.0000
IFDI2013	5.8294	0.0000	5.8294	5.8294	0.0000
IFDI2014	5.0544	0.0000	5.0544	5.0544	0.0000
IFDI2017	7.2526	0.0000	7.2526	7.2526	0.0000



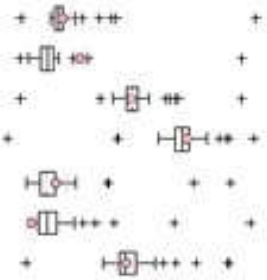
Group 6: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	0.1541	0.0000	0.1541	0.1541	0.0000
IFDI2016	4.4141	0.0000	4.4141	4.4141	0.0000
IFDI2019	9.7890	0.0000	9.7890	9.7890	0.0000
IFDI2018	4.8332	0.0000	4.8332	4.8332	0.0000
IFDI2013	3.0511	0.0000	3.0511	3.0511	0.0000
IFDI2014	2.5568	0.0000	2.5568	2.5568	0.0000
IFDI2017	7.1518	0.0000	7.1518	7.1518	0.0000



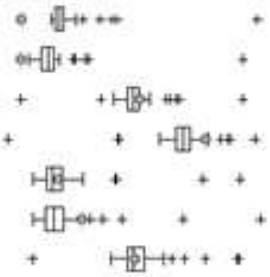
Group 7: Count = 2, Std. Distance = 3.5121, SSD = 0.5229

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	3.3343	2.3981	1.3399	6.1303	0.0555
IFDI2016	11.0231	1.4213	9.6018	12.4444	0.0500
IFDI2019	1.9461	0.1122	1.8339	2.0583	0.0432
IFDI2018	2.7763	0.4493	2.2870	3.2656	0.0771
IFDI2013	3.2181	1.2632	1.9549	4.5813	0.1027
IFDI2014	0.0751	0.7308	-0.6557	0.8059	0.0580
IFDI2017	2.4101	1.3870	1.0231	3.7971	0.1052



Group 8: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	-11.6739	0.0000	-11.6739	-11.6739	0.0000
IFDI2016	-4.2653	0.0000	-4.2653	-4.2653	0.0000
IFDI2019	3.2701	0.0000	3.2701	3.2701	0.0000
IFDI2018	5.2982	0.0000	5.2982	5.2982	0.0000
IFDI2013	2.6473	0.0000	2.6473	2.6473	0.0000
IFDI2014	5.6685	0.0000	5.6685	5.6685	0.0000
IFDI2017	2.4750	0.0000	2.4750	2.4750	0.0000



Group 9: Count = 6, Std. Distance = 2.9088, SSD = 1.4621

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	1.3205	1.4283	-0.5008	4.0746	0.0529
IFDI2016	-0.6722	1.2176	-2.1528	0.9314	0.0543
IFDI2019	0.5917	0.7770	-1.0038	1.2553	0.0618
IFDI2018	0.4490	1.0725	-1.5234	1.8627	0.0937
IFDI2013	1.0850	0.7389	0.2642	2.4749	0.0833
IFDI2014	1.0824	0.8876	-0.0825	2.5177	0.0889
IFDI2017	1.0831	1.3605	-0.6470	3.5746	0.1602

Group 10: Count = 1, Std. Distance = 0.0000, SSD = 0.0000

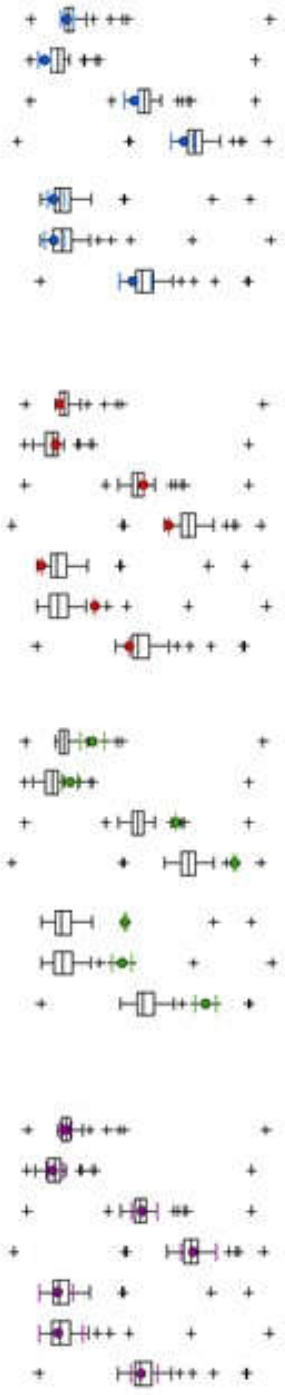
Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	0.8990	0.0000	0.8990	0.8990	0.0000
IFDI2016	3.5674	0.0000	3.5674	3.5674	0.0000
IFDI2019	3.0507	0.0000	3.0507	3.0507	0.0000
IFDI2018	-0.8766	0.0000	-0.8766	-0.8766	0.0000
IFDI2013	-0.0391	0.0000	-0.0391	-0.0391	0.0000
IFDI2014	6.7656	0.0000	6.7656	6.7656	0.0000
IFDI2017	1.1229	0.0000	1.1229	1.1229	0.0000

Group 11: Count = 2, Std. Distance = 5.2494, SSD = 0.6586

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	12.7802	4.4749	8.3053	17.2551	0.1036
IFDI2016	7.2279	2.0516	5.1763	9.2795	0.0722
IFDI2019	8.3460	0.0048	8.3411	8.3508	0.0003
IFDI2018	8.7294	0.1651	8.5643	8.8945	0.0091
IFDI2013	9.9655	0.0573	9.9082	10.0229	0.0043
IFDI2014	9.6248	1.2228	8.4020	10.8476	0.0837
IFDI2017	10.1609	1.3403	8.8206	11.5011	0.1017

Group 12: Count = 21, Std. Distance = 2.9446, SSD = 5.2555

Variable	Mean	Std. Dev.	Min	Max	Share
IFDI2015	2.1106	1.2740	0.1200	4.3647	0.0494
IFDI2016	2.2839	1.1262	0.5317	5.0309	0.0792
IFDI2019	2.3636	0.9271	0.8979	5.0121	0.1125
IFDI2018	2.3511	1.1208	0.6936	5.7424	0.1397
IFDI2013	1.7727	1.1206	-0.6121	3.7315	0.1637
IFDI2014	1.8021	1.2742	-0.5069	5.0245	0.1892
IFDI2017	2.3183	0.8853	1.0025	4.4100	0.1293



IFDI k12 Section 2 of the Output Report: Variable Wise-Summary. Comparing the variables (the Analysis Fields) ranges for each group, one analysis field (variable) at a time

IFDI2015: R2 = 0.98

Group	Mean	Std. Dev.	Min	Max	Share
1	21.6466	0.0000	21.6466	21.6466	0.0000
2	74.7406	0.0000	74.7406	74.7406	0.0000
3	6.1702	0.0000	6.1702	6.1702	0.0000
4	10.9725	0.0000	10.9725	10.9725	0.0000
5	23.3893	0.0000	23.3893	23.3893	0.0000
6	0.1541	0.0000	0.1541	0.1541	0.0000
7	3.7343	2.3361	1.3380	6.1305	0.0155
8	-11.6739	0.0000	-11.6739	-11.6739	0.0000
9	1.3205	1.4283	-0.5008	4.0746	0.0529
10	0.8990	0.0000	0.8990	0.8990	0.0000
11	12.7802	4.4749	8.3053	17.2551	0.1036
12	2.1106	1.2740	0.1200	4.3847	0.0494
Total	5.4249	12.7159	-11.6739	74.7406	1.0000

IFDI2016: R2 = 0.98

Group	Mean	Std. Dev.	Min	Max	Share
1	52.5607	0.0000	52.5607	52.5607	0.0000
2	13.1150	0.0000	13.1150	13.1150	0.0000
3	5.4821	0.0000	5.4821	5.4821	0.0000
4	13.0755	0.0000	13.0755	13.0755	0.0000
5	3.9179	0.0000	3.9179	3.9179	0.0000
6	4.4141	0.0000	4.4141	4.4141	0.0000
7	11.0211	1.4213	9.6018	12.4404	0.0500
8	-4.2653	0.0000	-4.2653	-4.2653	0.0000
9	-0.6722	1.2176	-2.1528	0.9314	0.0543
10	3.5674	0.0000	3.5674	3.5674	0.0000
11	7.2279	2.0516	5.1763	9.2795	0.0722
12	2.2839	1.1262	0.5317	5.0309	0.0792
Total	4.4179	8.6942	-4.2653	52.5607	1.0000

IFDI2019: R2 = 0.98

Group	Mean	Std. Dev.	Min	Max	Share
1	-16.3217	0.0000	-16.3217	-16.3217	0.0000
2	20.2440	0.0000	20.2440	20.2440	0.0000
3	7.7558	0.0000	7.7558	7.7558	0.0000
4	-3.0633	0.0000	-3.0633	-3.0633	0.0000
5	9.3011	0.0000	9.3011	9.3011	0.0000

6	9.7890	0.0000	9.7890	9.7890	0.0000
7	3.3963	0.1322	3.8379	2.2963	0.0072
8	3.2701	0.0000	3.2701	3.2701	0.0000
9	0.5917	0.7770	-1.0038	1.2553	0.0618
10	3.0507	0.0000	3.0507	3.0507	0.0000
11	8.3460	0.0048	8.3411	8.3508	0.0003
12	2.3636	0.9271	0.8979	5.0121	0.1125
Total	2.7650	4.9044	-16.3217	20.2440	1.0000

IFDI2018: R2 = 0.97

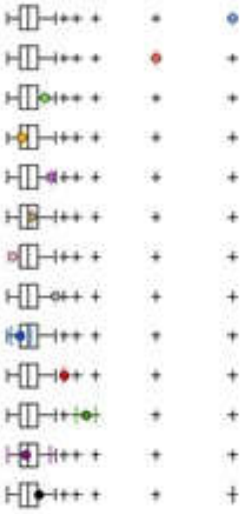
Group	Mean	Std. Dev.	Min	Max	Share
1	-23.6275	0.0000	-23.6275	-23.6275	0.0000
2	-7.3402	0.0000	-7.3402	-7.3402	0.0000
3	7.5998	0.0000	7.5998	7.5998	0.0000
4	-7.4657	0.0000	-7.4657	-7.4657	0.0000
5	12.5047	0.0000	12.5047	12.5047	0.0000
6	4.8332	0.0000	4.8332	4.8332	0.0000
7	2.7763	0.4883	2.2470	3.2656	0.0273
8	5.2982	0.0000	5.2982	5.2982	0.0000
9	0.4490	1.0725	-1.5234	1.8627	0.0937
10	-0.8766	0.0000	-0.8766	-0.8766	0.0000
11	8.7294	0.1651	8.5643	8.8945	0.0091
12	2.3511	1.1208	0.6936	5.7424	0.1397
Total	1.6924	5.4099	-23.6275	12.5047	1.0000

IFDI2013: R2 = 0.97

Group	Mean	Std. Dev.	Min	Max	Share
1	25.9279	0.0000	25.9279	25.9279	0.0000
2	21.2158	0.0000	21.2158	21.2158	0.0000
3	4.6115	0.0000	4.6115	4.6115	0.0000
4	0.1682	0.0000	0.1682	0.1682	0.0000
5	5.8294	0.0000	5.8294	5.8294	0.0000
6	3.0511	0.0000	3.0511	3.0511	0.0000
7	3.2181	1.1832	1.8048	4.5813	0.1027
8	2.6473	0.0000	2.6473	2.6473	0.0000
9	1.0850	0.7389	0.2642	2.4749	0.0833
10	-0.0391	0.0000	-0.0391	-0.0391	0.0000
11	9.9655	0.0573	9.9082	10.0229	0.0043
12	1.7727	1.1206	-0.6121	3.7315	0.1637
Total	3.4234	5.2199	-0.6121	25.9279	1.0000

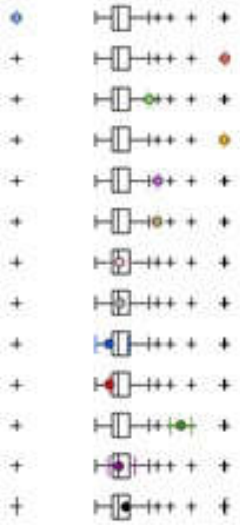
IFDI2014: R2 = 0.96

Group	Mean	Std. Dev.	Min	Max	Share
1	28.5801	0.0000	28.5801	28.5801	0.0000
2	18.6668	0.0000	18.6668	18.6668	0.0000
3	4.2631	0.0000	4.2631	4.2631	0.0000
4	1.3048	0.0000	1.3048	1.3048	0.0000
5	5.0544	0.0000	5.0544	5.0544	0.0000
6	2.5568	0.0000	2.5568	2.5568	0.0000
7	-0.0751	0.7388	-0.4557	0.8656	0.0530
8	5.6685	0.0000	5.6685	5.6685	0.0000
9	1.0824	0.8876	-0.0825	2.5177	0.0889
10	6.7656	0.0000	6.7656	6.7656	0.0000
11	9.6248	1.2228	8.4020	10.8476	0.0837
12	1.8021	1.2742	-0.5069	5.0245	0.1892
Total	3.5025	5.3591	-0.6557	28.5801	1.0000

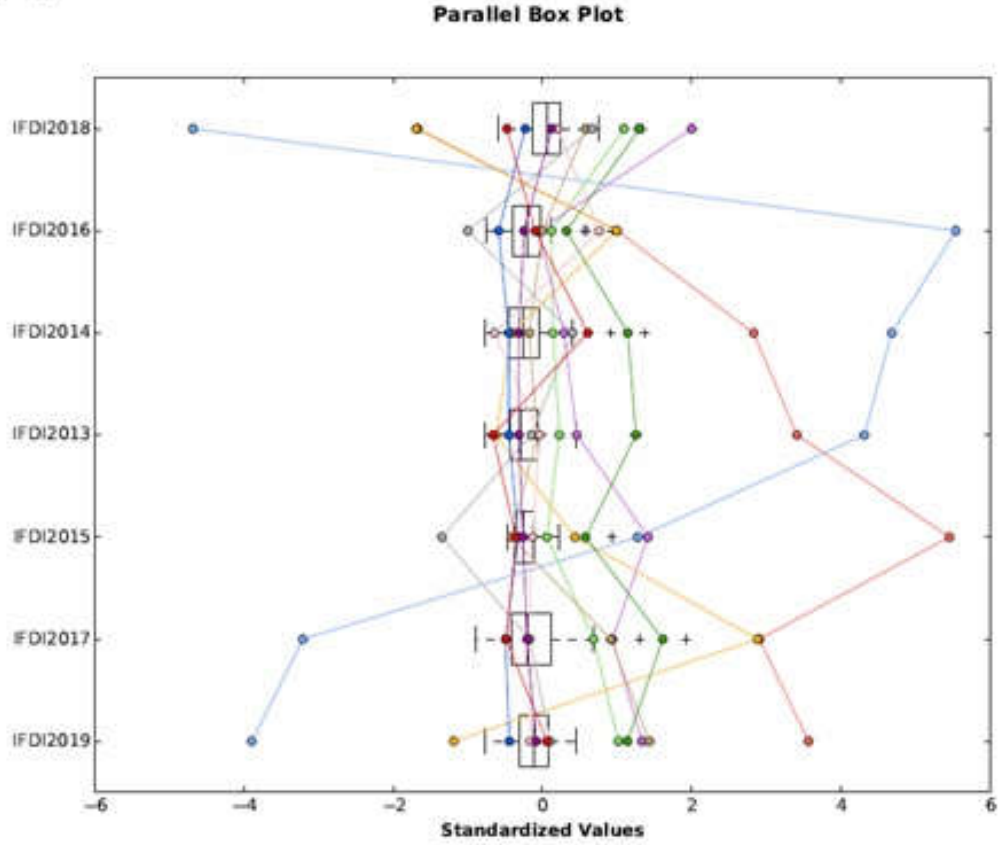


IFDI2017: R2 = 0.95

Group	Mean	Std. Dev.	Min	Max	Share
1	-10.6188	0.0000	-10.6188	-10.6188	0.0000
2	15.7405	0.0000	15.7405	15.7405	0.0000
3	6.1652	0.0000	6.1652	6.1652	0.0000
4	15.6332	0.0000	15.6332	15.6332	0.0000
5	7.2526	0.0000	7.2526	7.2526	0.0000
6	7.1518	0.0000	7.1518	7.1518	0.0000
7	2.4101	1.3870	1.0231	3.7971	0.1952
8	2.4750	0.0000	2.4750	2.4750	0.0000
9	1.0831	1.3605	-0.6470	3.5746	0.1602
10	1.1229	0.0000	1.1229	1.1229	0.0000
11	10.1609	1.3403	8.8206	11.5011	0.1017
12	2.3183	0.8853	1.0025	4.4100	0.1293
Total	3.2115	4.3111	-10.6188	15.7405	1.0000



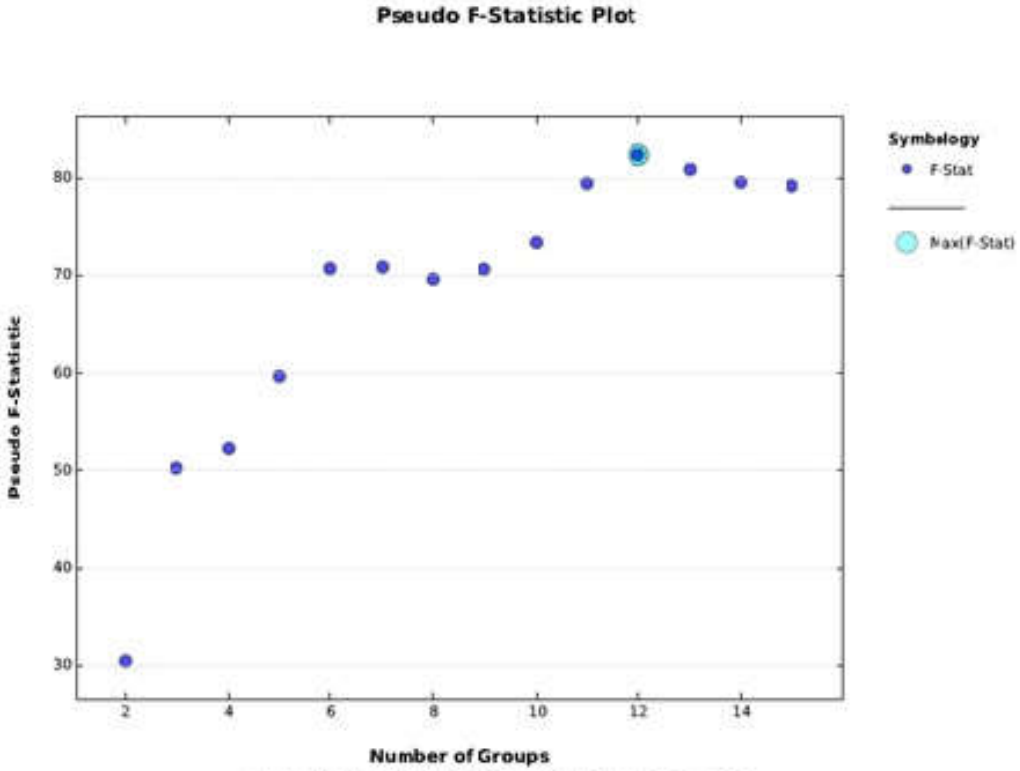
IFDI k12*Section 3 of the Output Report: The parallel box plot graph - summarizes both the groups and the variables within them*



IFDI k12 *Section 4 of the Output Report: check on the Evaluate Optimal Number of Groups parameter based on pseudo F-statistic values*

Grouping Analysis Parameters

Parameter Name	Input Value
Input Features	Europe_FER1
Unique ID Field	OBJECTID
Output Feature Class	None
Analysis Fields	IFDI2013
	IFDI2014
	IFDI2015
	IFDI2016
	IFDI2017
	IFDI2018
	IFDI2019
Spatial Constraints	GET_SPATIAL_WEIGHTS_FROM_FILE
Distance Method	EUCLIDEAN
Number of Neighbors	None
Weights Matrix File	D:\cristina_29_07_2014acasa\an2021\diseminare\todo\Bolzano\GIS\Europe_FER.swm
Initialization Method	FIND_SEED_LOCATIONS
Initialization Field	None
Selection Set	False



Pseudo F-Statistic Summary

Number of Groups	Pseudo F-Statistic
2	30.4646
3	50.2496
4	52.2696
5	59.6509
6	70.7142
7	70.8704
8	69.6259
9	70.6439
10	73.3941
11	79.4437
12	82.3765
13	80.8778
14	79.5488
15	79.1795

RELEVANCE OF TYPE OF INVESTMENT FOR GROWTH: EVIDENCE FROM EU-10 COUNTRIES

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Abstract
Whilst investment in both theoretical and empirical literature stands out as one of the most prominent determinants of growth, evidence on the importance of different types of investment for growth appears to be missing. This paper aims at filling this gap. The paper, thus, primarily contributes to the empirical literature by investigating the effects of different types of investment on growth in a group of EU-10 economies covering the period from 1995 to 2019. The panel data analysis provides some important and interesting findings. While overall investment is found to be strongly significant and positive, being in accordance with previous studies, the results provide new insights into the importance of different types of investment for growth. Not all types of investment affect growth (positively and significantly), thus sending also important message that it matters in which activities investment goes.

Keywords: Type of investment, Growth, EU-10 countries
JEL classification: E22, O4, O47

1. Introduction

Investment-growth relationship is one of the most robust relationships in economic literature. The positive impact of investment on growth is corroborated by a great number of empirical studies. This positive link holds firmly in developed and less developed economies, across different regional country groupings and across different periods. Whilst the evidence on the importance of investment for growth is abundant, evidence on the importance of different types of investment for growth appears to be missing. This paper aims at filling this gap in the literature.

The global financial and economic crisis of 2007/08, as well as the recent Covid-19 crisis, have resulted in fiscal expansions that took place via numerous stimulus packages, consequently resulting in rising government deficits and debts around the globe. Despite the substantial monetary and fiscal policy stimulus, real GDP in EU countries shrank by unprecedented levels - which have not been observed since the World War II (after the financial crisis, the EU's GDP dropped by 4.4% in 2009, while after the Covid-19 crisis it decreased by 6.1% in 2020). Investment has also been declining drastically. IMF (2020) and EIB (2021) estimate that total investment decreased by 19% in the second quarter of 2020, compared to previous year. A similar situation was experienced after the financial crisis of 2007/08, whereby investment fell almost 20%. It is especially important to stress that all components of investment are affected. Given the importance of investment for growth, this investment slowdown raises questions about future growth rates. Under those circumstances, the structure of investment becomes of crucial importance. Namely, presuming that various types of investment have diverse growth effects, the analysis of the composition of investment and its effect on growth can offer useful policy-implications. In the current situation where governments' fiscal capacities have been stretched to the limit and fiscal space is tight, investment becomes more important than ever.

This paper, hence, contributes primarily to the empirical literature by investigating the effects of different types of investment on growth in a group of EU-10 economies covering the period from 1995 to 2019. The panel data analysis provides some important and

interesting findings. While overall investment is found to be strongly significant and positive, being in accordance with previous literature, the results provide new insights into the importance of different types of investment for growth. Not all types of investment affect growth (positively and significantly), thus sending also important message that it matters in which activities investment goes. This information will enable policy-makers to create policies that encourage those types that are growth-enhancing.

The paper is structured as follows. Section 2 reviews briefly the previous literature on the relationship between investment and growth. Section 3 presents the data, modelling approach and the main findings. Section 4 concludes.

2. Paper background

There is ample evidence in economic literature on positive effects of investment on growth. Both theoretical and empirical studies seem to support this relationship; one might add, one of the most robust relationships in macroeconomics.

The neoclassical exogenous growth model described by Robert Solow (1956) was the first attempt to explain income differences between countries. In spite of obvious drawbacks (especially in terms of oversimplifying assumptions), textbook Solow model remains highly influential even today, as it offers valuable conclusions regarding the growth process. In this model, output growth is a function of physical capital accumulation and exogenously given labour and technological growth. A key component of growth is investment, which increases the capital stock, thus raising GDP. Mankiw et al. (1992) advocate that a textbook Solow model, once broadened with human capital accumulation, describes international cross-country data remarkably well. They, furthermore, find that the three core variables (human and physical capital, and population growth) explain 80 percent of the variation in income across countries. Their results, thus, indicate that the Solow neoclassical model, once augmented with human capital, is consistent with the international cross-country data.

Empirical work on growth extended the theoretical Solow model with a large number of various growth determinants, resulting in plethora of additions and empirical specifications. Durlauf et al. (2005) identify more than 140 proxies of growth determinants used by numerous empirical studies. As a result, researchers began exploring the robustness of growth regressions. Levine and Renelt (1991, 1992) find only investment and initial income to be robust in their effect on growth. Sala-i-Martin (1997) tests 62 variables used in the empirical literature, and concludes that the absence of a clear theoretical guidance "has led empirical economists to follow theory loosely and simply "try" various variables relating the various potentially important determinants of growth" (Sala-i-Martin, 1997: 2). Raymond et al. (2002) re-analyse the empirical results of growth regressions for a number of alternative definitions of robustness using quasi-experiments. They find investment in equipment and non-equipment to be consistent and robust in sign, size and statistical significance. More recently, Durlauf et al. (2008) conclude that neoclassical growth variables: initial income, investment and population growth, together with some macroeconomic policy variables, are significant in their effect on growth. Overall, irrespective of a wide array of growth determinants, the one variable that stands out as consistently robust in empirical estimations is investment.

In terms of the structural composition of investment, it can be assessed from several aspects. The literature recognises the difference between private and public investment in its effect on growth (see, for example Munnell, 1990 and Khan and Reinhart, 1990; for early contributions, and Ponce and Navarro, 2016 for a more recent one). Studies on the relative importance of public versus private investment for economic growth have mostly focused on the crowding out effect of public investment, and the mixed results emerge (for more on this topic, please consult Cavallo and Daude, 2011 and Bom and Ligthart, 2014 and references thereof). Furthermore, gross fixed capital formation can also be broken into particular asset groups (dwellings, other buildings and structures, transport equipment, other machinery and equipment, cultivated assets and intangible fixed assets). A number of papers in this field investigates the impact of a particular asset on growth (see, for example, Madsen, 2002; Brito and Perreira, 2002; Kohlscheen et al., 2018 to name a few). The impact of sectoral division of

investment by industry i.e. activity, and its effect on growth, however, has not been recognised.

Empirical data points towards a drastic decline in total investment in recent years. After the crisis of 2007/08, private investment rates in the EU have not returned to the pre-crisis levels; moreover, public investment has also declined due to budgetary pressures. Looking at the long run, the share of gross fixed capital formation (GFCF) in GDP in the EU has been steadily declining since the 1960s, from levels above 27%, to below 21%, on average. In the last decade (2010-2019), the annual growth of GFCF in EU countries was 2.15%, on average; however, in 2020 it plunged to -6.3%. In our sample of EU-10 countries, the annual growth of GFCF in the last decade (2010-2019) was 0.5%, while in the period 2008-2019 it was -2.26%, supporting the above claim of investment not returning to the pre-crisis level. If we look at investment across sectors, in the period under investigation (1995-2019), investment rates have dropped in 10 sectors (out of 19 sectors as classified in the NACE Rev. 2), while in the remaining 9 it grew. The average annual growth rates of investment also differed drastically between sectors, from -4.77 to 2.63%. If we look at the period after the 2007/08 financial crisis, the data shows that the only two sectors that did not experience a fall in investment were Professional, scientific and technical activities and Administrative and support service activities. Overall, the experiences of different sectors evidently differ, which raises questions regarding the impact of sectoral investment on GDP growth. The specific sectors that will be used in our investigation are specified in detail in Table 2 below.

The underrepresentation of studies investigating this aspect of investment presented above, coupled with empirical evidence on different sectoral experiences, calls for further research trying to shed additional light on the importance of different types of investment for growth. This paper contributes in this context to the empirical literature by focusing on the EU-10 countries from Central and Eastern Europe.

3. Empirical analysis

3.1. Modelling strategy and the data

In our empirical investigation we estimate econometrically the impact of investment on economic growth. As put forward previously, investment figures out as one of the main determinants of growth in a typical growth regression. Following the standard approach in growth literature, a number of additional variables are added as control variables. In consequence, we set up a model in which economic growth is regressed on investment, human capital and fertility (as a proxy for population growth), in line with the conclusions of Mankiw et al. (1992). Additionally, we add openness (globalization), life expectancy, government consumption and inflation. A similar model is applied in Dreher (2006) to account for the effects of globalization on growth. The effects are estimated econometrically by using panel data analysis. The model to be estimated is of the following form:

$$GDPGROWTH_{it} = \beta_1 INV_{it} + \beta_2 logGDP_{it-1} + \beta_3 HC_t + \beta_4 logLEX_{it} + \beta_5 logFR_{it} + \beta_6 KOF_{it} + \beta_7 GOV_{it} + \beta_8 INF_{it} + \varepsilon_{it} \quad (1)$$

$i = 1\ldots, 10,\ t = 1995\ldots, 2019$

where i refers to a country and t to a time period. The dependent variable $GDPGROWTH_{it}$ represents the growth rate of GDP per capita in country i and period t. INV_{it} is the main variable of interest representing investment (gross fixed capital formation) as percent of GDP. In our later estimations we will substitute this overall investment with investment by activities (again as percent of GDP). The following control variables are included in our estimations: lagged logGDPpc, human capital (HC), logarithm of life expectancy (*logLEX*), logarithm of fertility rate (*logFR*), KOF globalization index (*KOF*), share of government consumption in GDP (*GOV*), and inflation (*INF)*.

The used variables are specified in detail in Table 1 below. All data are annual and cover the period from 1995 to 2019.

Table 1. Description of variables and sources

Variable	Definition	Source
GDPGROWTH	GDP per capita growth rate (%)	World Bank WDI
*INV**	Gross fixed capital formation (% of GDP)	WiiW annual database
logGDPL	Logarithm of GDP per capita lagged	-
HC	Human capital	Penn World Table (Feenstra et al., 2015)
logLEX	Logarithm of life expectancy	World Bank WDI
logFR	Logarithm of fertility rate	World Bank WDI
KOFGI	KOF index of globalization	Gygli et al. (2019)
GOV	General government final consumption expenditure (% of GDP)	World Bank WDI
INF	Annual rate of inflation (%)	World Bank WDI

* Investment by activities will be specified in a separate table below.

The sample includes 10 countries from Central and Eastern Europe, the so called EU-10 countries (Bulgaria, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).

As outlined earlier, the particular contribution of this paper lies in investigating the effects of investment by type of activity on economic growth. In order to enable that kind of detailed investigation we found particularly handy the WiiW (the Vienna Institute for International Economic Studies) database which provides data on investment by activities (gross fixed capital formation by activities). The data we use in this investigation is the gross fixed capital formation in national currency units based on NACE Rev. 2 classification. The specific activities (Industry/Products) are reported below in Table 2. Each of the values of investment by activity (in national currency units) is divided by GDP (in national currency units) to have the standardly used variable on investment in growth regression, i.e. investment as a share of GDP.

Table 2. WiiW data on investment by activity

Classification	Digit	Industry/Product
NACE Rev. 2	NACE 1-letter	Total by activities
NACE Rev. 2	NACE 1-letter	A Agriculture, forestry and fishing
NACE Rev. 2	NACE 1-letter	B Mining and quarrying
NACE Rev. 2	NACE 1-letter	C Manufacturing
NACE Rev. 2	NACE 1-letter	D Electricity, gas, steam, air conditioning supply
NACE Rev. 2	NACE 1-letter	E Water supply, sewerage, waste manag., remediation
NACE Rev. 2	NACE 1-letter	F Construction
NACE Rev. 2	NACE 1-letter	G Wholesale, retail trade, repair of motor vehicles etc.
NACE Rev. 2	NACE 1-letter	H Transportation and storage
NACE Rev. 2	NACE 1-letter	I Accommodation and food service activities
NACE Rev. 2	NACE 1-letter	J Information and communication
NACE Rev. 2	NACE 1-letter	K Financial and insurance activities
NACE Rev. 2	NACE 1-letter	L Real estate activities
NACE Rev. 2	NACE 1-letter	M Professional, scientific and technical activities
NACE Rev. 2	NACE 1-letter	N Administrative and support service activities
NACE Rev. 2	NACE 1-letter	O Public administration, defence, compuls. soc. security
NACE Rev. 2	NACE 1-letter	P Education
NACE Rev. 2	NACE 1-letter	Q Human health and social work activities
NACE Rev. 2	NACE 1-letter	R Arts, entertainment and recreation
NACE Rev. 2	NACE 1-letter	S Other service activities

Source: WiiW

3.2. Results of empirical investigation

In this subsection we estimate the effects of investment on economic growth. As stated above, we set the growth model quite broadly, with the determinants of growth included as reported in the standard growth literature and following similar empirical studies investigating growth (please see Section 2). In addition to investment, which is our main variable of interest, we also account for the effects of globalization, government consumption, inflation, human capital, fertility rate and life expectancy. As a relatively large number of models will be estimated (in total 27), an introductory note is needed before presenting our results. We are focused on the coefficients on investment, and report those on other (control) variables only in passing. Our results will be reported across four tables. The first table with the estimation of a growth model (Table 3 below) estimated the growth regression focusing on the standard variable on investment (total investment as a share of GDP) including additional control variables as explained earlier. Tables 4 and 5 report the same model, but estimations are run substituting total investment by investment in a specific sector (investment by activity). Our data allowed 19 such activities (WiiW data using NACE rev. 2 classification as reported in Table 2), and hence a number of models will be reported. To make the exposition of our results using the sectoral investment data tractable we divide it into two tables (Tables 4 and 5). As reported and commented previously in the Introduction and Section 2, investment has been strongly impacted by the global financial crisis and Covid-19 crisis. This opens up the question as to whether the relationship between investment and growth may have changed. To that end, but also as an additional robustness check, we re-estimate our growth model focusing on the post-global financial crisis period only (2008-2019), and report the results in Table 6. Once again let us remind the reader to consult Table 2 repeatedly to allow himself/herself to track the type of investment activity. We start with the model focusing on total investment and its effects on growth (Table 3). The Redundant Fixed Effects Tests (available upon request) suggested that the panel data estimation be conducted using the fixed panel data model.

Table 3. The effects of investment on economic growth

VARIABLES	Overall period (1995-2019)
Investment (total as % of GDP)	0.386***
	(0.064)
LogGDP$_{t-1}$	-22.494***
	(3.367)
Human capital	11.947***
	(4.766)
logLifeexpectancy	85.537*
	(51.739)
logFertility	1.537
	(6.525)
KOF	0.311***
	(0.103)
Government (% of GDP)	-0.636***
	(0.162)
Inflation	-0.020***
	(0.004)
Observations	250
R-squared	0.362

Standard errors in parentheses
*** significant at 1% level, ** significant at 5% level, * significant at 10% level
Source: Authors' calculations

Table 3 reports the estimated growth model with the effect of investment on economic growth being positive and strongly statistically significant. The other variables included in the model are mainly in line with theoretical expectations, but not all of them are statistically significant. Human capital and globalization are statistically significant and have positive

effect on growth, while government consumption and inflation are also found to be statistically significant, but having a negative effect on growth. Logarithm of GDP per capita from the previous period is estimated to have a negative impact and is statistically significant, suggesting the presence of strong convergence effects (as expected given the relatively low levels of development at which the new EU-10 members started back in 1995). Fertility is not statistically significant, while life expectancy is a borderline case (significant at 10 percent level). The model reported in Table 3 may be treated as our starting point confirming the standard finding in the literature that investment is an important determinant of growth, alongside the other control variables reported there. Next, we set to investigate whether there are differences in the effects of investment on growth if the sectoral data on investment is used. Thus, as explained earlier, we account for investment by activity across 19 different sectors and due to many models to be estimated report our results across two tables (Table 4 and Table 5).

Table 4. Investment and growth: Investment by activity (sector) – sectors A to I

		Investment by activity (sector)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
VARIABLES	Total	A	B	C	D	E	F	G	H	I
Investment	0.386***	0.482	1.286	1.530***	0.153	-0.516	1.944***	2.810***	1.609***	9.098***
	(0.064)	(0.652)	(1.623)	(0.256)	(0.318)	(1.037)	(0.420)	(0.376)	(0.309)	(1.915)
$LogGDP_{t-1}$	-0.020***	-17.111***	-17.181***	-15.551***	-17.375***	-16.791***	-19.722***	-22.016***	-19.156***	-19.300***
	(0.004)	(3.497)	(3.495)	(3.269)	(3.518)	(3.590)	(3.392)	(3.206)	(3.332)	(3.370)
Human capital	11.947***	4.914	4.628	6.895	4.769	3.790	4.065	8.122*	4.692	2.724
	(4.766)	(5.036)	(4.967)	(4.622)	(5.092)	(4.997)	(4.727)	(4.466)	(4.676)	(4.726)
logLifeexpectancy	85.537*	1.936	5.247	35.622	3.064	2.586	106.404*	127.645**	54.748	114.207**
	(51.739)	(53.978)	(53.767)	(50.377)	(54.028)	(54.105)	(55.942)	(51.014)	(51.816)	(56.271)
logFertility	1.537	1.680	2.696	6.163	2.305	1.934	-3.184	6.900	6.435	4.234
	(6.525)	(7.076)	(7.023)	(6.567)	(7.019)	(7.074)	(6.824)	(6.331)	(6.689)	(6.714)
KOF	0.311***	0.362***	0.356***	0.239***	0.366***	0.363***	0.295***	0.330***	0.329***	0.293***
	(0.103)	(0.110)	(0.110)	(0.105)	(0.110)	(0.110)	(0.106)	(0.099)	(0.104)	(0.106)
Government (% of GDP)	-0.636***	-0.604***	-0.668***	-0.639***	-0.669***	-0.667***	-0.787***	-0.976***	-0.731***	-0.873***
	(0.162)	(0.195)	(0.174)	(0.162)	(0.174)	(0.174)	(0.169)	(0.162)	(0.165)	(0.172)
Inflation	-0.020***	-0.025***	-0.025***	-0.021***	-0.025***	-0.025***	-0.022***	-0.022***	-0.023***	-0.023***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)	(0.004)
Observations	250	250	250	250	250	250	250	250	250	250
R-squared	0.362	0.262	0.263	0.359	0.261	0.261	0.323	0.404	0.338	0.326

Standard errors in parentheses
*** significant at 1% level, ** significant at 5% level, * significant at 10% level
Source: Authors' calculations

In column 1 of Table 4 we repeat our estimations from Table 3 (Benchmark model with total investment, including all activities/sectors) to allow comparison. In columns (models) 2 – 10 we estimate the same growth regression (equation 1) as before, but replacing total investment with investment by activities/sectors from A – I (see Table 2 for explanation). A similar approach is followed and reported in Table 5 in which we focus on the ten remaining activities/sectors J – S. The results are organized and reported across two tables for a pure technical reason, as 20 models in total are estimated and not all would fit in one table. Below we introduce Table 5 and then provide explanation and interpretation of our results for both tables together.

Table 5. Investment and growth: Investment by activity (sector) – sectors J to S

	Investment by activity (sector)									
VARIABLES	(1) J	(2) K	(3) L	(4) M	(5) N	(6) O	(7) P	(8) Q	(9) R	(10) S
Investment	1.976***	-0.507	0.728***	3.211***	3.823***	-0.800**	1.377	2.495	4.877***	-2.635***
	(0.555)	(0.668)	(0.250)	(1.028)	(1.031)	(0.332)	(1.504)	(1.582)	(1.514)	(0.883)
$LogGDP_{t-1}$	-19.292***	-17.540***	-22.367***	-18.949***	-18.045***	-17.371***	-17.648***	-18.035***	-18.856***	-19.072***
	(3.458)	(3.524)	(3.868)	(3.473)	(3.408)	(3.457)	(3.528)	(3.521)	(3.462)	(3.496)
Human capital	10.965**	4.127	9.270*	5.135	3.045	4.605	5.214	5.196	3.703	6.224
	(5.175)	(4.935)	(5.158)	(4.850)	(4.810)	(4.883)	(5.062)	(4.957)	(4.836)	(4.917)
logLifeexpectancy	-13.618	8.096	34.920	-4.617	21.132	-5.352	14.340	23.569	61.888	13.760
	(52.695)	(53.892)	(53.841)	(52.840)	(52.485)	(53.362)	(54.626)	(54.780)	(55.518)	(54.179)
logFertility	4.124	3.155	1.883	-0.969	1.071	2.721	1.236	1.564	0.878	4.202
	(6.854)	(7.087)	(6.898)	(6.961)	(6.831)	(6.936)	(7.119)	(7.003)	(6.885)	(6.937)
KOF	0.376***	0.347***	0.365***	0.433***	0.375***	0.389***	0.348***	0.347***	0.331***	0.316***
	(0.107)	(0.112)	(0.108)	(0.110)	(0.107)	(0.109)	(0.111)	(0.110)	(0.108)	(0.110)
Government (% of GDP)	-0.750***	-0.688***	-0.626***	-0.683***	-0.661***	-0.730***	-0.676***	-0.691***	-0.765***	-0.875***
	(0.171)	(0.176)	(0.172)	(0.171)	(0.169)	(0.174)	(0.174)	(0.173)	(0.173)	(0.189)
Inflation	-0.024***	-0.025***	-0.025***	-0.025***	-0.024***	-0.026***	-0.025***	-0.025***	-0.025***	-0.026***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	250	250	250	250	250	250	250	250	250	250
R-squared	0.299	0.262	0.287	0.290	0.302	0.279	0.263	0.268	0.292	0.292

Standard errors in parentheses
*** significant at 1% level, ** significant at 5% level, * significant at 10% level
Source: Authors' calculations

As we are primarily interested in the effects of investment on growth, we will focus on that variable across sectors, but before that we comment in passing on the other growth determinants in general. Our results suggest that across all the estimated models four variables appear to be statistically significant. These variables are the globalization variable (as represented by the KOF index of globalization), government consumption as percent of GDP, inflation and log GDP per capita from previous period. As in our benchmark model with total investment globalization is statistically significant and affects growth positively. Government consumption and inflation are also statistically significant affecting growth negatively. The coefficient on GDP per capita from the previous period is statistically significant and appears to be negative suggesting strong convergence effects. While the coefficients on human capital and life expectancy are only sporadically statistically significant and in those cases with the theoretically expected positive sign, coefficients on fertility are typically not significant. This finding that fertility is consistently not statistically significant might raise the question as to why not exclude it altogether from the regression. However, as it is typically observed as an important determinant of growth in theoretical considerations (see for example Mankiw et al., 1992), and also included in empirical growth regressions (see for example Dreher, 2006), we decided to leave it as a part of our estimations. Nevertheless, please note that we also ran our estimations without fertility and we practically get the same results as when we have it included. These results are available upon request.

Now we turn our attention towards our main variable of interest in this paper and that is investment and its impact on growth. As already reported in Table 3 total investment (measured as percent of GDP) is statistically significant and affects growth positively. This comes as no surprise given the theoretical and empirical literature. Next we explore whether each type of investment is beneficial for growth, and if there were any differences, which activities/sectors do not exert the typical positive effect. Thus, in Table 4 in column 2 we have the model with investment in activity A (A Agriculture, forestry and fishing) estimated

alongside the other control variables. It appears that investment in this activity is estimated with a positive sign but the coefficient is not statistically significant. Column (model) 3 in Table 4 with investment in activity B (B – Mining and quarrying) suggests that the effect of investment in this activity is positive, but the estimated coefficient is not statistically significant. Unlike investment in activities A and B, it appears that investment in manufacturing (C – Manufacturing) is statistically significant and positive. Column 5 (the model with investment in activity D – Electricity, gas, steam, air conditioning supply) and Column 6 (the model with investment in activity E – Water supply, sewerage, waste manag., remediation) suggest that investment in these activities are not statistically significant and do not affect growth. Investment in construction (F – Construction, Column 7 in Table 4) is statistically significant and exerts a positive effect on economic growth. The same applies to investment in activities G (G – Wholesale, retail trade, repair of motor vehicles etc.), H (H – Transportation and storage) and I (I – Accommodation and food services activities) as reported in Column 8, Column 9 and Column 10 in Table 4, respectively.

Investment in the remaining 10 activities and the associated estimated effects on growth are reported in Table 5. As reported in Column 1 in this table the coefficient on investment in activity J (J – Information and communication) is estimated to be positive and statistically significant. Interestingly, the effect on growth by investment in activity K (K – Financial and insurance activities) is estimated with a negative sign, but the coefficient is not statistically significant (Column 2). As for the investment in the next 3 activities: L (L – Real estate activities), M (M – Professional, scientific and technical activities) and N (N – Administrative and support service activities) and Columns 3, 4 and 5 respectively, the coefficients are statistically significant and exert a positive effect on economic growth. Unlike investment in previous activities, investment in activity O (O – Public administration, defence, compuls. Soc. Security) is estimated to have a negative impact on economic growth with the coefficient being statistically significant (Column 6). As reported in Column 7 and 8 respectively, investment in activity P (P – Education) and investment in activity Q (Q – Human health and social work activities) are estimated with a positive sign, but lacking statistical significance. Investment in activity R (R – Arts, entertainment and recreation) is estimated to have a positive impact on growth and is statistically significant (Column 9 in Table 5). Investment in activity S (S – Other service activities) is statistically significant with the coefficient being negative (Column 10 in Table 5).

As a test of robustness, and in order to check whether the relationship between growth and investment may have changed after the global financial crisis, we estimate the growth regression over the period 2008-2019. The results are reported in Table 6. Please note that due to space preservation reasons we report only those growth models in which investment was found to be statistically significant.

Table 6. Investment and growth: Investment by activity (sector) – post-crisis period (2008-2019)

	Investment by activity (sector)						
VARIABLES	(1) Total	(2) C	(3) G	(4) H	(5) J	(6) K	(7) Q
Investment	0.332***	0.940**	2.830***	1.986***	2.775**	4.916*	6.107**
	(0.127)	(0.469)	(0.956)	(0.561)	(1.088)	(2.716)	(2.432)
$LogGDP_{t-1}$	-43.214***	-40.629***	-46.988***	-44.511***	-44.798***	-42.167***	-46.338***
	(8.322)	(8.410)	(8.437)	(8.134)	(8.413)	(8.443)	(8.546)
Human capital	22.556**	20.343*	22.252**	16.979*	27.290**	24.511**	21.524**
	(10.644)	(10.752)	(10.538)	(10.390)	(10.971)	(11.032)	(10.648)
logLifeexpectancy	308.130**	244.829*	369.054**	457.549***	260.603*	217.558	377.228**
	(138.697)	(140.152)	(140.863)	(144.730)	(138.094)	(142.892)	(144.895)
logFertility	13.731	13.177	14.223	18.637	10.808	14.219	18.264
	(13.047)	(13.281)	(12.914)	(12.695)	(13.214)	(13.283)	(13.057)
KOF	1.194***	1.186***	1.072***	0.988***	1.048***	1.254***	1.193***
	(0.272)	(0.276)	(0.272)	(0.270)	(0.277)	(0.281)	(0.273)
Government (% of GDP)	-0.794**	-0.824**	-0.876**	-0.467	-1.074***	-1.178***	-0.845**
	(0.370)	(0.380)	(0.357)	(0.385)	(0.353)	(0.363)	(0.366)
Inflation	0.253*	0.323**	0.264**	0.434***	0.352***	0.384***	0.463***

	Investment by activity (sector)						
VARIABLES	(1) Total	(2) C	(3) G	(4) H	(5) J	(6) K	(7) Q
	(0.139)	(0.134)	(0.133)	(0.117)	(0.125)	(0.126)	(0.121)
Observations	120	120	120	120	120	120	120
R-squared	0.564	0.552	0.572	0.586	0.563	0.549	0.562

Standard errors in parentheses
*** significant at 1% level, ** significant at 5% level, * significant at 10% level
Source: Authors' calculations

Table 6 reports the evidence on the importance of investment for economic growth in the aftermath of the global financial crisis. As reported earlier investment has been strongly impacted by the crisis, and in our sample of EU-10 economies it did not return to the pre-crisis levels. Our previous findings regarding the impact of investment on growth are confirmed but it appears this is the case across the smaller number of activities. While in Table 4 and Table 5 investment was found to produce a statistically significant impact on growth in 12 out of 19 sectors, in Table 6 we can notice a statistically significant impact only in 6 sectors. As for the total investment (Column 1 in Table 6) the coefficient on investment is positive and statistically significant, confirming our previous finding that total investment (including all the sectors) exerts a positive impact on economic growth. The positive and statistically significant impact is also confirmed for investment in activity C (C – Manufacturing), G (G – Wholesale, retail trade, repair of motor vehicles etc.), H (H – Transportation and storage), J (J – Information and communication), K (K – Financial and insurance activities) and in activity Q (Q – Human health and social work activities). As for these sectors these positive effects were found also previously in Table 4 and Table 5, thus suggesting a robust positive impact of investment on growth in these sectors. The only exception is investment in activity K (K – Financial and insurance activities) which was previously estimated to have a negative impact on growth, albeit it was not statistically significant (please see Column 2 in Table 5). When estimated across the post crisis period (Column 6 in Table 6) investment in this activity appears to have a positive impact on growth, but the effect is only marginally significant. As for the other variables in the model, the findings remain more or less similar as before, with an exception of inflation. Previously, in Table 4 and Table 5, inflation was estimated to have a negative and statistically significant impact on economic growth. Table 6, however, reports that this impact across the post crisis period is positive and statistically significant. While this finding is interesting, and deserves additional attention, it is out of scope of this paper and provides an interesting avenue for future research. That investigation of inflation on economic growth might become particularly important with strong increases in inflation around the globe recently.

4. Concluding remarks

This paper contributes to the literature by investigating the effects of different types of investment on growth in a group of EU-10 economies covering the period from 1995 to 2019. In our opinion, this is important because, firstly, total investment is a key variable affecting long-term economic growth and in the last decade it has been declining, especially in times of economic crises. Secondly, the structure of investment, i.e. its division by type, becomes increasingly important, particularly given the limited scope of government expenditure stretched to the maximum by combating the crises. Surprisingly, studies investigating the impact of investment by activity on growth seem to be missing. This is where the main contribution of our work lies. The theory is not straightforward regarding the precise list of variables that should be taken into account when assessing long-term growth, hence empirical literature has resulted in a wide array of possible growth determinants. The one variable, however, that stands out as consistently robust in various specifications, is investment. In this paper, therefore, we first explore the impact of total investment (as a percentage of GDP) on growth in EU-10 countries, and find that this effect is positive and statistically significant, as expected. This is true for the whole period under investigation (1995-2019), as well as for the period after the global financial crisis of 2007/08. Throughout this paper, we pay special attention to the period after the financial crisis, as the initial reviewing of the data indicated

that both; investment in total, as well as investment by activity, was affected drastically by this crisis.

After examining the overall investment our analysis switches to 19 different types of investment as disaggregated by NACE rev. 2 classification. For this we use the WiiW (the Vienna Institute for International Economic Studies) database which provides data on gross fixed capital formation by activities. Namely, empirical data points to the fact that experiences of different sectors evidently differ in terms of investment rates; which put the investigation of the impact of sectoral investment on GDP growth, in the middle of our focus. Our results, for the whole period, suggest that not all investment is growth enhancing. We find it to have positive and statistically significant effect on growth in 10 out of 19 sectors, while the effect was statistically significant and negative in two sectors. In the remaining sectors the effect was statistically insignificant. After the global financial crisis, investment in only 6 sectors is found to be growth-enhancing. The most robust findings (significant in both observed periods) refer to the following activities: C Manufacturing; G Wholesale, retail trade, repair of motor vehicles etc; H Transportation and storage and J Information and communication.

In terms of policy implications, our results suggest that not all types of investment contribute to growth equally, so incentives should be defined in such a manner as to account for this. More precisely, policy-makers should favor investment in the above-mentioned sectors, as these can be expected to contribute to GDP growth the most.

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INCREASING FUNDING FOR THE REGIONAL INDUSTRY OF KOSOVO AND THE IMPACT ON ECONOMIC GROWTH

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Abstract

All research so far, related to financing the needs of SMEs in Kosovo, show that financing remains among the main problems for starting the growth and development of the country's economy, especially for regional small and medium-sized manufacturing enterprises. This phenomenon has created negative consequences in the growth and development of businesses in general, as well as the growth of investment activities in particular. Despite the fact that SMEs affect the generation of new jobs, poverty reduction and economic growth, SMEs in Kosovo still face various and serious challenges in business development. Among other difficulties, there is access to finance, as well as the possibility of investing from external sources, as internal sources of funding are always insufficient. Due to the strategic importance of the manufacturing industry sector in the economy of a country and knowing that for each job contributes 2.3 new jobs in the total economy, we have selected this research which also corresponds to objective 9 of sustainable development and specifically target 9.3 that promotes increased access of small industrial enterprises and other enterprises, especially in developing countries, to financial services, including affordable loans, and their integration into value chains and markets. Referring to this importance, we conducted research in 103 Kosovo regional manufacturing companies in various sectors. The survey was structured with 16 questions which will be presented in detail in this research and which confirm that the increase of financing in the productive sector contributes to the sustainable economic development of Kosovo and to the reduction of unemployment.

Keywords: Financing, Sustainable Development, SMEs, Regional Industry, target
JEL classification: A10, E43, F65, F66, H60, L60, M10, R10

1. Introduction

Kosovo's economy is a young and dynamic economy. Its base has been transformed from a centralized (Polyzos, 2015, 2019) economy, directed, into an open market (Alexiadis et al, 2011; Polyzos, 2015, 2019) economy where it has undergone its profound transformation after 1999 which gained the status of autonomy and later in 2008 of independence. One of the challenges it has faced over the last decade is the privatization process. During 2009, a total of 114 new socially-owned enterprises were announced for privatization, bringing the total to 569. The goal in itself is already to increase the competitiveness (Alexiadis and Ladias, 2011; Alexiadis et al., 2020) of this economy, increasing its export capacity to reduce the trade deficit that Kosovo currently has at the moment. As an important place for business development (Perovic and Golem, 2019), Kosovo offers a number of comparative advantages (Xanthos et al., 2012; Polyzos, 2019; Tsiotas et al., 2021) such as: young and well-qualified population (Xanthos et al., 2013; Constantin, 2021), natural resources (Goula et al., 2015), favorable climatic conditions, new infrastructure (Polyzos and Tsiotas, 2020; Constantin et al., 2021), fiscal policy with the lowest tax rates in the region, geographical position with access (Tsiotas and Polyzos, 2018) to the regional market (Alexiadis et al., 2013) of CEFTA (Central European Free Trade Agreement) and that of the European Union (Alexiadis et al., 2020). In addition, Kosovo in June 2009 joined the IMF (International Monetary Fund) and the World Bank (World Bank) and aspires to other strong economic and financial mechanisms such as the EBRD, WTO, etc.

2. Literature review

Broadening access to economic and business opportunities for small and medium-sized enterprises (SMEs) can improve social welfare (Lincaru et al., 2016) and boost national productivity (Xanthos et al., 2012; Pnevmatikos et al., 2019). Financing is a key element of SME sector development. As national economies develop, the number of SMEs steadily increases, as does the need for access to long-term growth capital. Hence the need to develop innovative financing models that go beyond traditional bank lending to provide timely financing opportunities for SMEs according to their needs and stages of business growth (ADB, 2015). Micro-credit is not a miracle cure that can eliminate poverty in one fell swoop. Mohammed Yunus (Yunus, 2003).

Two indicators have been selected by SDG's to measure progress towards target 9.3. The first indicator, the Proportion of small-scale industries in total industry value added was selected as micro and small establishments or enterprises play an important role in the economy. Often established with a relatively small investment, SMEs are an important source of direct employment and self-employment, but also indirectly through purchases of local raw materials.

The second indicator, the Proportion of small-scale industries with a loan or line of credit, was selected as micro and small-scale firms often have limited access to funding and financial services. Unfortunately, in both cases, but in particular the latter case, there are few comparable data publically available to populate these indicators. Thus, the need for improved data on SME financing is obvious (ADB, 2015; United Nations, 2015).

Although comparable data on loans to manufacturing firms are not available globally as well as in Kosovo, so through the study we will try to discover the challenges of access to finance faced by firms and especially after the post Covid-19 situation.

2.1. Kosovo manufacturing industry

Kosovo is economically considered a developing country and possesses several important sectors (Pnevmatikos et al., 2019) that contribute to state revenues. Some of the most important of them we can know are: electricity (Polyzos, 2019) industry, mining (Polyzos, 2019), agriculture (Alexiadis et al., 2013), livestock, construction (Polyzos and Tsiotas, 2020), textile industry, tourism (Caca et al., 2016; Lincaru et al., 2020; Tsiotas et al., 2020), banking sector, etc.

3. Methodology and data

To conduct this research, we have chosen the methodology of collecting and processing primary data through the development of a questionnaire addressed to regional companies in the manufacturing sectors of Kosovo. The questionnaire contains 16 logical and easy-to-answer questions addressed to the sectors related to business development and financing difficulties in case of need, etc. In terms of importance, the questioner was anonymous and thus, we managed to interview about 103 regional companies in different manufacturing sectors which will be presented in detail in the results chapter.

3.1. Research Question

This research aims to provide answers to the *research questions A*: Does the increase in financing in the manufacturing industry affect the economic growth of Kosovo? And r*esearch question B:* Is banking interest a key factor in credit absorption? To answer these questions, we have conducted scientific research in order to generate some concrete answers on the perspective and 'obstacles' of Kosovo's regional manufacturing industry.

3.2. Sample of Manufacturing Sectors

In this research, 103 regional manufacturing companies from different sectors operating in the territory of Kosovo were interviewed and categorized as following:

Manufacturing Sectors participate	
Industry Sector	**Number of the regional companies participated**
Textile Industry	25
Construction Industry	18
Food Industry	27
Plastic Industry	8
Chemical Industry	12
Wood Industry	19
Total	**103**

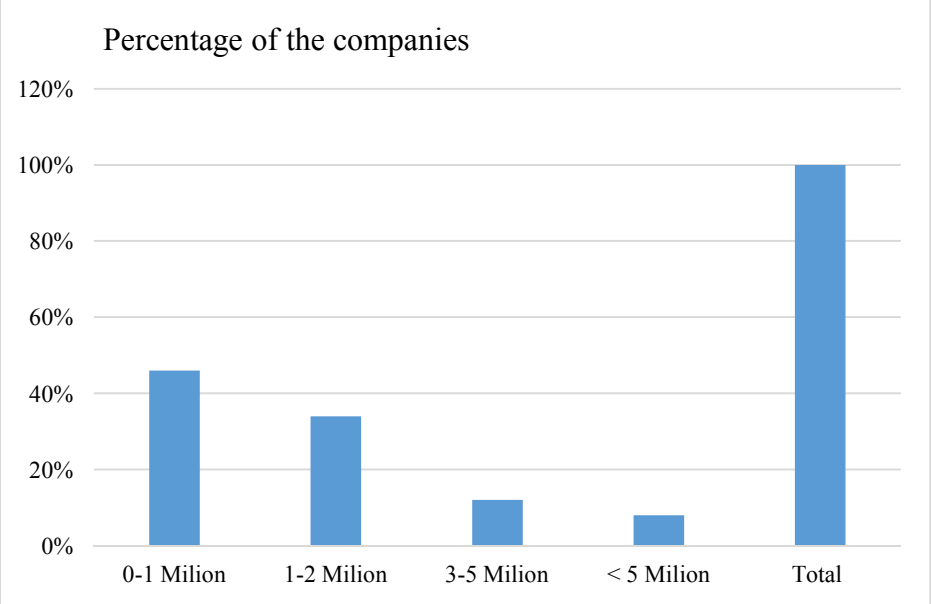
Source: Author's compilation

3.3. Data analysis and results

The analysis and processing of the questionnaire data is presented in detail through the figures and graphs below. The first question of the survey referred to the name of the company which was optional and for this reason most of the respondents avoided identification for understandable reasons but stated the manufacturing industry sector and all the necessary data required by this research to achieved his goal.

In the survey, companies were asked about the annual turnover and degenerated the following results: of 46% of them had a turnover of 0-1 million, of 34% had a turnover of 1-2 million, of 12% of them had a turnover of 3-5 million and the remaining 8% had an annual turnover over 5 million.

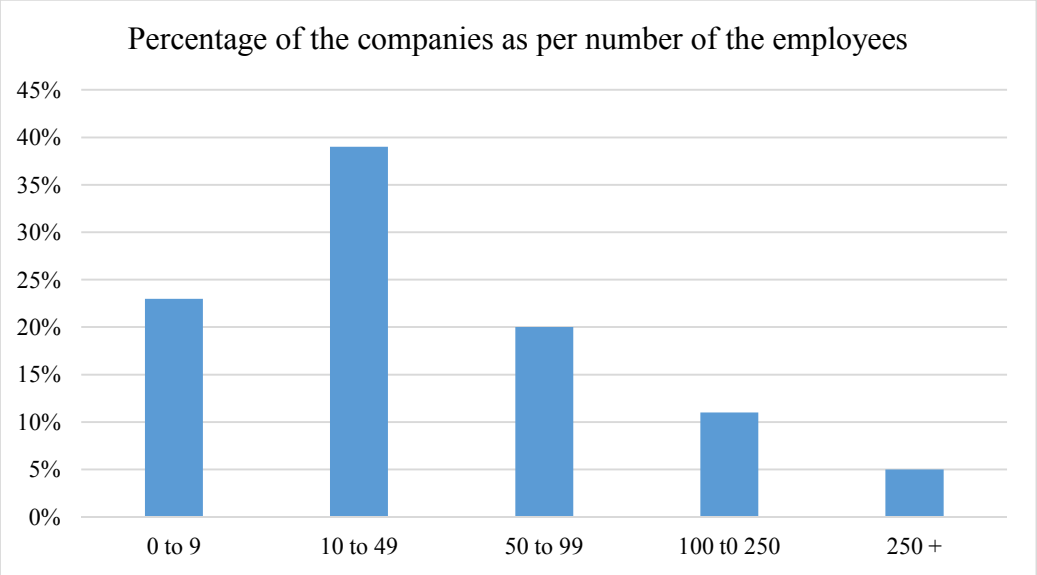
Figure 1. Classification of the regional manufacturing companies as per yearly turnover in Euro



Source: Author's compilation

In the second question of the survey, companies were asked about the total number of employees and the results are as follows: starting with 23% who have employees from 0-9, then 39% of them have 11-49 employees, from 20% of them have 50-99 employees, of 11% of them have 100-250 and the last 5% of them have over 250 employees in their companies.

Figure 2. Classification of the Kosovo regional industries as per number of the employees



Source: Author's compilation

The following figure presents the total number of regional manufacturing companies that have participated in the survey by major territories of Kosovo which are:

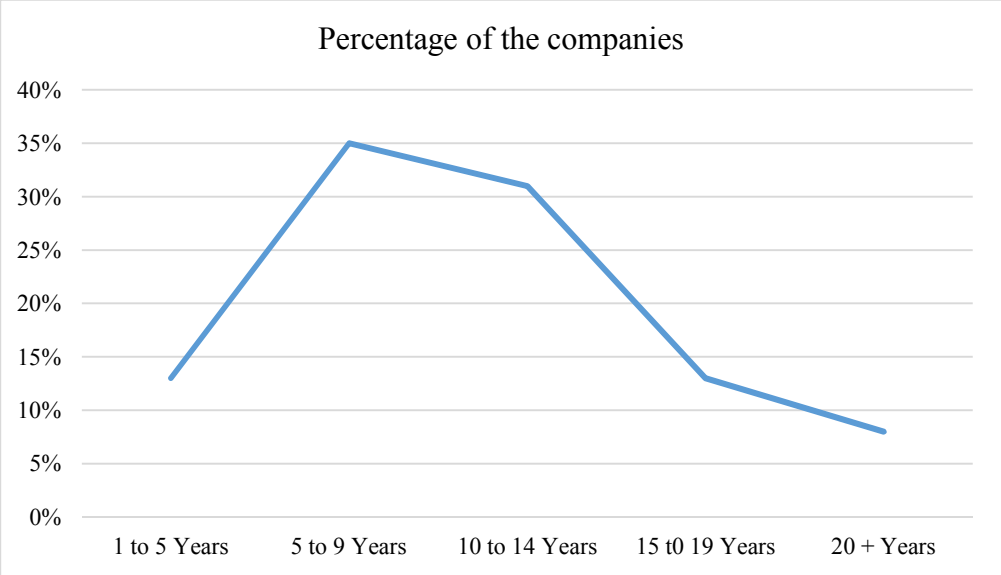
Figure 3. The companies that participated in the survey by regions

Companies by Kosovo Region	
Region	**Regional Companies**
Prishtina	32
Prizren	21
Ferizaj	15
Peje	12
Mitrovica	9
Gjilan	7
Gjakova	6
Total	**103**

Source: Author's compilation

In the next question of the survey are presented the years that these companies operate in the Kosovo market, they were: of 14% of them operated for 1-5 years in the Kosovo market, of 36% of them operated for 5-10 years, 31% of them operated for 10-15 years, 11% of these companies operated for 15-20 years in the market, and the last part which was 10% operated for over 25 years.

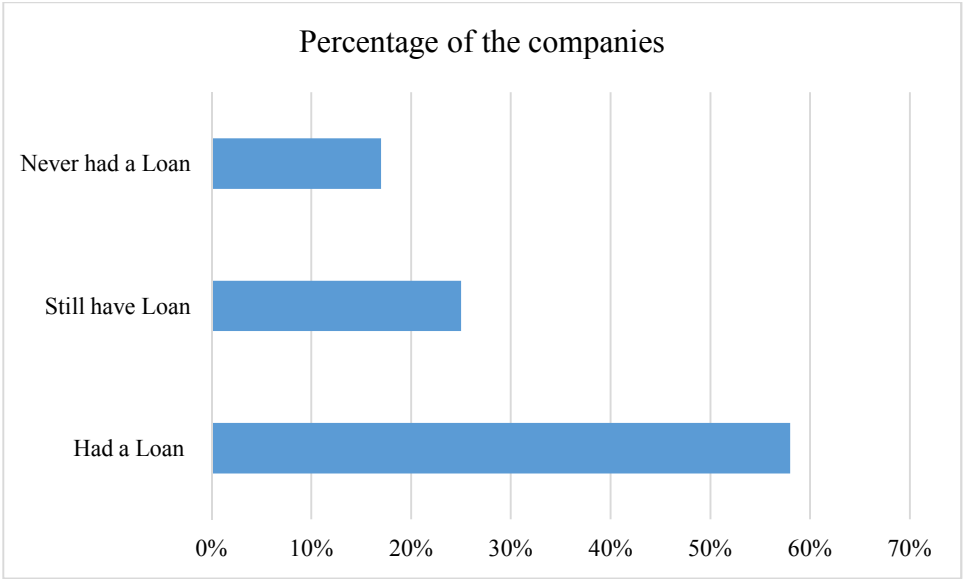
Figure 4. The companies as per years of operations in the Kosovo market



Source: Author's compilation

This figure shows the percentages of companies according to the answers they have provided regarding business loans where 58% of companies had closed loans, 25% of them currently have loans and the remaining 17% have never had business loans.

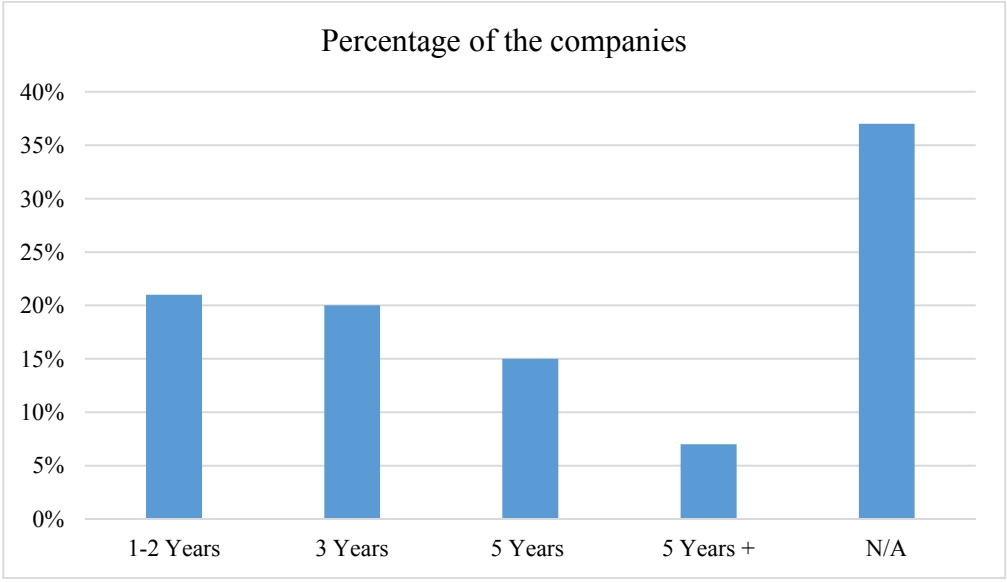
Figure 5. Business Loan status of Kosovo manufacturing companies participated in the survey



Source: Author's compilation

The figure below shows the answers of regional manufacturing companies about the duration of the loans they had. The research shows that 37% refused to answer, 21% of them had loans for 1-2 years, 20% of them had loans for 3 years, 15% of companies had loans for 5 years and 7% of them had loans for more than 5 years.

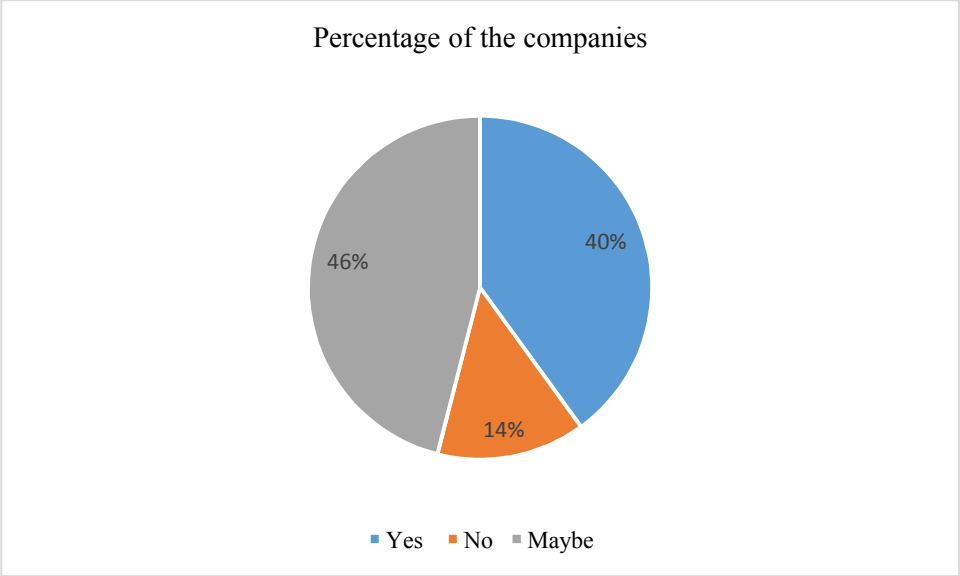
Figure 6. Duration of the business loan



Source: Author's compilation

In the next figure the companies are asked if they will get a loan again in the future and their answers show that 40% of them are determined to get a loan in the future, 14% of them will not get a loan and the rest of 46% state that they will probably receive a loan in the future.

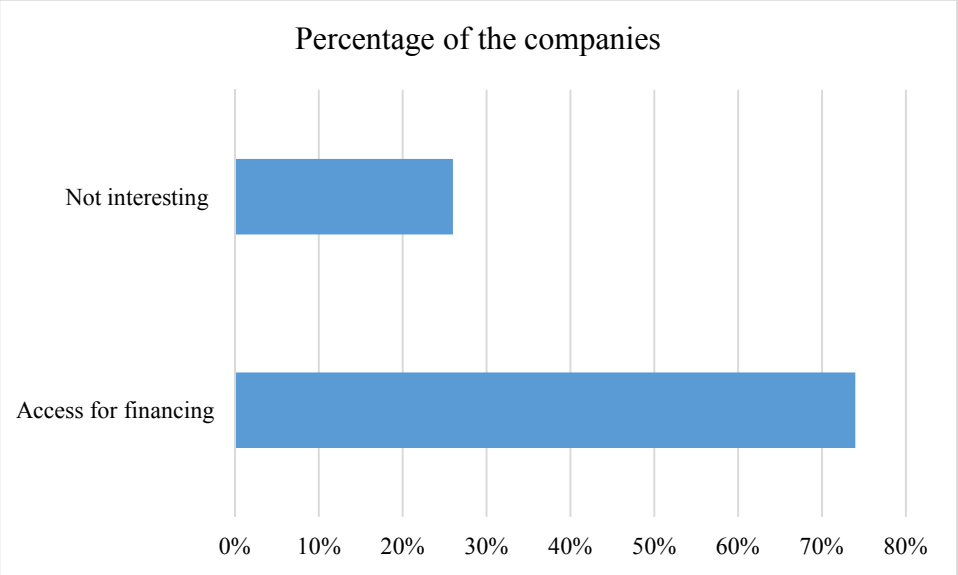
Figure 7. Interesting in applying for a business loan in the future



Source: Author's compilation

In this figure are presented the answers of the regional manufacturing companies of Kosovo about the question if they want to have access to financing in Banks and Financial Institutions. Most of them, about 74% stated that they need access to financing from banks and institutions, while 26% of them stated that they do not need financing.

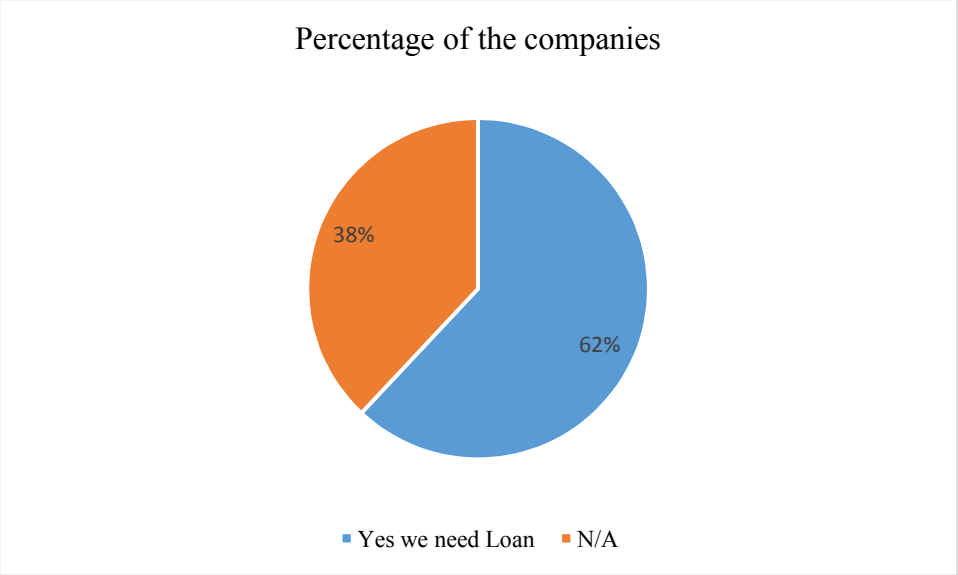
Figure 7. Desire for access in financing



Source: Author's compilation

The next figure shows the results of the question if they need bank loans in order to develop their business. The answers were that 62% of companies need credit in their business, while 38% of them do not need credit in business development.

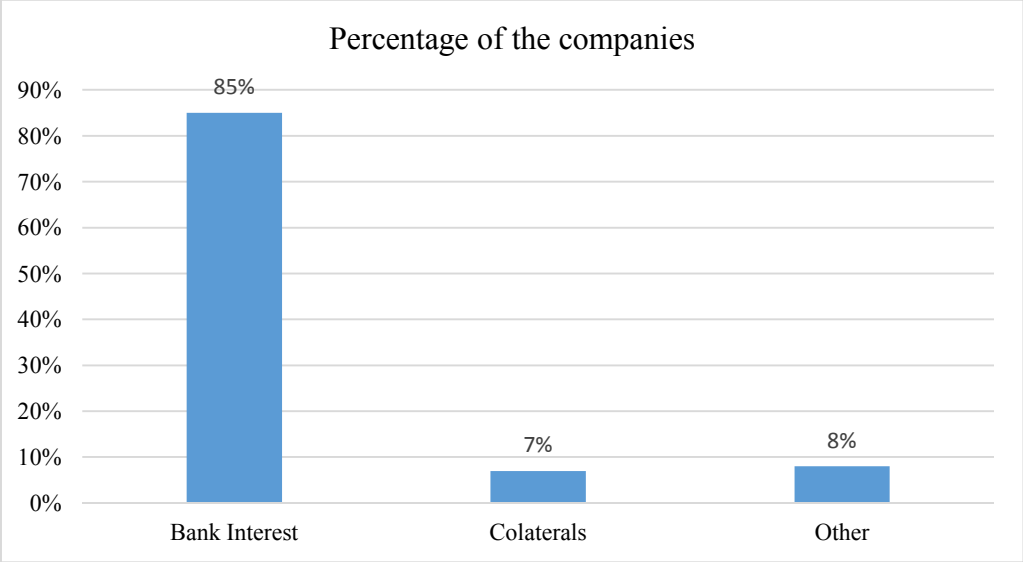
Figure 8. Need for business loan



Source: Author's compilation

The following figure presents the results of the research findings when Kosovo's regional manufacturing businesses were asked what they think are the difficulties for business loans. They answered that 85% of them believe that the biggest difficulty is high bank interest rates, 7% collateral guarantees and 8% various difficulties.

Figure 9. The key factors for absorbing a Business Loans



Source: Author's compilation

4. Conclusions

From this research we came to the conclusion that the interest rate on loans in Kosovo is high.

Both research questions were answered and confirmed based on the results of research that proves that the increase in financing of the manufacturing industry affects the economic development of Kosovo and it was confirmed that bank interest is a key factor in the absorption of bank loans. Given that Kosovo's economy is a transition economy and the need to have a stable and sound banking system is a serious challenge. As we know, this comes from problems such as unemployment, informality of the economy, institutional corruption, dysfunction of the judiciary, etc. However, despite these problems, it is possible for banks to offer lower-cost welfare, given that the interest rate is an instrument of a country's monetary policy. Therefore, the state, through the financial supervisor of Kosovo or the Central Bank must create appropriate conditions for the country's economy through the financial instruments at its disposal. The governor and the management of the banks should be unifying in representing the interests of the country, society and business in general and not representative of certain individuals or groups of interest or influence. The banking sector, within the legal framework, will need to have the necessary freedom and independence for decision-making oriented to the demands and needs of the market, which support the regional development policies of Kosovo's manufacturing industry. The manufacturing industry sector has a special importance in addition to being developed based mainly on local resources, it is also contributing with 2.3 jobs in the total economy. By informing the institutions about the results of this research, we hope for a reflection by them and specifically the banking sector in reducing interest rates on loans by providing favorable conditions for manufacturing businesses for a sustainable development.

5. Recommendation

The Bank of Kosovo is recommended to change the traditional lending methods and to promote new modern forms of credit that aim to increase financing in the regional manufacturing industry sector due to its importance in the overall development of Kosovo's economy. This strategy is also in line with Objective 9 of Sustainable Development recommended by the United Nations as an appropriate development strategy. In addition, government policies need to be adapted to provide solutions to the problems posed above by manufacturing companies by supporting them with financing grants or by playing the role of business guarantor to absorb affordable bank loans as well as also offered collateral guarantees. Commercial banks in Kosovo which are worth mentioning that they possess considerable liquidity, should promote their financial lending products on favorable terms not

only for a certain number of businesses or interest groups but for all businesses that operate in the manufacturing sector. Knowing that the global average of financing of manufacturing companies is low by about 35% and through objective 9 target 3 is intended to be exceeded in order to achieve sustainable economic development at the global level. In this regard, we recommend that initially state institutions set a funding target of over 50% of the total manufacturing industry sector and continuously with a long-term plan to exceed this level according to the development policies and performance of the sector and economy of Kosovo.

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TOOLS OF FORMATION OF THE SYSTEM OF SOCIO-ECONOMIC SECURITY OF TERRITORIAL COMMUNITIES OF THE REGION

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Abstract

The urgency of the stated subject of this scientific research is conditioned by the need to develop and integrate effective tools for the formation of a system of socio-economic security of territorial communities in a given geographical region, which is essential for the quality of economic development of these regional communities in the short and long term. The purpose of this research work is to study the tools of formation of the system of social and economic security of territorial communities of the region in the current system of social and economic relations in a given geographical region, as well as assessing the effectiveness of the practical application of such instruments in the context of assessing the role and place of these regions in the economic system of the whole State. The basis of the methodological approach in this scientific study is a combination of methods of quantitative and qualitative analysis of the key principles of the system of socio-economic security of territorial communities of the region, as well as tools to ensure this process. In the course of carrying out this scientific study, results have been obtained indicating the need to ensure the socio-economic security of a given region, through the creation of effective tools for the formation of a system of this kind of security, taking into account the specific features of a given region and its role and place in the socio-economic system of the whole state. The results obtained in the course of this scientific research, as well as the conclusions derived therefrom, have significant practical significance for representatives of specific territorial regional communities, whose immediate interests include addressing the socio-economic security of the territorial communities of the region through the use of the necessary effective tools for this task.

Keywords: region, socio-economic security, territorial communities of the region, economic development, development trends of regions, local socio-economic development

JEL classification: R1, R38, R50

1. Introduction

In modern scientific studies of the key aspects of the development of socio-economic systems of regions, increasing attention is paid to the search for new topical concepts, able to propose methodological tools for ensuring economic growth and meeting the interests of the society of territorial entities of the country (Feofilova, 2014; Polyzos and Tsiotas, 2020; Constantin, 2021). In the early 1990s, a number of countries of the former USSR experienced a sharp transition from an administrative and planned form of economic activity to market-based forms (Kokkinou et al., 2018) of economic activity. In the current conditions of systemic crisis (Alexiadis et al., 2013; Pnevmatikos et al., 2019), which covered all branches of government and elements of socio-economic systems, with periodic transition from active phases to passive, with a pronounced impact on the state and possibility of development of the regions of the country, ensuring adequate levels of economic and social security has become a priority (Karras, 2010; Hewitt et al., 2017; Perovic and Golem, 2019; Clark, 2021).

The issues of regional self-government are becoming more and more topical in the modern world, along with the tendencies of development of the processes of globalization (Karjoo and Sameti, 2015; Cao , 2021). The interest in this kind of questions is broadened in the context of broadening the understanding, comprehension, and rethinking of certain facets and parts of the concept. Many scholars and politicians cherish the hope of activating human potential, stimulating world integration, economic and democratic processes, and all these changes they necessarily associate with the process of regional structuring of the world and national space (Hamm and Goebel, 2010; Nijkamp, 2011; Xanthos et al., 2012, 2013; Karras , 2015; Vasilkova, 2018). The concept of "region" is directly related to the modern development of regionalism trends, which makes it essential to define the meaning of this concept in the context of modern regional, social and political currents (Deichmann and Senjalia, 2013; Colker, 2019; Perovic, 2021).

Socio-economic systems at the territorial level should be considered the driving force of any national economy, which is confirmed by the experience of economic development at the international level, as well as the experience of global globalization processes (Margarian, 2013; Goula et al., 2015; Tsiotas and Polyzos, 2018; Lechman and Marszk, 2019; Tsiotas and Tselios, 2021). At the territorial level there is a consistent formation of primary resources and financial flows (Karras, 2015), laying the foundations of division of labor and production cooperation, stable relationships and interdependence of various types of resource and socio-economic cycles are gradually being established, the basic needs of citizens are being met and measures are being taken to protect the environment; while the territorial development parameters create first of all indicators of the territorial level, after which macroscopic indicators are formed (Lincaru et al., 2010; Alexiadis et al., 2020; Tsiotas, 2020). Thus, the results of the development of the administrative and territorial units of a single state, as socio-economic systems of meso-level, depend on the development of the entire state in the subsequent (Smentyna, 2014).

To date, there is no clear definition of the concept of local community development either in the existing legislative framework of individual states or in the work of advanced researchers of key problems of social and socio-economic development (Khodakivska et al., 2021; Gavurova, et al., 2022). Scientific research mainly uses definitions established by Western scholars, in particular the World Bank approaches the economic development of local territorial communities as a process in which public cooperation takes place, business and government representatives in the direction of creating optimal conditions for economic growth and expansion of employment in order to raise the overall standard of living. Social resources, as resources for social interaction, are channeled through relationships between people and their associations (social groups) to address personal or social needs and are integral to the life forces of the community or society as a whole (Novikova and Shamileva, 2016). For this reason, a qualitative study of the mechanisms for the formation of tools of the system of socio-economic security of territorial communities of the region is of fundamental importance from the point of view of choosing the optimal strategy for the development of territorial communities and regions as a whole, as well as the preservation of the territorial integrity of the State, of which individual territorial communities of specific regions are an integral part.

In this scientific study the task of identifying and studying the key tools of formation of the system of socio-economic security of territorial communities of the region, which are crucial for the social and economic development of these communities in the short and long term.

2. Materials and Methods

In this scientific study the task of considering the main elements of the system of socio-economic security of territorial communities of the region. The basis of the methodological approach in this scientific study is a combination of methods of quantitative and qualitative analysis of the key principles of the system of socio-economic security of territorial communities of a given region, as well as tools to ensure quality implementation of the process. The main part of this scientific research is preceded by the creation of a theoretical base, including theoretical analysis of the results of research of a number of works of domestic and, primarily, foreign authors, devoted to the study of tools for the formation of a system of socio-economic security of territorial communities of different geographical regions.

This scientific study assumes compliance with a certain sequence of research operations, in order to ensure the highest quality and objective presentation of information, as well as obtaining objective results of scientific research and formation on their basis of full conclusions.

At the first stage of this research work, a theoretical base was created, including a theoretical analysis of the results of research of a number of domestic and, primarily, foreign authors, devoted to the study of tools for the formation of a system of socio-economic security of territorial communities of different geographical regions. In order to maximize the objectivity of the material presented in this research work, as well as to facilitate the perception of the information provided, all foreign research materials, the citation quoted in this scientific study was translated into Russian. In addition, at this stage of research work, a quantitative analysis of the key principles of the formation of a system of socio-economic security of territorial communities of the region, as well as the tools for ensuring this process, taking into account the real needs of the inhabitants of these regions and members of these communities.

In the second stage of this scientific study, a qualitative analysis of the principles of the system of socio-economic security of territorial communities of the region was carried out, taking into account the data obtained from the quantitative analysis. In addition, at this stage of the scientific study, an analytical comparison was made between the results of the study and the findings of other studies devoted to the problematic issues of ensuring the social and economic security of territorial communities of individual geographical regions. This combination of methods used in this scientific research contributes to the fullest possible disclosure of the stated topics and to obtain the most objective results of scientific research.

In the final stage of this research work, on the basis of the results obtained during it were formulated final conclusions, which are the final reflection of these results and summing up the whole complex of scientific research, the key tools for the formation of a system of socio-economic security of territorial communities of the region. In general, the results of this scientific study and the conclusions formed on their basis can be used in the future as a reliable methodological basis for conducting further scientific research in the field of studying the prospects for the formation of a social-economic security of territorial communities of a given region.

3. Results

At the present stage of economic development in the whole world, it is necessary to note a number of key aspects characterizing the characteristics of the development of the economy, of key importance in the context of ensuring the economic security of territorial communities of individual geographical regions. To date, the key features of economic development in individual geographical regions include:

– gradual transition from the simplest forms of economic activity to the forms of higher order;

– the relationship between the high level of development of productive forces and industrial relations, with a gradual increase in the level of production in individual regions;

– development of production technologies and consistent introduction of high-tech production solutions into the production sphere;

– development of the system of information transmission, preservation and practical application as one of the key components of scientific and technological progress in modern technocratic society.

In the context of ensuring the proper functioning of the system of socio-economic security of the territorial communities of the region, it should be noted that general and private laws of economic development are structurally interconnected with instruments of economic security. Table 1 presents data on the key features of the systemic interaction of general and private economic laws in the development of mechanisms for enhancing economic security, in the context of the relationship with instruments for ensuring economic security. The above principles may be applied to the assessment of the degree of socio-economic security of territorial communities of individual geographical regions.

Table 1. Key features of the systemic interaction of general and private economic laws in the formation of mechanisms to increase economic security, in the context of the relationship with tools for ensuring economic security

Economic laws (general and specific)	Economic security tools
The Law of Conformity of Industrial Relations with the Character of Productive Forces	Practical methods, forms and principles for determining the conformity of types of industrial relations to types of productive forces for a given production system
General Productivity Improvement Act	Production accounting systems describing patterns of production and methods of increasing productivity
Law of Interaction of Economic Systems in General and Private Form	Tools of systemic understanding of socio-economic structures as complex objects dependent on material achievements in modern society
The Intellectualization of Economic Systems	High-tech enterprises, intellectual industries, research laboratories
Economic innovation	Complex enterprises with dynamic type of production, providing the quickest implementation of innovative developments in the practical sphere

The Law of Conformity of Industrial Relations with the Character of Productive Forces regulates the presence of a clear relationship between modern social and economic formations in the context of their basis of development and succession. The quality and timeliness of the practical implementation of real methods and principles of determining the conformity of the types of industrial relations to the types of productive forces is of importance in the context of ensuring the socio-economic security of the region's territorial communities, for a single production system.

The General Productivity Improvement Act describes the regularities between the implementation of production efforts and the final output. Production accounting systems describing patterns of production and methods of increasing labour productivity, are designed to ensure a qualitative accounting of the rate of increase in production volumes in the context of maintaining a high quality of control over the correspondence between the volume of production effort and the volume of output.

The Law of Interaction of Economic Systems in General and Private Form implies Consistent Consideration of Principles of Market Fundamentalism with Mandatory Understanding of Underlying Principles, as an indispensable condition for efficient and safe economic activity. Social and economic structures are in this context complex interconnected

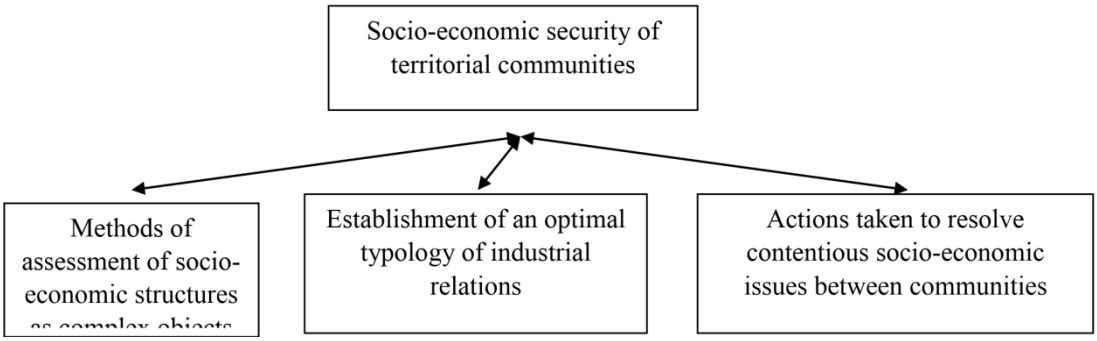
systems with clearly constructed dependencies on the real level of material achievements in society.

The Intellectualization of Economic Systems is essential for the social and economic security of both geographical regions and their constituent territorial communities, whose representatives are involved in the process of economic activity. Modern market theory adopts the determining fact that, the change of industrial relations does not lead to structural changes in the economy, which contributes to the deterioration of the economic structure: the destruction or significant reduction of the level of engineering development, electronics and a number of other high-tech industries, as well as increasing the share of the commodity economy in the GDP of the country. Consistent introduction of high-tech enterprises, branches of intellectual orientation, scientific laboratories for research activities are necessary for achieving a high level of social and economic security of enterprises and selected geographical branches (Davydchuk and Dema, 2020).

Innovation of economy implies the possibility of full-fledged economic development in conditions of innovative development of regional economies. In order to ensure the economic and social security of these farms requires a transition to an innovative type of economic development, In order to maintain an adequate level of social and economic security for certain geographical regions in general and their constituent territorial communities in particular. The introduction of complex enterprises with a dynamic type of production, in order to ensure the early introduction of innovation into practice, is intended to speed up the process.

Figure 1 schematically presents the relationship of the key tools of formation of the system of socio-economic security of territorial communities of the region in the current economic situation.

Figure 1. Key tools of formation of the system of socio-economic security of territorial communities of the region in the current economic situation



Local authorities have a key role in the task of identifying priorities for the socio-economic development of territorial communities. In this context, the following should be considered the highest priorities in strengthening socio-economic security:

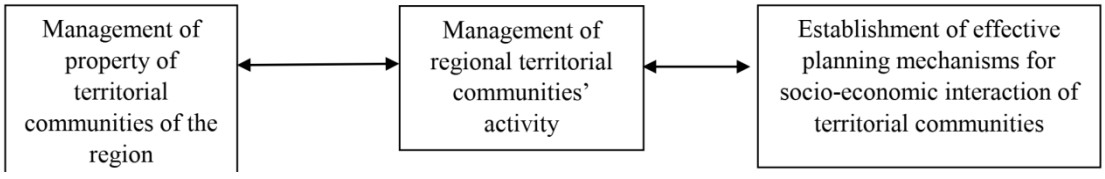
1. Strategic planning of activities aimed at growth social and economic ties between the territorial communities of a given geographical region.

2. Formation of basic budgetary funds of local significance, the means of which will be sufficient to solve the problems of ensuring the activity of territorial communities.

3. Rationalization of municipal governments to maximize the use of financial and non-financial instruments for private sector development.

Figure 2 presents the main components of the management of the activities of territorial communities of the region, which are of fundamental importance from the point of view of ensuring the socio-economic security of these communities:

Figure 2. Components of the management of territorial communities of the region



Tools for the formation of a system of socio-economic security of territorial communities of the region serve as a safeguard against the influence of external factors that have a destructive impact on the activities of these communities, as well as the prospects for their further development. In addition, a qualitative solution of the issues of ensuring the socio-economic security of the territorial communities of the region is necessary in order to ensure the full functioning of these communities in the current economic realities, which is an indispensable condition for the implementation of programs of socio-economic development of these regions as a whole. The tools under consideration for the formation of the socio-economic security of the territorial communities of the region should be evaluated in the context of their systemic relationship with the various spheres of social and economic life of the regions. This will contribute to understanding both the meaning and significance of the tools in the context of the management of the activities of territorial communities and understanding the main directions of the socio-economic development of these communities, in the context of their role and place in the social and economic system of the State, of which there are an integral part.

4. Discussion

The inequality of socio-economic development of the administrative and legal structures of the State in harmonizing economic interests, both between regions and between the center and regions, largely causes the emergence of political fragmentation, Economic disintegration and social explosions (Yaroshenko and Semigulina, 2015). In connection with this global goal of the regional policy of any State is the consistent elimination of significant unevenness of interregional development, primarily in terms of revenues of territorial entities (national and supranational) is one of the most pressing economic policy issues for most countries in the world. The importance and relevance of managing imbalances in regional development stems from the fact that they provoke and exacerbate contradictions, which are an important factor in the prospects for economic growth and well-being of the population.

Today, the need for methodological support and substantiation of models of qualitative assessment of the organizational efficiency of the system of socio-economic security of territorial communities of the region is becoming increasingly acute, in the context of the management of key socio-economic processes that have a direct impact on all spheres of their existence. It is becoming clear that the emphasis should be placed on the interrelationship of risk not only with the main management processes, but also with the functioning and change of the entire governance structure of territorial communities in the current economic situation. In these conditions, the problem of assessing the risks of management acquires an independent theoretical and applied value as a key component of the theory and practice of management (Li, 2017).

The social and economic security of the territorial communities of a given geographical region is closely linked to national and State security. To date, the social security of individual territorial communities should be considered as a state of social interaction and social relations, which completely exclude the possibility of economic, political and spiritual repression of individuals and social groups, as well as the use of force against them, both by the State and by other social subjects, in order to ensure their specific interests.

The sequence of development of the key theoretical provisions of socio-economic security, as well as their basic tools and mechanisms, should be in full compliance with the laws of economic development, which reveal the essence of industrial relations, activities aimed at managing production and consumption, taking into account the specific features of industries, regions, the level of globalization, etc. Any economic sphere, industry or region can be characterized by certain economic processes, which are justified by a specific approach to their disclosure. Justification of economic laws and key principles of economic theory of specific conditions and mechanisms of development of economic security is based on dialectical interaction of general and special (Eskiyev, Ugurchieva, 2019). At the current stage of development of the economy, as its key features should be noted the consistent transition from simple forms of economic activity to forms of complex and higher order, a high level of development of productive forces, in combination with an appropriate level of industrial relations, as well as the practical application of high-tech methods of production. These characteristics are also characteristic of the economic security of both the country and

the enterprise, as well as of a particular economic region, without finding any justification in the postulates of economic theory. The economic theory should be understood as an integrated combination of ready-made rules and regulations that are applied in a wide variety of situations.

The use of postulates of modern economic theory for qualitative assessment of peculiarities of formation of prerequisites of the system of economic and social security of territorial communities of the region does not allow to fully disclose mechanisms, which can be considered characteristic for determining the true reasons for strengthening social and economic security, because the qualitative solution of this problem requires the consideration of a whole complex of specific mechanisms.

Effective tools of formation of the system of socio-economic security of territorial communities of the region can be obtained provided that legal forms of governance in each state are preserved, taking into account its specific features and characteristics (Piero-Palomino et al., 2021).

The development of globalization processes in the present reality contributes to the simultaneous expansion of the development opportunities of regional communities through their gradual full or partial integration into international economic relations, and also forms a spectrum of negative interactions, which appear to be a factor preventing the development of such a scenario. All possible benefits or threats to certain regions are determined by the existence of the ability of their socio-economic systems to provide full-fledged resistance to negative external influences, with progressive prevention of possible damage of any type and form, which implies constant qualitative monitoring of factors and transformation of possible external negative impacts (Calcagnini and Perugini, 2019). The re-emergence of systemic negative impacts in the region is essential for the socio-economic development of individual regional communities. Typical threats to the economic security of individual regions and regional communities are corruption, an increase in the latent capabilities of the shadow economy, etc. In this case, it is not enough only to lead the negative effects to a slender system, without any identification of the characteristic features of a grouping of individual regions, to predict the sequence of transformation of all possible negative impacts from the moment of occurrence of sources necessary for qualitative formation of risks to the occurrence of well-defined damage social and economic system of the region or its constituent regional community. The absence of any full scientific substantiation significantly reduces the likelihood of effective management of the socio-economic system of the region, which in turn often makes it almost impossible to form a full-fledged assessment of the instruments, ensuring the creation of a full system of socio-economic security of territorial communities of the region.

The socio-economic security of the territorial communities of a given geographical region is a key element of social and economic security throughout the State, including these regions. It may be represented as an integral part of the national security of the entire State, in view of the fact that without the economic and social security of individual territories and civil communities living in the territories in question, The state cannot claim qualitative solutions to the problems that are the most urgent at the moment, both in the national and international terms (Guarini et al., 2020; Semenenko et al., 2021).

In the current economic situation in the world, threats to the national security of any State can be conditionally divided into external and internal. Threats of the first type include foreign policy and foreign economic threats, while those of the second type include financial, social and economic threats. In today's realities, many States are witnessing a significant decline in production, coupled with a palpable decline in the flow of investment into their national economies, which should generally be viewed as significant domestic threats to a given region (Garbolino and Voiron-Canicio., 2020). Naturally, the extent to which events of this kind have an impact on the standard of living in the region and on the socio-economic development of the communities in the region varies and is largely determined by the individual characteristics of each particular region, but they are all closely linked in the context of social and economic security at the level of the State as a whole. In this context, all factors relevant to the functioning of the socio-economic security system can be divided into State-managed (macro-level) and region- or environment-managed (meso-level).

Management of socio-economic security at the regional level should address the challenges of preventing certain factors of destabilization (potential) from becoming operational threats to security, while maintaining a secure level of security facility.

In a narrow sense, the social and economic security of the territorial communities of a given geographical region can be reduced to the general security of operations of a social and economic nature, which are the basis of the activities of these communities. Moreover, the general development of tendencies to build security of communities in social and economic terms largely depends directly on the legal security of contractual relations, which these communities have with other subjects only in the legal field. A territorial community carried out activities within the legal framework of a particular State and such activities required the conclusion of treaty relations. At the same time, the system of economic security is directly dependent on the specifics of a specific activity, within the framework of which it is necessary to conclude treaties confirming the integrity of legal relationships (Bruno et al., 2017). This kind of specificity determines the degree of differences between the forms of relationships between specific subjects of the legal field. At the same time, a qualitative solution to the issues of ensuring the social security of territorial communities requires the establishment of social stability in a given region and the creation of conditions which provides opportunities for the qualitative development of the region as a whole and of individual communities in particular. Otherwise, it will simply not be possible to deal qualitatively with the issues of ensuring an adequate level of social and economic security for individual territorial communities.

For any modern civilized society, of which the territorial communities are a separate component part, with various social and economic needs and tasks, is characterized by the perception of any offences that represent a real social threat, as situations that transcend everyday reality. In this context, the issues of social and economic security, both for individual members of territorial communities and for all communities as a whole, depend on a multitude of interrelated factors, which include problems of disturbance of public order in a given territory and problems of a purely economic nature, which could potentially have a significant impact on the life of territorial communities within and outside a particular region. Various types of violations of a legal nature committed by members of specific regions against members of particular communities themselves pose a threat to the social security of a particular community. The economic factor may be manifested in this context, but may be completely excluded from consideration when assessing the possible consequences of intervention in the life of a particular community. Therefore, the question of ensuring an adequate level of social and economic security for a given territorial community can be successfully addressed only by considering in a comprehensive manner a combination of factors, both social and economic plans relevant in terms of assessing the prospects of social and economic development of regions in general and providing opportunities for the development of territorial communities of these regions in particular (Builes-Jaramillo and Lotero, 2020). In terms of social and economic security, it is important to maintain public order and to address in a timely manner the pressing economic needs of members of specific communities in the regions.

Formation of the system of socio-economic security of territorial communities of the region is a long multi-factor process, which requires taking into account a whole range of factors, both social and economic, the interaction of which makes the effective development of territorial communities on a single territory, both in the short and medium term.

5. Conclusions

The conducted scientific research of tools of formation of the system of socio-economic security of territorial communities of the region led to the following conclusions.

The socio-economic security of the territorial communities of a given region is closely linked to the role of these communities in the social and public life of the region, as well as to the establishment of effective planning mechanisms for social and economic interaction of territorial communities. This is particularly relevant at the current stage of economic development worldwide, as economic risks are increasing due to the development of globalization processes. In addition, the current situation is transforming existing industrial relations due to deep systemic changes in the economy and the formation of a fundamentally

new economic model for the management of social processes. Thus, the issues of ensuring the socio-economic security of the territorial communities of the region, in the context of creating the necessary tools to ensure this type of security, they extend well beyond a particular economic region and address various aspects of economic and social security on a global scale.

In today's prevailing economic conditions throughout the world, a modern approach to assessing the issues of ensuring the socio-economic security of the territorial communities of the region involves the creation of effective tools for the formation of this type of security, taking into account the real social and economic situation in a given region. At the same time, the effectiveness of this type of tools is determined by the concrete results of their practical application in order to resolve. There are social and economic problems in a given region and in the context of the role and place of a given region in the economic system of the whole State. Social and economic security of the region is a complex concept, on the correct definition of the key principles to ensure which depends to a large extent both the development of the region as a whole and its place and role in the system of the entire regional development of the State.

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Announcements, Conferences, News

AMERICAN ECONOMIC ASSOCIATION

ASSA 2023 Annual Meeting

January 06 -08 2023 | New Orleans, USA

Event Overview

The **American Economic Association** (AEA), which was established in 1885, is a non-profit, non-partisan, scholarly association dedicated to the discussion and publication of economics research. The Association currently **counts over 20,000 members** from academic, business, government, and consulting groups, within diverse disciplines from multi-cultural backgrounds.

The AEA is dedicated to economics research and teaching and supports established and prospective economists with a set of career-enhancing programs and services. The AEA, in conjunction with 64 associations in related disciplines known as the **Allied Social Science Associations** (ASSA), holds a three-day meeting, each January, to present papers on general economics topics.

Over 13,000 of the best minds in economics are assembled to network and celebrate new achievements in economic research.

The meeting is generally organized as follows:

- **Program:** Offers in-depth coverage of economics topics across many disciplines via hundreds of speakers and panels.
- **Job Interviews:** The concurrent economics job fair brings together thousands of job-seekers and recruiting companies in pre-registered interview sessions.
- **Special Events:** The Presidential Address, award presentations, lectures, and many networking opportunities are also part of the experience.
- **Proceedings:** The American Economic Association publishes a Papers and Proceedings edition, in May, highlighting selected papers from the meeting, and a limited number of sessions are featured on webcasts.

- **Exhibit Hall:** Meet representatives offering specialized products and services serving economists and those in related disciplines

ASSA is the premier event to expose scientific and research work with colleagues and hear about the latest research emerging in the field. Economists from around the world take advantage of this unique opportunity to share, collaborate, and learn... all in one place.

The **upcoming meeting** is **scheduled** to be held in **New Orleans, USA, on 6-8 January 2023 (Friday to Sunday)**. The headquarters hotel is the Hilton Riverside. Sessions proposals and papers were submitted electronically (submissions are no any more available), via the American Economic Association website, until April 15, 2022. Information about the upcoming 2022 annual meeting is announced on the AEA website (https://www.aeaweb.org) as it becomes available for presenters, attendees, and exhibitors.

Event overview edited by Dimitrios Tsiotas, Assistant Professor, RSI J.

The Home of Regional Science in Europe

AECR International Conference 2022

"Challenges, policies, and governance of the territories in the post-COVID era"
19-21 October 2022 | University of Granada, Spain

Event Overview

The Spanish (AECR) and Andalusian Associations (AACR) of Regional Science have the pleasure of inviting scholars, researchers, and practitioners to participate in the **XLVII International Conference on Regional Science** and in the **XIII Congress of the AACR**, which will take place at the *University of Granada* on 19-21 October 2022. The events will be held with the support of the *University Institute for Regional Development Research* (IDR), the *University of Granada*, and the *Joint Research Center* (JRC) of the *European Commission*.

Following the tradition of the previous editions, the International Conference on Regional Science is a multidisciplinary meeting point, offering an overview of regional science and the analysis of the territory, along with the study, debate, and presentation of academic works around territorial and regional concepts. The title of the XLVII edition is "*Challenges, policies, and governance of territories in the post-COVID era*", and intends to focus on the analysis of the great territorial challenges that the society is about to face after this pandemic, as well as on the actions and the need for coordination of the actors that implement the relevant policies. The COVID-19 pandemic has contributed to the growth of the regional problem, such as the increase of asymmetries in factor endowments; the increase of the employment destruction and the productive fabric, especially in the most peripheral areas; the enlargement of migratory pressure; the strengthening of urban concentration; and a series of problems affecting the areas: environmental, social, and economic. Within this challenging context, the Organizing Committee invites the all that are interested in regional science to participate in the XLVII International Conference on Regional Science, on October 19-21, 2022, at the University of Granada, and to enjoy the monumental and heritage city, as well as the magnificent provincial environment.

The abstract submission for the Conference is already open. Submissions are expected to have a minimum length of 1,500 words. Templates and more information about submission are available at the Conference webpage (www.aecr.org). Unpublished papers written by researchers under 33 years or who defended their Ph.D. thesis during the two years before the Conference are welcomed and eligible for the *Juan Ramón Cuadrado Young Researchers' Prize*, accompanied by accreditation and a gift. The jury of that prize will be the Scientific Committee of the Conference. Discounts for Ph.D. students, in the first stages of their dissertations, and master's degree students, with a research orientation, will apply to facilitate access to the parallel sessions of the Conference.

The Thematic Areas of the Conference are:

1. Growth, convergence, and development.
2. Competitiveness, efficiency, and productivity.
3. Economy of knowledge and geography of innovation.
4. Globalization and territory.
5. Location of economic activities.
6. Sustainability, environment, and natural resources.
7. Demographic change, population, and migratory movements.
8. Inequality and social cohesion of the territories.
9. Labor market and territory.
10. Entrepreneurship and business dynamics.
11. Tourism, culture, and heritage.
12. Governance and impact of territorial policies.
13. Land planning, urban planning, and housing.
14. New frontiers in territorial statistical information.
15. Methods for territorial analysis.
16. S-TC University-Environment knowledge transfer sessions
17. S-JI.- Young Researchers Sessions: "I have an idea…"

Important dates

Presentation of extended abstracts-papers: June 15.
Acceptance of extended abstracts-papers: June 30.
Ordinary payment: ends on July 10.
Congress dates: October 19-21.

Secretary

Technical Secretary of the AECR, Conxita Rodríguez Izquierdo, Telephone: 00 34 93 310 11 12, Email: info@aecr.org

More on the event website (www.aecr.org)

Event overview edited by Dimitrios Tsiotas, Assistant Professor, RSI J.

Academic Profiles

Prof. Oleg Itskhoki has been *awarded the 2022 John Bates Clark Medal*, one of the most prestigious and eagerly anticipated AEA awards annually each April (formerly biennially from 1947-to 2009) to an American economist under the age of 40, who is judged to have made the most significant contribution to economic thought and knowledge. Established as an American prize, it is sufficient that the candidate works in the US at the time of the award and US citizenship is not required. The Clark medal brings notable professional benefits, and several winners have gone on to become Nobel Laureates. This award has been formerly granted to prominent scholars, such as Paul A. Samuelson, Milton Friedman, Franklin M. Fisher, Daniel McFadden, James J. Heckman, Paul R. Krugman, and other distinguished scholars offering a seminal work to economics.

Prof. Oleg Itskhoki holds a BA in economics, from Moscow State University, an MA in economics, from the New Economic School, and a Ph.D. in economics, from Harvard University. Prof. Oleg Itskhoki holds the Venu and Ana Kotamraju Endowed Chair in Economics, at the University of California, Los Angeles, he is an NBER research associate, CEPR research affiliate, and an associate editor of the American Economic Review. His research interests concern macroeconomics and international economics, where he studies globalization and labor markets, currencies, exchange rates, and international relative prices, as well as other topics. He is a distinguished scholar and his research currently enjoys more than 6.5 thousand citations, according to the Google Scholar database. Prof. Oleg Itskhoki was a participant of the Review of Economic Studies Tour, a Sloan Research Fellow, a recipient of the Excellence Award in Global Economic Affairs from the Kiel Institute for the World Economy, and was on the IMF's list of 25 influential economists under the age of 45.

The Editor-in-Chief and the Editorial Board of the RSI J **congratulate Prof. Oleg Itskhoki** on this achievement!

Academic Profile by:
Dimitrios TSIOTAS, Assistant Professor, RSI J

Prof. **Christos A. LADIAS**, Ph.d., was born in 1950, in Trikala, Thessaly, Greece. He holds a B.Sc. from the Department of Economics, University of Athens; an M.Sc. in Urban and Regional Development, from Panteion University of Social and Political Sciences, Institute of Regional Development (IPA), and a Ph.D. in Urban and Regional Development, from the Department of Urban and Regional Development, Panteion University.

Currently, he is the Publisher and Editor-in-Chief of the international scientific journal *Regional Science Inquiry Journal* (rated by EconLit, Scopus, and R.S.A.I.), published under the aegis of the Hellenic Association of Regional Scientists; the author of authorized University textbooks, a Special Consultant of the Economic and Social Committee of Greece (O.K.E.); and a full member of the *American Economic Association* (A.E.A.).

His former titles include:

• *Professor* of *Regional Economics*, at the *Department of Economic and Regional Development*, Panteion University of Social and Political Sciences, Greece (2005-2018)

• *Professor* of *Economics*, at the Engineer Stream (S.M.A.), and *Professor* of *Probability and Statistics* at the Pilot Stream, of the Hellenic Air Force Academy – H.A.F.A., Greece (1995-2005),

• *Prefect* in the Prefectures of *Phthiotis* and *Corinthia*, Greece (1990-1993),

• *Academic Researcher*, at the *Institute of Regional Development*, Panteion University of Social and Political Sciences (2004-2007),

• *Member of the Committee* for the Institutional Modernization of the Greek Regions, of the Hellenic Ministry of the Interior Public Administration and Decentralization (2007-2009),

• *Member* of the *National Land Planning and Sustainable Development Council*, at the Hellenic Ministry for the Environment, Physical Planning and Public Works, (2005-2012)

• *President* of the Greek Regional Economists' Association (S.E.P.) (2004-2012),

During his academic career, he taught in Postgraduate Programs at the Panteion University of Social and Political Sciences, the National and Kapodistrian University of Athens, and the University of the Aegean, Greece, as well as at other Institutions of Higher Education, such as the Hellenic Army Officers School (Evelpidon), the Hellenic Police Academy (Officers' Section), the Police Academy, and the Technological Institute of Higher Education of Athens. He has also taught in Seminar Programs, at the Institute of Regional Development (IPA), Panteion University, the National Centre of Public Administration, and many more.

He has published several scientific papers in international and Greek peer-review journals, several chapters in collective volumes, and has been a lecturer in Greek and international scientific conferences in economics, as well as a lecturer on various topics of important events. He also authored the following scientific and academic books:

• *Regional Policy Issues in Greece*, Athens, Greek Regionalists' Association, 1999,

• *The Institutional Framework and Water Resource Management in the Prefecture of Corinthia*, Corinthos: Independent Organization of Stymfalia Asopos, Corinthia Prefecture, 1993,

• *Notes on Regional Economic Policy Issues University Lessons*, Athens: Institute of Regional Development of Panteion University of Social and Political Sciences, 1993,

• *The development of cotton cultivation in the Region of Thessaly*, Athens: European Institute of Economic Development, 1990,

• *Regional Economic Theory and Policy*, *Student University Notes, 1st Issue*, Theoretical Documentation, Athens, 2011,

• *The contemporary institutional framework of regional development in Greece*, *1st edition*, Athens, Papazisis Publications (309p), ISBN 978-960-02-2747-5, authorized university textbook (best seller), 2013,

• *Specific issues of local government*, *1st edition*, Athens, Papazisis Publications, (350p), ISBN

978-960-02-3056-7, authorized university textbook (best seller), 2014,

• *The European Regions today*, *1st edition*, Athens, Papazisis Publications, (480p), ISBN 978-960-02-3128, authorized university textbook, 2015.

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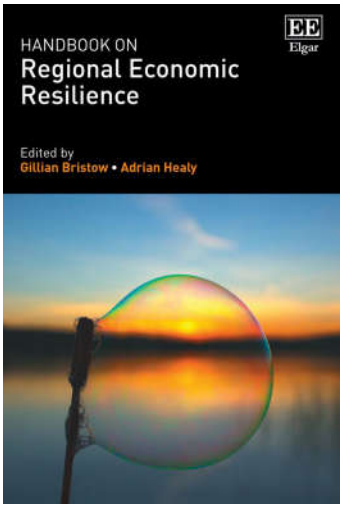
Academic Profile by:
Dimitrios TSIOTAS, Assistant Professor, RSI J

Book Reviews

Handbook on Regional Economic Resilience, Edited by Edited by Gillian Bristow and Adrian Healy, published by Edward Elgar



The Handbook on Regional Economic Resilience (p.320), Publication Date: 2020, is a collection of articles addressing a cutting-edge question of the twenty-first century: Why are some regions more economically resilient than others? The handbook provides critical contributions capturing both key theoretical debates around the meaning of resilience, its conceptual framework, utility, and empirical interrogation of its key determinants in different international contexts. The list of contributors includes authors belonging to the proponent scholars of this research subject, along with acknowledged academics in the scientific fields of regional science, regional economics, and economic geography.

The handbook consists of 17 chapters (including the Editors' introduction and the conclusion) and is organized into three parts. The first part contributes to a conceptualization of regional economic resilience, unraveling its complex configuration in equilibrium, evolutionary, economic, and geographical terms. The second part illustrates the demanding process of measurement of economic resilience, while the third part provides insightful empirical case studies on the concept. The handbook offers a range of methodological approaches and rich empirical analyses of regions around the world and explores key theoretical debates and emerging pathways for the application of resilience in policy and practice.

This handbook is suggested for (i) researchers and academics, who work in economic geography and regional studies and require insights into the breadth of debate on regional economic resilience; (ii) practitioners and policymakers, who work in regional economic development and experience a broad empirical approach to resilience; and (iii) Ph.D. students, who are interested in doing research in the subject of regional economic resilience and need to shape an overall picture of this research subject.

Overall, the Handbook on Regional Economic Resilience is a collection of quality papers shaping a concise picture of the conceptual, methodological, and empirical framework of regional economic resilience, a property conceived in the context of complexity ruling regional economic systems light. The handbook is driven by an interdisciplinary way of thinking and is a must-to-have book for regional scientists, geographers, economists, engineers, and other scholars activating in spatial analysis and research.

The Contributors to the Handbook are:

P. Benczur, E. Beqiraj, G. Bristow, J. Courvisanos, M. Cowell, G. Di Bartolomeo, P. di Caro, M. Di Pietro, D. Diodato, E. Evenhuis, R. Hassink, A. Healy, X. Hu, A. Jain, E. Joossens, T. Kitsos, A.R. Manca, K.K. Mardaneh, R. Martin, B. Menyhert, N. Pontarollo, Y. Psycharis, C. Serpieri, P. Sunley, V. Tselios, M. Tsiapa, J. Vincente, A. Weterings, and S. Zec

The Table of Contents of the Handbook is:

Book Review by
Dimitrios TSIOTAS, Assistant Professor, RSI J

Natural Resource Management and Sustainable Development, by Serafeim Polyzos, Tziolas Publishing [in Greek]

The book ***Natural Resource Management and Sustainable Development*** (p.712), written by Prof. **Serafeim Polyzos**, Ph.D., is a newly released work (Publication Year: 2022) available in the Greek academic literature. The author is a Civil Engineer and Economist and currently serves as a Full Professor at the Department of Spatial Planning, Urban Planning, and Regional Development, at the University of Thessaly. More than 200 articles by Prof. Serafeim Polyzos have been published in scientific journals, book chapters, and conference proceedings, covering a broad topical range, such as Urban and Regional Development, Project Management and Appraisal, Project and Investment Evaluation, Natural Resource Management, and Sustainable Development.

In the context of the interdisciplinary academic background of the author, this book covers a significant number of issues related to the multidisciplinary field of Natural Resource Management and Sustainable Development. The book includes twenty (20) chapters, which provide more than the essentials on the relationship between natural resources, environmental goods, and sustainable economic development. In particular, the first three (1-3) chapters provide a conceptual context for the pillars of natural resources, environmental problems, and growth and sustainability. The following four chapters (4-8) configure a basis to conceive natural resources in the context of economics, as a production coefficient and discuss methods for the assessment of projects and investments, environmental goods, and environmental optimization. The following two chapters (9-10) illustrate the framework of the field of Environmental Economics. The last ten chapters (11-20) cover topical items, such as pollution and environmental protection; optimal use of natural resources; urban and suburban green; landscape restoration and natural environment; the effects of transportation and large scale works on the environment and development; rural land reclamation and development; renewable energy sources; tourism and environment; and environmental impact assessment.

Being equipped with a broad topical range, multidisciplinary conceptualization, high level of quantitative analysis, examples on problems solution, attractive colored illustration, and quality page paper and hardcover binding, the book Natural Resource Management and Sustainable Development, is multiplex useful and is a must-to-have book for (*i*) scholars, academics, and researchers, who activate in this field and need to have its framework included in a single book; (*ii*) students, at all levels, who need a comprehensive, sound, well-structured, and attractive course-book; and (*iii*) practitioners and policymakers, who work in all related fields and need a reference book. The overall added value of this book may motivate the author to consider editing an English version in the future to make it available to the international community.

Book Review by
Dimitrios TSIOTAS, Assistant Professor, RSI J

GUIDELINES

for the Writers & a format model for the articles submitted to be reviewed & published in the journal

Regional Science Inquiry Journal

(EconLit, Scopus, RSA I) – www.rsijournal.eu

Guidelines for the Writers & a format model for the articles submitted to be reviewed & published in the journal

The Title of the paper must be centered, and the font must be Times New Roman, size 12, in Uppercase, in Bold

For the writers' personal information use the Times New Roman font, size 11, in bold, and centered. Use lowercase for the first name and uppercase for the last name. The line below the name includes the professional title and workplace; use the Times New Roman font, size 10, centered. In the third line write only the contact e-mail address in Times New Roman 10, centered.

Name LAST NAME
Professional Title, Workplace
E-mail Address

Name LAST NAME
Professional Title, Workplace
E-mail Address

Abstract

The abstract consists of a single paragraph, no longer than 250 words. The font must be Times New Roman, size 11. The text must be justified. The title "Abstract" must be aligned left, in Times New Roman, size 11, in bold. A space of one line must be left between the title and the text of the abstract. The abstract must contain sufficient information, be factual, and include the basic data of the paper.

Keywords: Use 3 to 5 keywords, separated by commas

JEL classification: We kindly request that you classify your paper according to the JEL system, which is used to classify articles, dissertations, books, book reviews, and a variety of other applications. The use of the JEL classification is necessary so that your paper be properly indexed in databases such as EconLit. Select the codes that represent your article and separate them by commas. You can find information on the JEL system here: https://www.aeaweb.org/jel/guide/jel.php

1. Introduction

All articles must begin with an introduction, a section which demarcates the theoretical background and the goals of the paper.

The present document provides the necessary information and formatting guidelines for you to write your article. We recommend that you copy this file to your computer and insert your own text in it, keeping the format that has already been set. All the different parts of the article (title, main text, headers, titles, etc.) have already been set, as in the present document-model. The main text must be written in regular Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph.

We recommend that you save this document to your computer as a Word document model. Therefore, it will be easy for you to have your article in the correct format and ready to be submitted. **The only form in which the file will be accepted is MS Word 2003**. If you have a later version of Microsoft Office / Word, you can edit it as follows:

- Once you have finished formatting your text, create a pdf file, and then save your file as a Word "97-2003" (.doc) file.

- Compare the two files – the pdf one and the Word "97-2003" (.doc) one.
- If you do not note any significant differences between the two, then – and only then – you can submit your article to us, **sending both the pdf and the Word "97-2003" (.doc) files** to our e-mail address.

If you use a word processor other than Microsoft Word, we recommend that you follow the same procedure as above, creating a pdf file and using the appropriate add-on in order to save your document in MS Word "97-2003" (.doc) form. Once you compare the two files (and find no significant differences), send us both.

2. General Guidelines on Paper Formatting

2.1. Body

The body of the text consists of different sections which describe the content of the article (for example: Method, Findings, Analysis, Discussion, etc.). You can use up to three levels of sections – sub-sections. For the Body of the text, use the default format style in Word, selecting the Times New Roman font, size 11, justified, with a 0.5 cm indent for the first line of each paragraph (this is further detailed in the section "Paragraphs").

2.2. References

The references included in the paper must be cited at the end of the text. All references used in the body of the paper must be listed alphabetically (this is further detailed in the section "References").

2.3. Appendices

The section "Appendices" follows the section "References".

3. Page formatting

3.1. Page size

The page size must be A4 (21 x 29,7 cm), and its orientation must be "portrait". This stands for all the pages of the paper. "Landscape" orientation is inadmissible.

3.2. Margins

Top margin: 2,54cm
Bottom margin: 1,5cm
Left and right margins: 3,17cm
Gutter margin: 0cm

3.3. Headers and Footers

Go to "Format" → "Page", and select a 1,25cm margin for the header and a 1,25cm margin for the footer. Do not write inside the headers and footers, and do not insert page numbers.

3.4. Footnotes

The use of footnotes or endnotes is expressly prohibited. In case further explanation is deemed necessary, you must integrate it in the body of the paper.

3.5. Abbreviations and Acronyms

Abbreviations and acronyms must be defined in the abstract, as well as the first time each one is used in the body of the text.

3.6. Section headers

We recommend that you use up to three sections – sub-sections. Select a simple numbering for the sections – sub-sections according to the present model.

3.7. First level header format

For the headers of the main sections use the Times New Roman font, size 11, in bold and underlined, and leave a size 12 spacing before the paragraph and a size 6 spacing after the paragraph. The header must be aligned left. Use a capital letter only for the first letter of the header.

3.8. Second level header format

For second level headers, follow this model. Use the Times New Roman font, size 11, in bold, and leave a size 12 spacing before the paragraph and a size 3 spacing after the paragraph. Select a 0.5 cm indent. The header must be aligned left. Use a capital letter only for the first letter of the header.

3.8.1. Third level header

For third level headers, follow this model. Use the Times New Roman font, size 11, in bold and italics, and leave a size 6 spacing before the paragraph and a size 0 spacing after the paragraph. The header must be aligned left, with a left indent of 1 cm. Use a capital letter only for the first letter of the header.

4. Paragraphs

In every paragraph, use the Times New Roman font, size 11, with single line spacing. We recommend you modify the default (normal) format style in Word and use that in your text. For all paragraphs, the spacings before and after the paragraph must be size 0, and the line spacing single. Use a 0,5cm indent only for the first line of each paragraph. Leave no spacings nor lines between paragraphs.

4.1. Lists

In case you need to present data in the form of a list, use the following format:

- Bullet indent: 1,14cm
- Text:
    - Following tab at: 1,5 cm
    - Indent at: 1,5cm

Use the same format (the above values) if you use numbering for your list.

1. Example of numbered list 1
2. Example of numbered list 1

5. Figures, images, and tables

5.1. Figures and images

Insert your figures and images directly after the part where they are mentioned in the body of text. They must be centered, numbered, and have a short descriptive title.

Figures put together "as they are", using Office tools, are absolutely inadmissible. The figures used must have been exclusively inserted as images in Word, in gif, jpg, or png form (with an analysis of at least 200dpi), and in line with the text. The width of an image must not exceed 14,5cm so that it does not exceed the margins set above.

The images, figures, and tables must be inserted "as they are" in the text, in line with it. **Figures and images which have been inserted in a text box are absolutely inadmissible.**

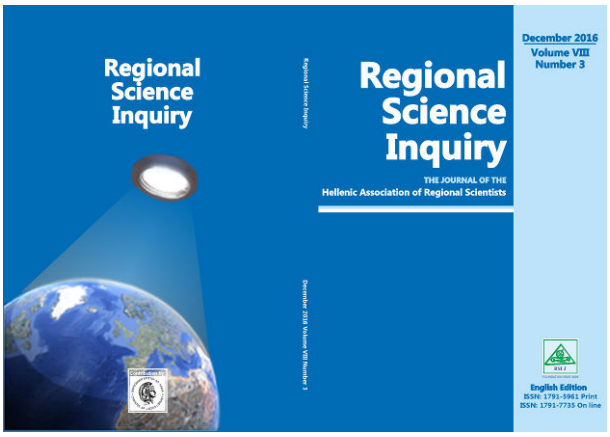
5.1.1. Reference inside the text

Avoid phrases such as "the table above" or the "figure below" when citing figures and images. Use instead "in Table 1", "in Figure 2", etc.

5.1.2. Examples

A model of how to format figures/images follows. For the title, use the Times New Roman font, size 10, in bold. Write the title above the figure, and set a size 6 spacing before the title and a size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the image and its title must be centered.

Image 1: Title



Source: cite the source

Directly below the figure you must cite the source from which you took the image, or any note regarding the figure, written in Times New Roman, size 10. Write it below the figure, leaving a size 0 spacing before and after it, use a line spacing of 1.5 line, and make it centered.

5.2. Tables

For the title, use the Times New Roman font, size 10, in bold. Write the title above the table, and set a size 6 spacing before the title and a size 0 spacing after it. The line spacing of the title must be 1.5 line. Both the table and its title must be centered. The width of the table must not exceed 14,5cm so that it does not exceed the page margins set.

Table 1. Example of how a table must be formatted

Age	Frequency	Percentage %
Under 40	44	32.1
40 - 49	68	49.6
Over 50	25	18.2
Total	**137**	**100.0**

Source: cite the source

If the table needs to continue on the next page, select in the "Table properties" that the first line be repeated as a header in every page, as in the above example of Table 1. **Tables (or figures or images) which are included in pages with a "Landscape" orientation are absolutely inadmissible.**

Every table must have horizontal lines 1 pt. wide at the top and bottom, as shown in the example. The use of vertical lines and color fill at the background of the cells is strictly prohibited.

Directly below the table you must cite the source or any note regarding the table, written in Times New Roman, size 10. Write it below the table, leaving a size 0 spacing before and a size 6 spacing after it, and make it centered.

6. Mathematical formulas

There is a variety of tools in order to insert and process mathematical formulas, such as the "Mathematics", found in the most recent editions of Word, "Math Type", "Fast Math Formula

Editor", "MathCast Equation Editor", "Math Editor". Since it is impossible for us to provide you with compatibility with all these tools in all their editions, **we can only admit your paper if it contains mathematical formulas solely in the form of images.**

Keep a continuous numbering for the mathematical formulas and center them in the page, as shown in the following example:

$$y = ax^2 + bx + c \tag{1}$$

The same stands for formulas or particular mathematical symbols you may have integrated in your text. For instance, if you want to use the term ax^2 in your text, you must insert it as an imaged, in line with the text. The images containing the mathematical formulas must be legible (at least 300dpi).

In the exceptional case of a text which may contain a great number of mathematical formulas, the writer may send it to us in TeX form if they so wish.

7. References

We recommend that you use the Chicago Manual of Style Author-Date system, as it is recommended by the AEA (American Economic Association) for the journals included in the EconLit database, and it is the dominant style of bibliography in the field of Economics. For more information you can go to the following links:

- https://www.aeaweb.org/journals/policies/sample-references
- http://www.chicagomanualofstyle.org/tools_citationguide.html
- http://libguides.williams.edu/citing/chicago-author-date#s-lg-box-12037253

7.1. Online references (internet citations)

Check your links again before sending your file, to confirm that they are active.

Avoid long internet links. Where possible, also cite the title of the website operator-owner. Return the font color to black, and remove the hyperlink. Links such as the following are impractical and distasteful, therefore should be avoided.

Example of an inadmissible hyperlink

https://el.wikipedia.org/wiki/%CE%9F%CE%B9%CE%BA%CE%BF%CE%BD%CE%BF%CE%BC%CE%B9%CE%BA%CE%AC

7.2. References Formatting

For your list of references, use the Times New Roman font, size 10, with single line spacing. The paragraph format must include a size 0 spacing before the paragraph and a size 0 spacing after it, aligned left. Use a 0,5 cm indent only for the first line of each paragraph. Leave no spacings or lines between paragraphs.

7.3. Example of how References must be formatted

Bureau of Labor Statistics. 2000–2010. "Current Employment Statistics: Colorado, Total Nonfarm, Seasonally adjusted - SMS08000000000000001." United States Department of Labor. http://data.bls.gov/cgi- bin/surveymost?sm+08 (accessed February 9, 2011).

Leiss, Amelia. 1999. "Arms Transfers to Developing Countries, 1945–1968." Inter-University Consortium for Political and Social Research, Ann Arbor, MI. ICPSR05404-v1. doi:10.3886/ICPSR05404 (accessed February 8, 2011).

Romer, Christina D., and David H. Romer. 2010. "The Macroeconomic Effects of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks: Dataset." American Economic Review. http://www.aeaweb.org/articles.php?doi=10.1257/aer.100.3.763 (accessed August 22, 2012).

Ausubel, Lawrence M. 1997. "An Efficient Ascending-Bid Auction for Multiple Objects." University of Maryland Faculty Working Paper 97–06.

Heidhues, Paul, and Botond Kőszegi. 2005. "The Impact of Consumer Loss Aversion on Pricing." Centre for Economic Policy Research Discussion Paper 4849.

Zitzewitz, Eric. 2006. "How Widespread Was Late Trading in Mutual Funds?" http://facultygsb.stanford.edu/zitzewitz.