

Understanding creative, information and knowledge determinants of the economic growth of the EU regions within smart development strategies

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ABSTRACT

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The article substantiates the relevance and necessity of involving creativity, information and knowledge-based capital while forming and implementing the smart specialization policy of the EU regions. The scientific views on the relationship between the processes of economic growth, the use of creative, information and knowledge approaches, smart-oriented spatial and territorial planning are generalized. A new approach for assessing the creative, information and knowledge determinants of the EU regions' economy transformations with the use of the multivariate regression analysis, a composite method, and strategic structural and functional design is developed. The scores of the sub-indices of the Global Innovation Index, the Global Talent Competitiveness Index and the World Digital Competitiveness Ranking are selected as the initial parameters of regression analysis. The relationships between these factors and the change in the GDP volume per capita, the share of GDP used for gross investment, high-tech exports, and the Global Quality of Life Index are revealed. The composite indicators of the concentration of creative and digital (ICT) industries in the EU regions are calculated (based on the level of enterprise concentration in an industry, the share of the employed in the field and the share of an industry in the regional economy in terms of wages). The priorities of smart specialization strategies of the EU's individual regions, which are related to creative, information and knowledge factors, are identified. The calculations have confirmed sufficient closeness of the relationship between the use of creative, information and knowledge factors and the fulfillment of the tasks of smart specialization strategies in the EU regions. The sequence of the formation of tools and means for the implementation of the strategy of the regions' smart specialization in the context of attraction and effective use of the determinants grouped by three directions (creativitization, digitalization and new knowledge) is presented.

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1. Introduction

The current basic trend of the European Union's policy with respect to the further intensification and levelling of regional disparities is the development and implementation of smart specialization strategies. At the same time, the main criteria for assessing the quality of smart specialization in the EU regions include: whether the strategy defines innovations and development priorities *based on knowledge*; how the strategy supports clusters, the relations between clusters, innovation ability by

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promoting the dissemination and adaptation of key *technologies* (nano-technology, micro-nano-electronics, advanced materials, industrial biotechnology, advanced production systems); whether the document is considered as a regional strategy of *smart specialization*.

The goal of ‘Knowledge and Innovation Economy’ is defined as one among the four main goals of the Research and Innovation Smart Specialization Strategy in the EU (RIS3). Given these circumstances, including strategic orientation within smart specialization on the development of economic activities with innovation potential and a general increase in the level of the regions’ innovation and investment activity, creative, information and knowledge determinants, their involvement and use to achieve the goal and objectives of the strategies are becoming especially important and relevant. However, the studies are being foregrounded that either confirm or, conversely, refute the direct positive impact of the analyzed determinants on the transformations of the EU regions’ economy. To some extent, such relations are well covered in several publications on the problems of the economy’s competitiveness. While the issues of a general definition of the competitive advantages of the EU territories’ development within the framework of a smart specialization strategy are investigated in Thissen, Oort, Diodato & Ruijs (2013), the tools and means of the state regional policy for the formation of the regional economies’ competitiveness directly under the influence of a knowledge and innovation economy are discussed in Carayannis & Grigoroudis (2016), and with the application of knowledge, information, advanced technological innovations – in Aranguren, Magro & Wilson (2017). Moreover, the principles of regional development and competitiveness predominantly concern innovative approaches with the focus on digitalization. However, the direct quantitative measure of the impact of creative, information and knowledge determinants in these and some other publications on the issues of competitiveness of the EU regional economies is less analyzed. An important theoretical and methodological basis for the study of creative, information and knowledge determinants of economic growth includes more functionally specialized publications, where the researchers consider certain groups of determinants (Vasylytsiv & Levytska, 2020). For example, in Bailey & Propris (2019) and Balland, Boschma, Crespo & Rigby (2017) the emphasis is shifted towards innovative technologies and the economy’s intellectualization, their contribution to the development of the industrial sector and creation of new complex technologies that are built on local related capabilities. At the same time, Correia & Costa (2014), Reimeris (2016), Whittle (2020) focus on the development of creative industries, as well as entrepreneurial skills and creativity, setting up smart clusters based on them, which further act as drivers of the regional development. The Feltynowski study (2012) analyzes the processes of the environment formation, providing with the creation and development, as well as the impact of the functioning of ICT clusters on the complex socio-economic development. In all these works, the scholars agree on the high level of contribution of creativity, new knowledge and information technologies to sustainable human-centric development with high efficiency of processes in all the areas of the regional economic system based on smart specialization. Mulcka & Levytska (2018) analyze a cause-consequence relationship between non-standard forms of employment and ICT as an important driver for innovations in the national labour market and the most favourable, fast-developing platform for the implementation of new work practices. However, these studies do not provide a comprehensive empirical analysis of the impact of creative, information and knowledge determinants on the main parameters of the EU regions’ economic and social development.

As proved in recent studies, the introduction of creative, information and knowledge determinants is a particularly powerful factor in accelerating the economic growth of less developed regions and thus providing with the levelling of the economic development rate of the territories. In particular, Ilyash, Yildirim, Doroshkevych, Smoliar, Vasylytsiv & Lupak (2020), Havlovska, Rudnichenko & Lisovskyi (2019) show the contribution of investment to the development of creative industries and the impact of digitalization of the economy on improving the overall investment attractiveness of territories and strategically important enterprises. Vasylytsiv, Lupak & Osadchuk (2017) analyze the positive consequences of the creation and implementation of ICT and technological innovations in the realization of effective import substitution programs at the regional level and thus in contribution to the intensification of domestic production, entrepreneurship and economic growth. The findings of these studies can be useful in identifying strategic priorities, as well as the means to achieve them in the EU regions with a lower level of socio-economic development. A specially developed methodological basis for analyzing the relations between creative, information and knowledge determinants and the economic growth of regions (countries) is still insufficient. However, global and regional indices of innovation, regional competitiveness, talent competitiveness, digital technology competitiveness, territorial development (including the adapted methods by Annoni, Dijkstra & Gargano (2017), Kleibrink & Gianelle (2016), etc.) may be used to some extent for such purposes. However, the obtained data would rather allow ranking regions and economies according to the relevant characteristics, without allowing full assessment of the impact level or grouping regions by the parameters of the contribution of creative, information and knowledge determinants to economic growth. When supplementing the theoretical and methodological basis of the research problem, as well as the use of creative, information and knowledge determinants providing with social transformations of the territories’ economic development, it is important to mention the results of the research within which the forecasting of the regions’ development based on smart specialization was made (Gheorghiu, Andreescu & Curaj, 2016; McCann & Ortega-Argilés, 2015), as well as planning of the conditions, factors and resource provision of the regional policy, in particular the EU, in the analyzed area (Radosevic, Curaj, Gheorghiu, Andreescu & Wade, 2017; Morgan, 2015; Rusu, 2013). Their results are important in summarizing the conclusions of the analysis of the impact of creative, information and knowledge determinants on economic growth, as well as determining the principles of the policy of their involvement while forming and implementing the strategies of regions’ smart specialization.

The *aim* of this study is to develop a complex approach to assessing the creative, information and knowledge determinants of the EU regions' economy transformations with the use of the multivariate regression analysis, a composite method, and strategic structural and functional design. The *novelty* of the paper lies in the substantiation of a prospective of the EU regions' economic growth within smart development strategies involving creativity, information and knowledge-based capital.

2. Methodology

2.1. Theoretical Design of Creative, Information and Knowledge Components of Economic Growth

The methodology for studying the relationship between creative, information, knowledge factors and the social transformations of the EU regions' economy is sufficiently developed in scientific discourse, but the authors hypothesize that in today's dynamic society, creativity, information and knowledge are the drivers of economic growth at the macro- and meso-levels. A certain methodological basis for such an analysis is the normative and methodological recommendations of a number of leading international financial and economic and other organizations, including the World Bank, the European Bank for Reconstruction and Development, the World Economic Forum, the United Nations Industrial Development Organization, the International Alliance and also interstate regional entities, in particular the European Union, the Organization for Economic Co-operation and Development, etc. Thus, at the global level, the analysis of creativity as a factor of economic development is represented by the measures: the Index of Technological Readiness and the level of Innovation Development as the components of the Global Competitiveness Index of the World Economic Forum (*WEF GCI*); the Technology Infrastructure Index as a component of the IMD World Competitiveness Yearbook (*IMD WCY*); the Global Innovation Index (*GII*) of the International Business School INSEAD; the Innovation Capacity Index of the European Business School (*ICI EBS*); the Bloomberg Innovation Index (*BII*); the Global Talent Competitiveness Index (*GTCI*), etc.

In turn, the methodology for analyzing the information and knowledge component of economic growth is quite comprehensively presented by: the World Digital Competitiveness Ranking (*WDCR*); the Knowledge Economy Index (*KEI*); the Intellectual Property Right Index (*IPRI*), etc. Although, so far, the aspect of creativity at this level is still not represented, there have been a number of attempts: the Creative Community Index (*SV-CCI*), USA, 2002; the Hong Kong Creativity Index (*HKCI*), Hong Kong, 2004; the Czech Creative Index (*CZCI*), Czech Republic, 2007; the Composite Index of the Creative Economy (*CICE*), USA, 2008; the European Creativity Index (*ECI*), European Commission, 2009, which, as a rule, were only local in nature or were not limited to a very complete set of characteristics. Today, one of the most comprehensive and sophisticated, although not yet used by official institutions, is the Index of Creativity in the EU Member-States (*CSI*) (Correia & Costa, 2014). Its theoretical design is based on 37 indicators, divided into nine groups: talent; openness of the country; cultural environment and tourism; technology and innovation; development of creativity in industry; regulation and incentives (stimulation of talent development); entrepreneurship; accessibility of the country; livability of the population. At the regional level, relevant ratings are not sufficient due to significant limitations and difficulties in measuring indicators. The most comprehensive among such studies is the EU Regional Competitiveness Index (*RCI*), which includes the indicators of a creative innovation and digital economy (Annoni, Dijkstra & Gargano, 2017). However, the disadvantage of such ratings is that some indicators become available at the regional level, while others are not updated or do not correspond to a single statistical structure. In addition, methodological improvements and changes in NUTS regions make territorial comparisons in dynamics problematic. The methodology of the authors' research of the relationship between creative, information and knowledge factors and the social transformations in the EU regions' economy provides for three successive stages:

Stage 1. Multivariate regression analysis of creative, information and knowledge factors determining social transformations in the EU countries' economy.

Stage 2. Correlation analysis of regional composite indicators of the concentration of digital (ICT) and creative industries and the GDP of the EU regions.

Stage 3. Generalization of the research results and definition of the tools and means to ensure the impact of creative, information and knowledge factors on the social transformations in the EU regions' economy.

2.2. Multivariate Regression Analysis of Creative, Information and Knowledge Factors Determining Social Transformations in the EU Countries' Economy

The use of rating data to analyze the relationship between a number of selected sub-indices and the socio-economic development allows tracking and confirming (refuting) the existence of relations between indicators – the characteristics of creative, information and knowledge factors and the economy's transformations. For this purpose, the numerical scores of the sub-indices of the Global Innovation Index (*GII*, 2019), the Global Talent Competitiveness Index (*GTCI*, 2019) and the World Digital Competitiveness Index (*WDCI*, 2019) of the EU-28 countries for 2016-2018 were used. The selection of those very data allowed presenting the set of creative, information and knowledge factors of development in the best and most complete way. To analyze the availability and density of the relationship between creative, information and knowledge factors and the selected dependent variables, a multivariate regression analysis is used and the initial characteristics of which are given in Table 1.

Table 1

Parameters of the multivariate regression analysis of the relationship between creative, information, knowledge factors and the transformations in the EU economy

<i>Indices</i>	<i>Creative, information and knowledge factors</i>	<i>Variables of socio-economic development</i>	<i>Data and sample</i>
Global Innovation	<i>INST</i> – institutions; <i>HCR</i> – human capital and research; <i>INFRSTR</i> – infrastructure; <i>MARKET</i> – market sophistication; <i>BUSIN</i> – business sophistication; <i>KNTECH</i> – knowledge and technology outputs; <i>CREAT</i> – creative outputs;	<i>GDP</i> – gross domestic product per capita in PPP terms;	Sub-indices scores and dependent variables values by EU-28 countries, 2016-2018
Global Talent Competitiveness	<i>MBL</i> – market, business and labour landscape; <i>ATTR</i> – ability to attract talent; <i>GROWTH</i> – access to growth opportunities; <i>RETAIN</i> – ability to retain highly-skilled professionals; <i>VTS</i> – vocational and technical skills; <i>GKS</i> – global knowledge skills;	<i>INVEST</i> – share of GDP that is used for gross investment; <i>EXP</i> – share of high-tech exports;	
World Digital Competitiveness	<i>KNOWL</i> – knowledge; <i>TECH</i> – technology; <i>RDNS</i> – future readiness	<i>QL</i> – Global Quality of Life Index	

Source: compiled by authors

2.3. Correlation Analysis of Regional Composite Indicators of the Concentration of Digital (ICT) and Creative Industries and the GDP of the EU Regions

The contribution of creative and digital (ICT) industries to the regional development of the EU is investigated using the composite method, having found out the level of their concentration in the regions. However, given the limited statistical base within the standard of territorial division developed by the EU (NUTS), and the lack of clear approaches to assessing the development of new industries, and even more their impact on economic growth, there is a problem of choosing optimal indicators (structural components) to build a composite indicator of the concentration of the studied industries. The composite method aims to clarify the level of the spread of creative and digital (ICT) industries in the EU regions and study their role in shaping the regions' economic potential. The implementation of these goals involves the accomplishment of the tasks:

- formation of a database for the analysis of the components of the composite indicator of the industry concentration in the region (according to the NUTS-2 standard);
- construction of regional composite indicators for digital (ICT) and creative industries;
- grouping of the EU regions according to the concentration level of the studied industries and selection of the most progressive ones;
- analysis of the correlation between regional composite indicators of the concentration of the industries and the GDP to further confirm the dependence of economic growth of the EU regions on the development of new industries (drivers of the economy).

To create a composite indicator of the industry concentration in the region, the three main components are selected:

1. The enterprise concentration level in the industry (the ratio of the number of enterprises in the industry to the total number of economic entities in the region).
2. The share of the employed in the industry in the structure of total employment in the region (the ratio of the number of employed on a regular basis in the industry to the total number of the employed in the region).
3. The share of the industry in the regional economy in terms of wages (the ratio of the wage fund in the industry to the total wage fund in the region).

Thus, the authors propose to calculate the composite indicator of the industry concentration in the region, which considers n components with equal statistical weight by the formulas (1-2).

$$CI_j^t = \frac{\sum_{i=1}^n IND_i^t}{n} \quad (1)$$

$$IND_i^t = UN_j^t + EMP_j^t + WG_j^t \quad (2)$$

In which CI_j^t is the composite indicator of the industry concentration in j -region ($j = \overline{1, m}$);

IND_i^t is the group indicator involving n components at t -time ($i = \overline{1, n}$);

UN_j^t is the level of enterprise concentration in the industry in j -region at t -time (in %);

EMP_j^t is the share of the employed in the industry in j -region at t -time (in %);
 WG_j^t is the share of the industry in terms of wages in j -region at t -time (in %).

The information and analytical basis for the calculations was the official EU statistical database *EUROSTAT* (indicators in terms of the NUTS-2 regions and economic activities, including ICT for 2008-2017) (Eurostat, 2018) and the database of the Center for Strategies and Competitiveness (CSC) – the European Cluster Observatory (indicators by the cluster ‘creative industries’ in terms of the NUTS-2 regions) (ECO, 2015). It is worth noting that the database of the European Cluster Observatory is the only platform where the indicators of the cluster development by the EU regions are collected. However, given that this database was formed as a result of the implementation of the European Commission project in 2004-2013, the database has not been renewed since 2013. Despite these limitations, the proposed data are sufficient to elucidate the most ‘creative’ regions and to identify the relationship between the development of creative industries and the economic growth of the EU regions.

3. Results and Discussion

3.1. Region-Specific Priorities and Initiatives of Smart Specialization Strategies

The strategic orientation within the smart specialization of the EU regions on the application of creative, information and knowledge factors, their involvement to achieve the goals and objectives of the strategies is confirmed by the prevailing focus of the priorities identified in the strategies of smart specialization of the EU regions to provide with changes that are closely related to the use of knowledge capacity, creativity and ICT. A number of the examples of such relations are given in Table 2.

Table 2

Priorities of the strategies of smart specialization of the individual EU regions related to creative, information and knowledge factors

Countries	Regions	NUTS codes	Priorities	Specific targets
Austria	Vienna	NUTS 2: AT13	ICT. Creative industries. Humanities knowledge	Innovative technologies and projects based on a public-private partnership; creative industries development and strengthening; promoting the city as a research and knowledge hub
Belgium	Brussels region	NUTS 1: B1	ICT: digital economy	Big Data, Internet of things, information security, image processing
Spain	Madrid	NUTS 2: ES30	Biotechnology and agricultural products. ICT and services with a high value added	Biotechnology, including plants, microorganisms, bioprocess and food industry; development of applications and content; infrastructure, networks and advanced communications systems
Italy	Emilia-Romagna	NUTS 2: ITH5	ICT and new technologies, cultural and creative industries	ICTs and new technologies; digital platforms and web services for tourism and cultural promotion; new technologies and digital contents for the communication of products and services
Germany	Bavaria	NUTS 1: DE2	Innovation and technology services. Smart materials, nano- and micro-technologies. ICT	Innovative technology-based services; nano- and micro-technology; automatization and robotics; cyber-security, Big Data, cloud computing, robotics for automation, e-Environment, e-Commerce, e-Health, e-Finance, e-Tourism, smart energy and smart construction, digital agriculture
Poland	Lubelskie Voivodeship	NUTS 2: PL31	IT and automation	The use of mechatronics, smart buildings, control systems, industrial automation and mobile application in the value chains of manufacturing, advanced products and production systems and system services in the sectors of software and IT consultancy, information services
Portugal	Centre	NUTS 2: PT16	ICT and electronics. Biotechnology	E-Mobility, e-Health, e-Learning, cloud computing and near-shoring; production and manufacturing, sustainable industrial processes, services, linked to Portugal's leading technological park (BIOCANT)
Romania	West	NUTS 2: RO42	ICT	Activities assisting core production and service sectors with the added value and a high degree of successful knowledge by a competitive resources on software development, design and engineering
France	Burgundy	NUTS 2: FR26	Digital medicine. New transport and mobility technologies	E-Health, drug delivery technologies, preventive medicine; intelligent vehicles, reduction of gas emission, traffic management, electric engines
Finland	Helsinki-Uusimaa	NUTS 3: FI1B	Digital economy sector	Industry renewal by utilizing the opportunities provided by digitalization and ICT, Big Data, new knowledge creation

Source: Smart Specialisation Platform (2020)

To better understand the nature, features and completeness of the place and role of creative, information and knowledge factors in providing the social transformations in the regions' economy under the influence of smart strategies, it is important to identify their composition and structure (Fig. 1). A fairly sound methodological basis for this is the regulatory and methodological recommendations of a number of leading international financial and economic and other organizations, including the World Bank, the European Bank for Reconstruction and Development, the World Economic Forum, the United Nations Industrial Development Organization, the International Alliance and interstate regional entities, in particular the European Union, the Organization for Economic Cooperation and Development, etc.

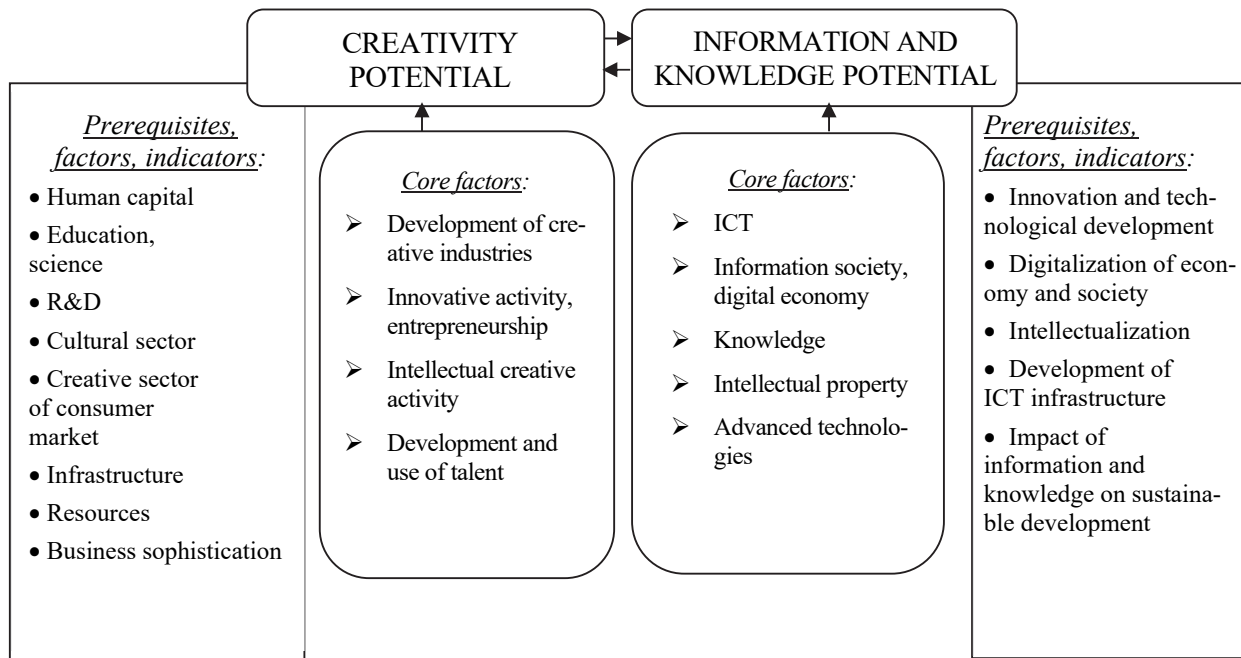


Fig. 1. Creative, information and knowledge factors of the regions' economic development
 Source: authors' elaboration

3.2. Creative, Information and Knowledge Factors Determining GDP per Capita

The multivariate regression analysis is used to analyze the availability and strength of the relationship between creative, information and knowledge factors. Based on results of the analysis, the availability of a statistically significant influence of creative, information and knowledge factors on key integral parameters of the socio-economic development is identified. Thus, the GDP growth is directly influenced by the improvement of the factors by the spheres of development of *innovation* activity (regression model I) – human capital and research (regression coefficient is 1.073), as well as business sophistication (1.644); *talent* development (regression model II) – ability of employers to attract talent (2.3450), the ability to retain highly-skilled professionals (1.2243), the availability of prerequisites for career growth, which are growth opportunities (1.166); development of the *digital* sector (regression model III) – future readiness to create and implement technologies (3.148). The inverse relationship between the analyzed regressors (knowledge (-1.382), advanced technologies (-0.553)) is identified. The reliability coefficients of the variables are given in Table 3.

Table 3

The availability and strength of the relationship between factor-regressors (creative, information and knowledge) and GDP per capita

Variables	Beta	Std. Err. of beta	b	Std. Err. of b	t-statistics	p-value
HCR	0.4177	0.0717	1.0733	0.1842	5.8277	0.0000
BUSIN	0.5401	0.0717	1.6435	0.2181	7.5363	0.0000
MBL	-0.4749	0.1219	-1.7767	0.4561	-3.8955	0.0002
ATTR	0.7478	0.1091	2.3450	0.3421	6.8553	0.0000
GROWTH	0.4101	0.1025	1.1958	0.2989	4.0004	0.0001
RETAIN	0.2364	0.0886	1.2243	0.4586	2.6694	0.0092
KNOWL	-0.3982	0.1481	-1.3822	0.5140	-2.6891	0.0087
TECH	-0.1804	0.1272	-0.5532	0.3900	-1.4184	0.1600
RDNS	1.3234	0.1237	3.1484	0.2944	10.6956	0.0000

Regression model I: with **innovation** factors $GDP_I = -3.139 + 1.073HCR + 1.644BUSIN_{adj.R^2 = 0.729DW = 1.81}$

Regression model II: with **creativity** factors $GDP_{II} = -3.829 - 1.777MBL + 2.345ATTR + 1.196GROWTH + 1.224RETAIN_{adj.R^2 = 0.788DW = 1.46}$

Regression model III: with **information** (digital) factors $GDP_{III} = -0.840 - 1.382KNOWL - 0.553TECH + 3.148RDNS_{adj.R^2 = 0.734DW = 1.13}$

3.3. Creative, Information and Knowledge Factors Determining the Share of Gross Investment

The availability of a relationship between knowledge development, creativity and information technologies and the quality of investment activity is identified too. In particular, the share of GDP that is used for gross investment is direct correlation by the improvement of such factors in the field of *innovation* (regression model I) as support institutions (1.3594) and innovation

infrastructure (0.5539), knowledge and technology outputs (0.2476); *talent* competitiveness (regression model II) – market, business and labor landscape (0.8563), vocational and technical skills (0.2903); development of the *digital* sector (regression model III) – up-to-dateness of technology (0.3502) (Table 4). Herewith, the authors revealed the inverse relationship between the share of gross investment in GDP and the factors such as human capital and research, the market sophistication, creative outputs, ability to retain highly skilled professionals, which may be due to the need to direct investment immediately to the training and development of talent, stimulating creativity and forming new knowledge. The reliability coefficients of the variables are given in Table 4. It is important to use creative, information and knowledge factors to strengthen the economy's technological competitiveness, one of the key indicators of which is the importance of the share of high-tech exports.

Table 4

The availability and strength of the relationship between factor-regressors (creative, information and knowledge) and the share of gross investment in GDP (*INVEST*)

Variables	Beta	Std. Err. of beta	b	Std. Err. of b	t-statistics	p-value
<i>INST</i>	0.7252	0.1845	1.3594	0.3459	3.9298	0.0002
<i>HCR</i>	-0.4004	0.1390	-0.2978	0.1033	-2.8813	0.0051
<i>INFRSTR</i>	0.3425	0.1337	0.5539	0.2163	2.5612	0.0124
<i>MARKET</i>	-0.2738	0.1354	-0.3066	0.1517	-2.0217	0.0467
<i>KNTECH</i>	0.3747	0.1345	0.2476	0.0889	2.7863	0.0067
<i>CREAT</i>	-0.4231	0.1492	-0.4125	0.1455	-2.8352	0.0058
<i>MBL</i>	0.7960	0.1519	0.8563	0.1634	5.2399	0.0000
<i>RETAIN</i>	-0.6093	0.1536	-0.9005	0.2270	-3.9677	0.0002
<i>VTS</i>	0.2726	0.1098	0.2903	0.1169	2.4832	0.0151
<i>TECH</i>	0.3976	0.1013	0.3502	0.0893	3.9239	0.0002
Regression model I: with innovation factors	$INVEST_I = -0.925 + 1.359INST - 0.298HCR + 0.554INFRSTR - 0.307MARKET + 0.248KNTECH - 0.413CREAT$ $adj.R^2 = 0.364$ $DW = 1.60$					
Regression model II: with creativity factors	$INVEST_{II} = 0.89 + 0.856MBL - 0.901RETAIN + 0.2903VTS$ $adj.R^2 = 0.331$ $DW = 1.84$					
Regression model III: with information (digital) factors	$INVEST_{III} = 0.670 + 0.350TECH$ $adj.R^2 = 0.148$ $DW = 1.32$					

3.4. Creative, Information and Knowledge Factors Determining the Share of High-Tech Exports

This is confirmed by the availability of a steady direct correlation of the following factors (Table 5): innovation infrastructure (1.1149), business sophistication (0.7602), knowledge and technology outputs (0.5622) (regression model I with *innovation* factors); market, business and labour landscape (1.2119), vocational and technical skills (0.7503) and global knowledge skills (0.7610) (regression model II with *creativity* factors); future readiness to create digital technologies (0.6389) (regression model III with *information* (digital) factors). However, the inverse relationship of factors (human capital and research, ability to retain highly skilled professionals) on the share of high-tech exports is also identified. To some extent, this is due to a certain focus of business on the commercialization of technological innovations in the domestic market.

Table 5

The availability and strength of the relationship between factor-regressors (creative, information and knowledge) and the share of high-tech exports (*EXP*)

Variables	Beta	Std. Err. of beta	b	Std. Err. of b	t-statistics	p-value
<i>HCR</i>	-0.2568	0.1180	-0.5592	0.2570	-2.1759	0.0325
<i>INFRSTR</i>	0.2354	0.1291	1.1149	0.6116	1.8229	0.0721
<i>BUSIN</i>	0.3007	0.1828	0.7602	0.4622	1.6447	0.1040
<i>KNTECH</i>	0.2905	0.1653	0.5622	0.3199	1.7573	0.0827
<i>MBL</i>	0.3848	0.1849	1.2119	0.5824	2.0808	0.0407
<i>RETAIN</i>	-0.3285	0.1665	-1.4217	0.7205	-1.9732	0.0519
<i>VTS</i>	0.2407	0.1183	0.7503	0.3688	2.0344	0.0453
<i>GKS</i>	0.2913	0.1479	0.7610	0.3864	1.9695	0.0524
<i>RDNS</i>	0.3188	0.1047	0.6389	0.2098	3.0456	0.0031
Regression model I: with innovation factors	$EXP_I = -2.141 - 0.559HCR + 1.115INFRSTR + 0.760BUSIN + 0.562KNTECH$ $adj.R^2 = 0.344$ $DW = 2.10$					
Regression model II: with creativity factors	$EXP_{II} = -1.14 + 1.212MBL - 1.422RETAIN + 0.750VTS + 0.761GKS$ $adj.R^2 = 0.257$ $DW = 2.16$					
Regression model III: with information (digital) factors	$EXP_{III} = -1.143 + 0.639RDNS$ $adj.R^2 = 0.910$ $DW = 1.52$					

3.5. Creative, Information and Knowledge Factors Determining the Quality of Life Index

There is also the impact of information, knowledge, innovation technology and creativitization on social development parameters. Thus, according to the results in Table 6, there is a statistically significant direct relationship between *innovation* factors and the growth of the quality of life index (regression model I), such as support institutions (0.8446), knowledge and technology outputs (0.1013) and creative outputs (0.1787); *talent* competitiveness factors (regression model II) – ability to attract talent (0.1483), access to growth opportunities (0.2796) and ability to retain highly-skilled professionals (0.2132); *digital*

economic development (regression model III) – digital knowledge (0.3334) and future readiness to create digital technologies (0.2421). There is also an inverse relationship between the dependent variable (quality of life index) and factors of the market sophistication (in the context of intensifying innovation activity), business sophistication, global knowledge skills, and digital technology. This situation may be the evidence of uneven development of business digitalization and business technologies, their use for commercial purposes, on the one hand, and development of information society, the direction of modern digital technologies in all areas of a social system, social defence, support and assistance, social security, on the other hand. The reliability coefficients of the variables are given in Table 6.

Table 6

The availability and strength of the relationship between factor-regressors (creative, information and knowledge) and the quality of life index (*QL*)

<i>Variables</i>	<i>Beta</i>	<i>Std. Err. of beta</i>	<i>b</i>	<i>Std. Err. of b</i>	<i>t-statistics</i>	<i>p-value</i>
<i>INST</i>	0.6589	0.1553	0.8446	0.1991	4.2416	0.0001
<i>HCR</i>	0.4251	0.1064	0.2162	0.0541	3.9963	0.0001
<i>MARKET</i>	-0.2162	0.1037	-0.1656	0.0794	-2.0849	0.0404
<i>BUSIN</i>	-0.5485	0.1741	-0.3239	0.1028	-3.1505	0.0023
<i>KNTECH</i>	0.2242	0.1292	0.1013	0.0584	1.7355	0.0867
<i>CREAT</i>	0.2680	0.1169	0.1787	0.0780	2.2918	0.0247
<i>ATTR</i>	0.2391	0.1532	0.1483	0.0950	1.5607	0.1226
<i>GROWTH</i>	0.4932	0.1439	0.2796	0.0816	3.4272	0.0009
<i>RETAIN</i>	0.2110	0.1290	0.2132	0.1303	1.6356	0.1059
<i>GKS</i>	-0.1960	0.1219	-0.1195	0.0744	-1.6073	0.1111
<i>KNOWL</i>	0.4871	0.2058	0.3334	0.1409	2.3667	0.0204
<i>TECH</i>	-0.3131	0.1772	-0.1886	0.1067	-1.7671	0.0810
<i>RDNS</i>	0.5173	0.1724	0.2421	0.0807	3.0011	0.0036
<i>Regression model I: with innovation factors</i>	$QL_I = 0.61 + 0.845INST + 0.216HCR - 0.166MARKET - 0.324BUSIN + 0.101KNTECH + 0.179CREAT$ <i>adj.R² = 0.618 DW = 2.32</i>					
<i>Regression model II: with creativity factors</i>	$QL_{II} = 1.276 + 0.148ATTR + 0.280GROWTH + 0.213RETAIN - 0.120GKS$ <i>adj.R² = 0.529 DW = 1.49</i>					
<i>Regression model III: with information (digital) factors</i>	$QL_{III} = 1.51 + 0.333KNOWL - 0.189TECH + 0.242RDNS$ <i>adj.R² = 0.487 DW = 1.49</i>					

Thus, there are grounds to confirm the hypothesis of much higher efficiency of a regional policy in case of considering and involving creative, information and knowledge factors while forming and implementing the strategies of smart development of territories. In particular, economic growth (measured by GDP) is directly affected by the development of human capital, close cooperation of business with the sector of innovation and research, the focus of enterprises on the ability to attract talent, the comprehensive digitalization of economy. The quality of the investment environment and export orientation on the high-tech products (services) are mainly determined by the innovation environment and infrastructure, factors of the development and use of talent, the design of digital technologies of the future. The improvement of life quality is influenced by the active development of innovation support institutions, the formation and retaining of human capital, increasing volumes of the intellectual and creative performance of researchers, the innovation and technological activity of enterprises, development and use of talent, in particular, directly at enterprises, the creation and implementation of information knowledge and digital technology.

3.6. Concentration of Digital (ICT) and Creative Industries in the EU Regions

The contribution of creative and digital (ICT) industries to the regional development of the EU is confirmed by the use of the composite method, having found out the level of their concentration in the regions. The summary results of the analysis of the level of concentration of digital (ICT) and creative industries in the EU regions are given in Fig. 2 and Fig. 3. By dividing the EU regions (273 units) into four groups according to the criterion of the average value of aggregate (4.73% in 2017), the areas with different concentration of ICT industries are distinguished. The groups with low (96 regions) and below average (78 regions) values of the composite indicator are the most numerous. The most active in the context of the development of digital industries are the capitals of European countries (London, Stockholm, Prague, Berlin, etc.) and some regions with the level of ICT concentration from 11% to 18%. The main ‘digital’ leaders among the countries are the United Kingdom, Sweden, Luxembourg, Ireland, Malta and Denmark. So, in particular, the British ICT market is represented by numerous enterprises in the field of geo-location, financial technologies and the production of microchips for smart phones (Skyscanner, Fanduel, Performance Horizons, ImpulsePay, ARM Holdings). At the same time, the main ‘outsiders’ have turned out to be Spain, Italy, Greece and Portugal, where the concentration of digital industries in the economy on average is less than 4%. Along with the total digitalization of the EU regions, the creative sector is developing rapidly, which determines the economic growth of both individual territories and Europe as a whole, as it is a source of innovation and non-standard solutions. The level of the concentration of creative industries in the EU regions (for the 138 surveyed territories) on average reached 8.31% in 2013. According to the study findings, the most ‘creative’ regions are Stockholm, Prague, the Danish capital region, Berlin, Vienna, Helsinki-Uusimaa, Bratislava Region, Mazowieckie Voivodeship and others (the level of concentration of the creative sector

for this group ranged from 12.80% to 26.04% in 2013). The lowest rates of creativitization are found in some regions of Portugal (Autonomous Region of the Azores, Northern Portugal), France (Picardy, Limousin, Lorraine), Romania (Southern Romania, South-Western Romania), Spain (all the regions except the Balearic Islands). These territories form the fourth group with a low level of concentration of creative industries (0.89% – 5.61% in 2013) and, accordingly, low innovation opportunities.

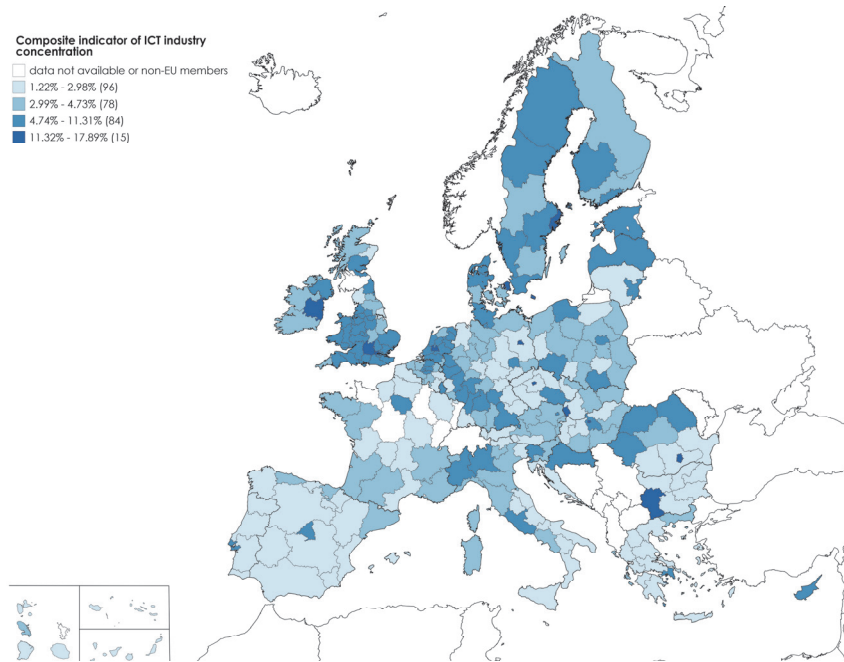


Fig. 2. Level of the concentration of ICT industry in NUTS-2 regions in 2017 (composite evaluation)
Source: authors' calculations based on the Eurostat database (2018), created with mapchart.net

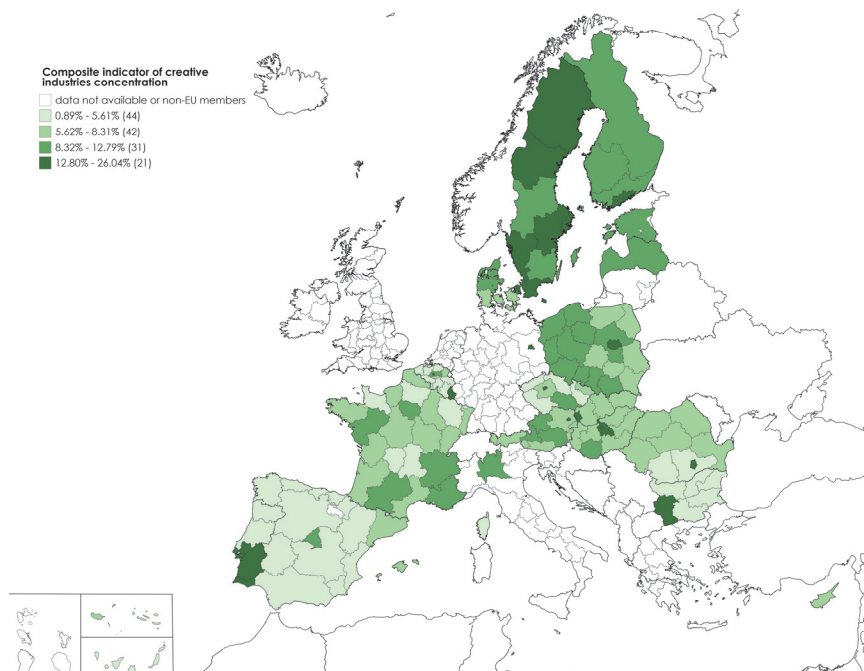


Fig. 3. Level of the concentration of creative industries in NUTS-2 regions in 2013 (composite evaluation)
Source: authors' calculations based on the data from the European Cluster Observatory (2015), created with mapchart.net

To confirm the hypothesis of the dependence of the economic growth of the EU regions on the development of new industries (digital and creative ones), the analysis of the correlation relationship between the regional composite indicators of the industry concentration (*CI*) and GDP by the EU regions is shown in Fig. 4(a), (b).

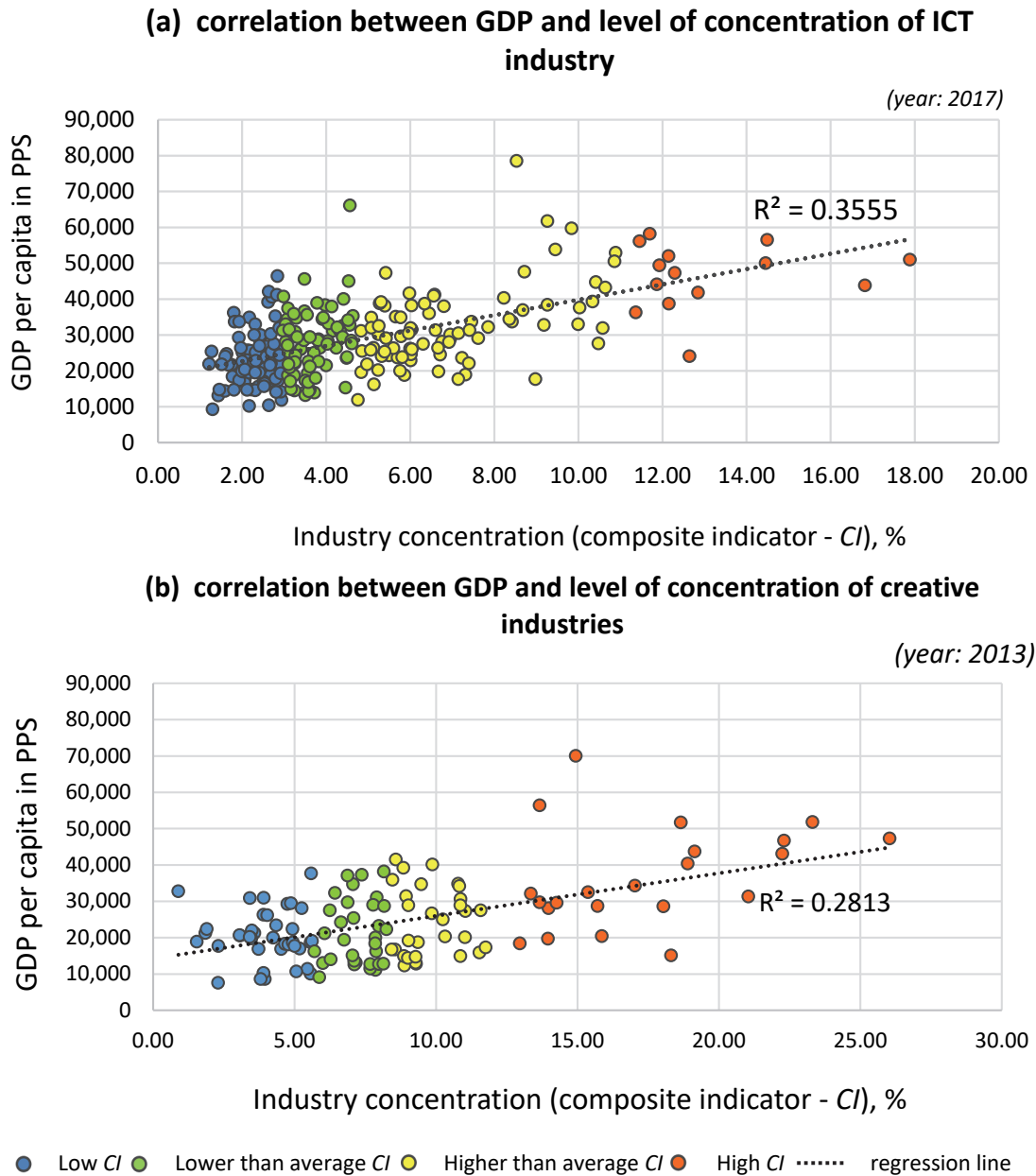


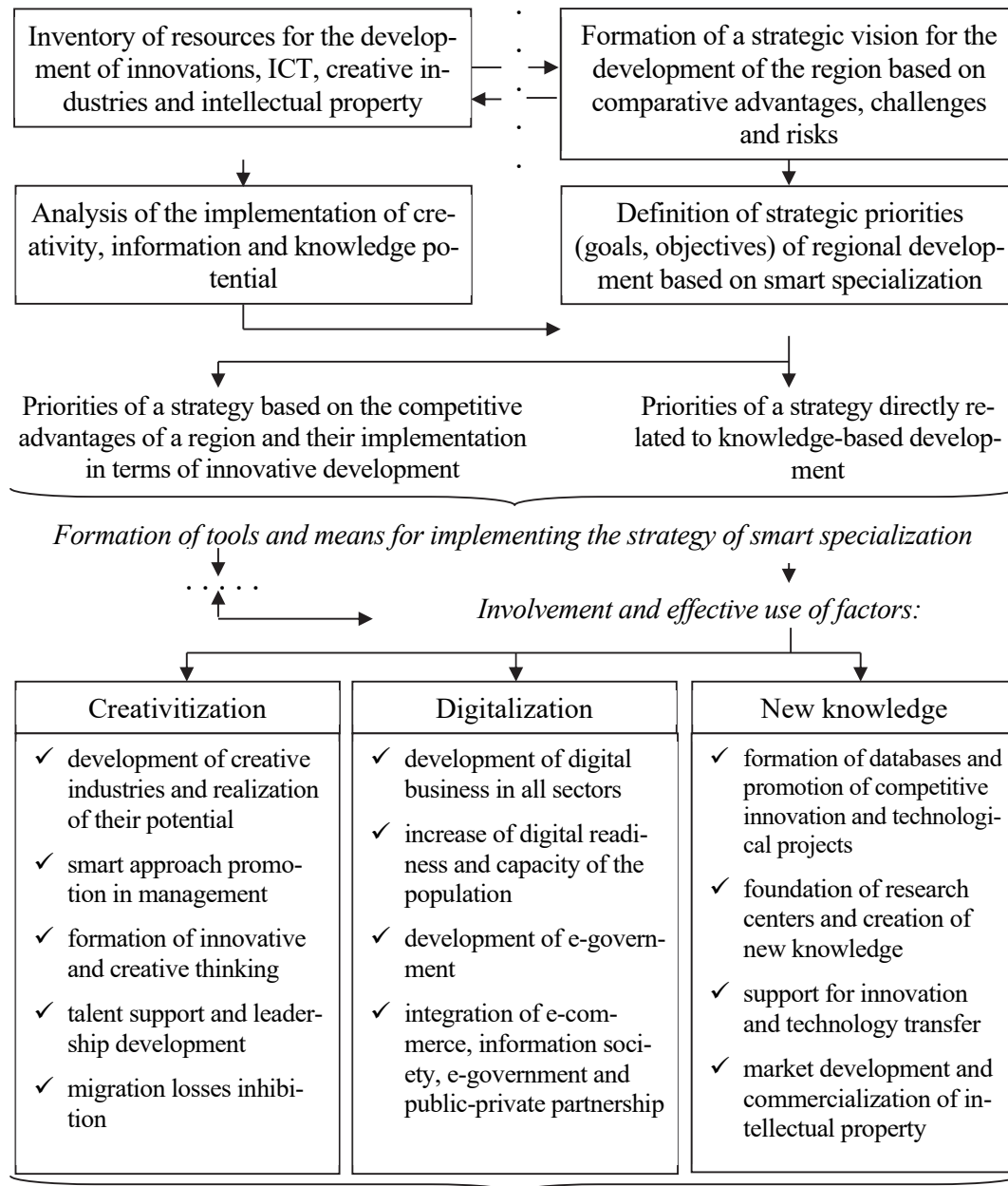
Fig. 4. Results of the correlation analysis of the regional CI of the concentration of digital (ICT) and creative industries and GDP per capita in PPS (NUTS-2 regions)

The correlation analysis results presented in the scattering diagrams confirm the availability of a noticeable relationship between the studied variables (by the Chaddock scale). As for the ICT industries, the relationship strength with the GDP is approx. 0.60, and for the creative industries, the correlation coefficient is 0.53. In both cases, there is a direct relationship. Thus, the analysis results empirically confirm the close relationship and influence of creative, information and knowledge factors on social transformations in regional economies; the studied industries are modern drivers of the EU regions' economy and form new factors of the economic growth of European countries in general.

Given the availability of quite a close confirmed relationship between the involvement of creative, information and knowledge factors and the achievement of the priorities and objectives of smart strategies in the EU regions, the task of their consideration in regulatory and methodological support and practical approaches to the strategic planning of regional development in the EU is of great relevance.

3.7. Development of Strategies for the Regions' Smart Specialization

It is fundamentally important that at the stage of the formation of a strategic vision of the region's development based on comparative advantages, challenges and risks, the analysis of the state and resource support (intellectual, financial and investment, material and technical, information and technological, infrastructural) of the development of innovation activities, the ICT sector, creative industries, the intellectual property market in the region should be carried out.



Implementation of smart strategies for regional development based on the principles of national and regional research and innovation strategies for smart specialization in EU

Fig. 5. Creative, information and knowledge factors while forming and implementing strategies for the regions' smart specialization

Source: authors' elaboration

This is necessary given the definition of potential and the extent of its implementation at the current stage of socio-economic development, as well as possibilities to use the factors of creativitization, knowledge, information technologies, etc. while implementing the priority tasks and strategic goals of further regional development. Thus, the availability of creativity potential and information and knowledge potential, their specifics can, firstly, directly determine the priority fields of the regional development, and secondly, form the core of the tools for implementing the priorities of a regional development strategy,

including those based on traditional competitive advantages of the region, and those that have creative, innovative and technological prerequisites. Accordingly, in the measures of the realization of regional development strategies, due role should be given to a regional policy implemented in the directions of: (1) creativitization, (2) digitalization, (3) new knowledge. This approach will allow making a full use of the opportunities of creative, information and knowledge factors as the most capable drivers of the social transformations in regional economies (Fig. 5). In terms of the creativitization of a regional economy, one of the leading roles is given to the development and implementation of regional and local programs to support the development of creative industries, to form and use the potential of youth and talent. In this regard, attention should also be paid to the implementation of organizational and economic measures aimed at regulating youth migration through the introduction of the programming of a regional migration policy, improving the monitoring and analytical support of the migration management, the preparation and implementation of interstate educational, research and business projects, the stimulation of entrepreneurial and innovative activities of youth, the improvement of the institutional infrastructure of forming young talent competitiveness.

Under any circumstances, the strategic guidelines for the development of regional economies must be objectively coordinated with their widest possible digitalization. The information society, digital business, e-government and their cooperation on single digital platforms are a modern reality, and the innovations in the field of digital technologies accelerate the growth and improvement of life quality; the development of information technologies creates new types of economic activity, opens new markets and products. Therefore, within the implementation of regions' smart specialization strategies, a number of leading measures should relate to the development of digitalization processes in all sectors of the economy, and should be based on public and private partnership of the government, business and society. An effective integrative means of using the creativity potential and information and knowledge potential is the creation and functioning of research centers and the production of new knowledge. Such centers are developed, as a rule, on the basis of leading universities and research organizations, IT clusters, and other local integrated structures specializing in the research and development of advanced, including digital, technologies, technological innovations. Centers for the research and creation of new knowledge simultaneously serve as places for the allocation of business and innovation activities, intellectual creative activities and the commercialization of intellectual property results, the implementation of start-ups in the field of ICT and digital technologies, smart services, including social sphere, urban infrastructure, transport, etc. The practice of introducing creative, information and knowledge factors into the criteria of quality assessment, as well as into normative and methodical recommendations on monitoring the fulfillment of measures and implementation of smart specialization strategies in the EU regions should become effective and efficient.

4. Conclusions

The use of creative, information and knowledge determinants while forming and implementing smart specialization strategies in the EU regions can significantly increase their efficiency; in particular, it has a positive effect on the GDP, the investment attractiveness of regions, export volumes and life quality. This is proved using the authors' methodology, which involves identifying the factor influence of creative, information and knowledge factors on the social transformations of the EU economy through carrying out the multivariate regression analysis, the evaluation of correlation between regional composite indicators of the concentration of digital (ICT) and creative industries and GDP of NUTS-2 regions, the development of tools and means of the strategic support of the smart-oriented transformations in the EU regions' economy based on creative, information and knowledge determinants. Thus, regression modeling is used to analyze the availability and strength of the relationship between dependent variables (regions' social and economic outcomes) and creative, information and knowledge factors. It is ascertained that the development of human capital, a close cooperation of business with the innovation and research sector, the focus of enterprises on the development and use of talent, the economy's comprehensive digitalization have a direct positive impact on economic growth (GDP). The investment environment quality and export orientation on the high-tech products (services) are mainly determined by the environment and innovation infrastructure, the environmental factors of talent development and use, the design of digital technologies of the future. The improvement of life quality is influenced by the active development of innovation support institutions, the formation and retaining of human capital and increasing volumes of the intellectual and creative performance of researchers and the innovation and technological activities of enterprises, development and use of talents, the creation and implementation of information knowledge and digital technologies. The contribution of creative and digital (ICT) industries to the regional development of the EU is confirmed by the application of the composite method and calculations of their concentration level in the regions. To confirm the hypothesis of the dependence of the economic growth of the EU regions on the development of new industries (digital and creative ones), the analysis of a correlation relationship between the regional composite indicators of the industry concentration and GDP by the EU regions is carried out. The correlation analysis results presented in the scattering diagrams confirm the availability of a noticeable relationship between the studied variables. As for the ICT industries, the relationship strength with the GDP is 0.60, and for the creative industries, the correlation coefficient is 0.53 (direct relationship in both cases). Thus, the analysis results empirically confirm the close relationship and influence of creative, information and knowledge factors on the social transformations of regional economies; the studied industries are modern drivers of the regions' economy and form new factors of the economic growth of European countries in general.

Given the availability of quite a close confirmed relationship between the involvement of creative, information and knowledge factors and the achievement of the priorities and objectives of smart specialization strategies in the EU regions, the task of taking them into account in regulatory and methodological support and practical approaches to the strategic planning of regional development in the EU is actualized. At the same time, it is appropriate to separate the whole set of strategic tools depending on the support of creativitization, digitalization, new knowledge acquisition while taking into account the system of principles of strengthening the smart-oriented development of territories.

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