Knowledge Management and Economic Growth: The Assessment of Links and Determinants of Regulation

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Abstract

Purpose: In order to make an informed choice of the most effective tools for ensuring the development of a competitive economy, it is important to take into account the links between macroeconomic indicators of progress and the most important components of knowledge management. In this regard, the aim of our study is to assess the relationship between knowledge management factors and economic growth in order to select the factors that most determine the positive changes in Gross national income per capita.

Methodology/results: As a result of the systematization of the main international indices, which use knowledge management factors and the authors' correlation analysis of their relationships with GNI per capita, conclusions are made about the greatest effectiveness at the present stage of action, which results in skills development (such as the ability to work with new technologies and with people, flexibility and cooperation), innovative capacity, access to information and means of communication.

Findings: The perception of these factors as determinants of economic development and the appropriate direction of the levers of economic policy will result in achieving the greatest economic efficiency on the basis of the development of the knowledge economy.

Keywords: knowledge economy, economic growth, GNI per capita, knowledge management.

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Introduction

In the light of current trends for the general strengthening of knowledge factors' influence on economic development, the modern economy is increasingly being analyzed through the prism of such concepts as "knowledge economy," "digital economy," "creative economy." Obtaining and using relevant knowledge today is a competitive advantage for organizations, industries, and economies in general. At present, knowledge acts both as a necessary factor of production and as an independent product. At the same time, effective knowledge management is a powerful factor in the high level of economic development of the world. In order to take full advantage of this opportunity, countries should focus on the following five main aspects (UNDP, 2019): education (focus on curriculum quality, orientation on new technologies); research, development, innovation, and science (skills/knowledge of researchers and organizations to stimulate the development of new technologies and the formation of necessary skills in the future); technologies (providing a high level of technological infrastructure and ICT needed to share knowledge, promoting the development of new technologies and teaching methods); economy (as a source of financial resources for the introduction of new technologies); favorable environment (organizational support for entrepreneurship development and innovation). These elements are an integral part of the concept of knowledge management, so knowledge growth is a crucial determinant of economic growth.

However, such assessments of knowledge's impact at the macroeconomic level are complicated by dynamic changes in knowledge management, along with the emergence of new opportunities. Despite the steep development of efficient entrepreneurial knowledge management systems and employment practices, the support that aims at attracting highly skilled employees – described by Oliinyk et al. (2021) as the scientific justification of knowledge management factors – influences economic growth with some information inconsistencies. They are caused by too generalized information base on the macroeconomic level. Such a research is conducted mainly based on the use of composite indices, which to varying degrees consider factors of knowledge and innovation as a result of knowledge management in relation to the competitiveness of the economy (Poór et al., 2018). Incomplete information at the macroeconomic level is compensated by research on the level of knowledge's impact on business efficiency and scaling of obtained dependencies so as to understand patterns of macroeconomic processes. Researchers have proven the strengthening of the influence of knowledge factors on economic growth due to the influence of information and communication

technologies (Rymarczyk, 2020), the quality of knowledge management (Ulewicz and Blaskova, 2018; Atkociuniene, Mikalauskiene, 2019; Fitri et al., 2019; Limba et al., 2020; Novikova et al., 2020; Podra et al., 2020), including in Industry 4.0 (Ungerman et al., 2018; Písař, Tomášková, 2020; Portna et al., 2021; Rymarczyk, 2021), and as a component of economic development infrastructure (Dinh, 2020; Yousif et al., 2020; Bogdan, Lomakovych, 2021).

To consider components of knowledge management is currently part of the main indices that characterize economic progress: Global Competitiveness Index, Global Skills Index, or Global Knowledge Index. As a source of information in this study we used the results of international generalizations of dynamics and knowledge management results presented in analytical reports on the dynamics and components of these and other indices related to knowledge management. Thus, our work seeks to assess the relationship of knowledge management factors with the results of economic growth to select the factors that most determine the positive macroeconomic changes.

The paper is organized in four sections: the literature review substantiates current research perspectives on knowledge management in relation to economic growth; this is the basis for our choice of factors and substantiation of methodological bases for evaluating their connections in section two, with the presentation of results in the third section of the study. The fourth section concludes what can be used as a basis for developing recommendations for improving knowledge management to promote macroeconomic growth.

Literature Review

Economic growth is a complex category influenced by such various factors as politics, social issues, and financial matters. Boldeanu and Constantinescu (2015) claim that economic growth is affected by direct factors such as human resources (increase in the active population, investment in human capital), natural resources (land, water, fossil fuel), increase in fixed capital, and technological progress. Moreover, there is the influence of indirect factors such as institutions, the magnitude of aggregate demand, interest on deposits, investment rates, the efficiency of the financial system, budgetary and fiscal policies, labor and capital migration, and government efficiency.

Simultaneously with the spread of intellectualization of the global economy and its active digitalization, knowledge is increasingly becoming important in achieving eco-

nomic stability. Although the role of knowledge management in economic development is obvious, many issues in this area remain unexplored. Scholars pay not enough attention to determining the impact of knowledge management on macroeconomic indicators, which currently are the main ones in the process of assessing economic growth. These issues are considered by researchers using cases of countries with different economic development and dynamics of progress (Bryl, 2018; Chlebisz, Mierzejewski, 2020; Kitrar, Lipkind, 2021). The existing scientific and methodological developments are more related to the study of the relationship between the individual components of knowledge management and economic growth. In this aspect, Kalashi et al. (2020) prove a significant positive impact of the application of information and communication technology skills on the process of knowledge management. To confirm this thesis, Adam (2020) considers four elements: ICT development, e-government development, institutional quality, and economic development. The development of ICT is measured by the ICT Development Index, which is based on ICT indicators grouped into three clusters: access, use, and skills. The obtained results allow us to state that country development in the field of ICT is positively related to its economic development and can lead to economic growth.

The impact of ICT on economic growth has been confirmed at various hierarchical levels (Takhtravanchi, Pathirage, 2018; Bilan et al., 2019; Suknunan, Maharaj, 2019; Polyakov et al., 2020). The authors use data of correlation analysis and modeling of the impact of ICT factors on the main financial results and prove that sustainable socioeconomic growth has acquired the features of constant digital development. Given the current trends in the development of ICT in business and their relationship with financial results, our study proposes the main measures that should be aimed primarily at expanding Internet access and the effective use of web technologies, especially in the field of e-commerce.

Moreover, we should emphasize the studies that confirm the significant relationship between knowledge management and other aspects and performance indicators. These include the significant positive impact of knowledge management on regional development (Klimuk, 2019; Kostiukevych et al., 2020), organizational performance (Majid and Mahmud, 2019; Soniewicki and Paliszkiewicz, 2019; Wijaya and Suasih, 2020), marketing effectiveness (Raeeszadeh et al., 2016), resource planning (Akimova et al., 2020), and the improvement in the quality of supply chains and creating competitive advantages (Azizi et al., 2016; Karpenko et al., 2017; Haseeb et al., 2019). Askarian and Abdollahi (2016) found in their study that there is a significant relationship between knowledge management and organizational behavior.

Quantitative analysis also demonstrates the relationship between knowledge management capabilities, processes, and organizational performance. The opportunities created by knowledge management have a significant positive impact on operational processes, but also on financial and non-financial indicators (André Luhn et al., 2017). At the same time, the shortage of skilled workers slows down business development and leads to additional costs for human capital development (Grishnova et al., 2019; Bilan et al., 2020; Oliinyk, 2020). In this regard, we must indicate the significant links between knowledge sharing and organizational culture, but also between organizational structure and knowledge management (Chión et al., 2019).

The above overview confirms the opinion that knowledge management is an important factor in economic development. At the same time, one of the most important tasks of the organization is the formation of employees' relevant skills and competencies to achieve planned business goals. From this viewpoint, scholars find that knowledge management tools have a significant positive impact on the work activity of employees (Raeeszadeh et al., 2016). The study analyzes some aspects of knowledge management such as hires, employee work competencies, mentors' roles, motivation, employee management, communication, favorable working environment, and human capital investments. Raeeszadeh et al. (2016) determine that each of these elements has a significant positive impact on employment and employee involvement.

Besides, knowledge management can increase the job satisfaction of individual employees. Kianto et al. (2016) propose a theoretical model that relates to the relationships between job satisfaction and five components of knowledge management (acquisition, exchange, creation, codification, and retention). The presence of knowledge management processes in the workplace significantly affects the growth of job satisfaction. The key process is the internal organizational exchange of knowledge.

Masa'deh et al. (2019) explore the role of technological, organizational, and cultural knowledge management infrastructure in increasing job satisfaction. The results show that the technological and cultural infrastructure of knowledge management has a significant positive impact on job satisfaction, as technology is one of the tools that contribute to the creation of new knowledge using information and communication systems in order to integrate fragmented information flows and technologies. This removes communication barriers between different structural units of the organization.

In the process of analysis, one cannot neglect scientific developments that allow assessing the impact of knowledge management on innovation, because innovation activity is one of the key factors that ensures sustainable competitiveness in modern conditions.

Therefore, increasing the efficiency of innovation is critical to creating a competitive advantage. The results obtained by Inkinen (2016) and Klopova et al. (2018) evidence that the implementation of knowledge management practices strongly drives innovation. Moreover, specific leadership characteristics and organizational arrangements support competitiveness through the better management of knowledge resources.

Therefore, the availability of information and knowledge can be identified as one of the best ways to increase the innovative capacity of organizations. In this regard, the role of leadership in knowledge management and organizational innovation development is growing (Bannay et al., 2020). Sadeghia and Rad (2018) investigate the relationship between knowledge-based leadership, knowledge management, and innovation efficiency. Data analysis and hypothesis testing prove a significant relationship between these three measures. In particular, there is a positive and meaningful relationship between knowledge management and innovation efficiency with a correlation coefficient of 0.73.

Obeidat et al. (2016) prove the impact not only of the whole system but also of individual processes of knowledge management (acquisition, exchange, and use) and approaches to knowledge management (social network, codification, and personalization) on innovation. The knowledge management studies within the results of knowledge sharing are typical not only for the national but also entrepreneurial level (Tvaronaviciene, Burinskas, 2021). Particularly, what develops steadily is the practice of ICT-based personnel selection tools in the framework of firms' knowledge management systems (Balcerak, Woźniak, 2021).

Within the study of existing approaches to assessing the impact of knowledge management on economic growth, an important place is occupied by the category of "knowledge economy," which acts as a new type of economy based on knowledge and ideas, while the most important factor of development and prosperity is knowledge capitalization. The Organization for Economic Cooperation and Development (OECD, 1996) has introduced the following definition into scientific circulation: a knowledge economy or a knowledge-based economy is an economy that is directly based on the creation, distribution, and use of knowledge and information. Thus, knowledge management emerged as a necessity in a post-industrial society and a new knowledge economy. Changes in the structure of the economy and its important assets led to a new type of economy, in which the scarcity of material resources was replaced by the sufficiency of intangible resources, while economic theories of resource optimization and profit maximization were brought in line with knowledge creation and business sustainability (Vovk et al., 2017; Bolisani and Bratianu, 2018).

Simplice et al. (2020) prove that developing countries can accelerate their development and catch up with advanced economies by identifying knowledge as a driver of development. It is based on this approach that they assess the potential of knowledge and its impact on economic progress. Given the close relationship between the individual elements of the knowledge economy, the results of the study demonstrate the positive impact of the interaction between them on economic growth. This agrees with the findings of Roszko-Wójtowicz and Grzelak (2020) about the positive impact of the components that characterize knowledge management in the Global Competitiveness Index and the EU Regional Competitiveness Index on macroeconomic stability. The significant macroeconomic effect of innovation in the system of factors of the knowledge economy is also confirmed in studies of competitiveness factors of the Visegrád Group countries (Ivanová and Čepel, 2018).

Van Dung et al. (2017) also consider the role of different components of the knowledge economy in economic growth. Using the Driscoll-Krai estimation method, regression analysis, and the three-stage least squares method, they argue that there is a positive relationship between economic growth and components of the knowledge economy such as ICT infrastructure, education, and innovation.

Thus, in recent decades, the topic of the knowledge economy has become increasingly popular in academia and business, as it is viewed as a major source of economic growth and sustainable competitiveness in all economic activities. As a result, the main drivers of economic growth are the following main elements (pillars) of the knowledge economy: incentives for economic and institutional development; educated and skilled workers who can contribute to the creation and dissemination of knowledge; an adequate system of innovations able to cover the globalized stock of knowledge, understand it, and adapt to specific regional/local conditions; modern information infrastructure that allows people to communicate, transmit, and process information and knowledge (Hadad, 2017).

Data and Methodology

To study the links between knowledge management and economic growth, we formed and tested the following *hypotheses*:

H1: The high level of knowledge management factors development leads to GNI per capita growth.

H2: The factors that characterize the possession of current skills have a significant impact on changes in GNI per capita.

Basing on the above hypotheses, we assessed the impact of knowledge management factors by indicating the most significant factors that should be used in state policy aimed at economic development by appropriate knowledge management.

In both research hypotheses, we selected the GNI per capita (gross national income per capita, US dollars; WBG, 2020) as the dependent variable Y, which is currently the basic indicator in international statistics that characterizes macroeconomic growth.

In order to select knowledge management indicators to assess their impact on economic growth, we analyzed the composition of international indices in this area (Table 1).

The choice of international indices is justified by a generally accepted approach (Mishchuk et al., 2016; Lestari and Hamka, 2018; Torres et al., 2018), according to which the main components of knowledge management are people, technologies, and processes. Therefore, we selected and analyzed international indices whose calculation methodology is based on indicators that correspond to the concept of knowledge management. Such indices include in particular the Global Knowledge Index, whose main purpose is to establish a comprehensive link between knowledge and sustainable development (UNDP, 2021). This approach seeks to help politicians, researchers, civil society, and business to jointly work to promote "knowledge-based development." At the same time, it seeks to provide people from an early age with the necessary skills for sustainable competitiveness in the labor market in the future.

However, our study used indices that aim to assess individual elements of knowledge management (e.g. ICT, innovation, skills, education, intellectual property). The use of such indices and sub-indices will detail the role of each of the components of knowledge management in economic growth.

The values of the independent and dependent variables were selected for the group of 20 EU countries for which such data were the most complete, i.e. the relevant factors were monitored according to the selected indices.

The obtained results were further used as a basis for substantiation of management decisions at different hierarchical levels, in particular on the feasibility of investing in different areas of knowledge management.

Table 1. International indices and sub-indices containing components
of knowledge management

Title	Coverage of countries	Components	Indicator	Symbol
The Global Competitiveness Index. 'Skills' Sub-Index (WEF, 2020)	141	Current workforce: mean years of schooling. Skills of current workforce: extent of staff training; quality of vocational training; skillset of graduates; digital skills among active population; ease of finding skilled employees. Future workforce: school life expectancy. Skills of future workforce: critical thinking in teaching; pupil-to-teacher ratio in primary education.	score	X_1
The Global Competitiveness Index. 'Innovation Capability' Sub-Index (WEF, 2020)	141	Interaction and diversity: diversity of workforce; state of cluster development; international co-inventions; multi-stakeholder collaboration. Research and development: scientific publications; patent applications; R&D expenditures; research institutions prominence. Commercialization: buyer sophistication; trademark applications.	score	X_2
The Digital Economy and Society Index (EC, 2020)	29	Connectivity; capital; use of internet services; integration of digital technologies; digital public services.	score	X_3
Global knowledge index (UNDP, 2019)	134	Pre-university education; technical, vocational education and training; higher education; research, development, and innovation; information and communication technologies; economy; general enabling environment.	value	X_4
Prosperity index. 'Education' sub-index (Legatum Institute, 2020)	167	Pre-primary education; primary education; secondary education; tertiary education.	score	X_5
The Social Progress Index. 'Foundations of Wellbeing' sub-index (The Social Progress Imperative, 2020)	149	Access to basic knowledge; access to info and comms; health and wellness; environmental quality.	score	X_6
Global Entrepreneurship Index. 'Entrepreneurial Abilities' Sub-Index (GEDI, 2020)	137	Opportunity startup; technology absorption; human capital; competition.	score	X_7
The Global Innovation Index (Cornell, INSEAD & WIPO, 2020)	129	Institutes; human capital and research; infrastructure; market sophistication; business sophistication; knowledge and technology outputs; creative outputs.	score	X_8

The Global Social Mobility Index. 'Lifelong Learning' Sub-Index (WEF, 2020)	82	Extent of staff training; active labor market policies; impact of ICTs on access to basic services; percentage of firms offering formal training; digital skills among active population.	score	X_9
The Global Connectivity Index (Huawei, 2020)	79	Four pillars in ICT: supply, demand, experience, potential.	score	X_{10}
International Intellectual Property Index (GIPC, 2020)	53	Patents, related rights, and limitations; copyrights, related rights, and limitations; trademarks, related rights, and limitations; design rights, related rights, and limitations; trade secrets and the protection of confidential information; commercialization of IP assets; enforcement; systemic efficiency.	score	X_{11}
The International Property Rights Index. 'Intellectual Property Rights' Sub-Index (Property Rights Alliance, 2020)	129	Protection of intellectual property rights; patent protection; copyright piracy.	score	X_{12}
The Global Skills Index (Coursera, 2020)	60	Business; technology; data science.	percent	X_{13}
The Hays Global Skills Index (Hays plc., 2020)	34	Education flexibility; labor market participation; labor market flexibility; talent mismatch; overall wage pressure; wage pressure in high-skill industries, wage pressure in high-skill occupations.	score	X_{14}
The Global Talent Competitiveness Index (INSEAD, 2020)	132	Input: enable, attract, grow, retain talents. Output: Vocational/Technical Skills (VT), Global Knowledge Skills (GK).	score	X_{15}
The Global AI Index (Tortoise, 2020)	54	Implementation: talent, infrastructure, operating environment. Innovation: research, development. Investment: government strategy, commercial.	score	X_{16}

Source: own elaboration.

We conducted the further identification of connections in accordance with the research hypotheses by the method of correlation analysis using the MS Excel software. In particular, we determined Pearson's correlations with a significance level of p-values of 0.95. The statistical significance of correlation coefficients was verified by standard rules: by comparing the critical and calculated values of t-statistics.

To use the assessed links in the practice of knowledge management, we also modeled the impact of factors on the GNI based on the use of the most significant links.

Results

The obtained results of the correlation-regression analysis proved the existence of a close relationship between the components of knowledge management and GNI per capita (WBG, 2020) (Table 2).

The results of the correlation analysis confirm the high importance of knowledge management in ensuring the economic growth of European countries, as the correlation coefficients exceed 0.7. Their statistical significance was checked using the Student's criterion (Table 2). The only exception is the Global AI Index, as its correlation coefficient is 0.461, and the calculated value of the Student's criterion is below critical. Let us note that this index contains components that are within the concept of knowledge management. In particular, the Global AI Index includes the Talent sub-index, which assesses the availability of qualified practitioners to provide artificial intelligence solutions, and the Research sub-index, which focuses on specialized research in artificial intelligence, the number of publications and citations in credible scientific journals. However, its main object of research is artificial intelligence, investment in its development, and its implementation (Tortoise, 2020). Therefore, from the calculations we can conclude that the introduction of artificial intelligence today cannot be perceived as a determinant of economic growth; its role is more pronounced in certain activities and in combination with the influence of other factors, such as the Global Connectivity Index. However, artificial intelligence as a separate factor has not yet played a decisive role in the formation of general macroeconomic results.

The most important factors at the present stage of world development for economic growth are the indicators considered as components of the Global Talent Competitiveness Index and the Global Connectivity Index with correlation coefficients of 0.939 and 0.935, respectively. The Global Talent Competitiveness Index examines the impact of technological change on talent competitiveness and confirms that – despite the trend of displacing jobs at all levels by machines – technology also creates new opportunities. The skills that are key to success are the ability to work with new technologies and with people, along with flexibility and collaboration (INSEAD, 2020). The Global Communications Index assesses the transformation of the digital economy as it constantly expands and updates its own methodology as innovation is implemented and promoted around the world. Currently, this index includes technologies such as broadband, cloud computing, AI, and the internet of things (IoT; Huawei, 2020). Therefore, the penetration of IT into all areas of activity will facilitate the creation and exchange of knowledge, as time and space barriers slowly disappear. Innovative technologies such as big data, machine learning, and cloud computing allow organizations to collect

Table 2. Results of correlation analysis of knowledge management relationship with the GNI per capita

	y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}
Austria	51300	79.4	74.5	54.3	64.7	83.01	87.41	65.1	50.9	73.2	65	*	8.434	97	5.9	68.87	23.6
Belgium	47350	79.3	71.4	58.7	64.8	83.57	87.29	67.4	50.2	68.0	65	*	8.195	93	3.9	68.87	17.6
Bulgaria	9410	67.9	45.0	36.4	48.3	74.78	75.3	26.5	40.3	52.9	51	*	5.687	*	*	45.76	*
Croatia	14910	63.5	37.8	47.6	50.6	73.64	80.88	31.8	37.8	48.4	50	*	4.791	*	*	43.53	*
Cyprus	27710	72.2	46.3	44.0	53.9	78.41	86.84	49.3	48.3	56.0	*	*	6.226	*	*	57.47	*
Czech Republic	22000	72.9	56.9	50.8	57.5	81.78	82.52	42.6	49.4	65.5	58	*	7.401	64	4.2	60.91	17.3
Denmark	63240	85.7	76.2	69.1	67.6	87.84	90.18	90.14	58.4	75.1	78	*	8.245	81	6.5	75.18	24.9
Finland	49580	85.7	75.8	72.3	69.7	86.58	89.25	64.6	59.8	78.0	75	*	8.903	100	*	74.47	26.6
France	42400	71.9	77.2	52.2	62.5	81.23	90.72	66.8	54.2	64.4	68	91.50	7.929	73	6.0	64.83	34.1
Germany	48520	84.2	86.8	56.1	64.6	83.24	87.70	68.2	58.2	69.6	69	91.08	8.292	90	6.5	72.34	35.3
Greece	20320	70.5	45.1	37.3	47.2	75.30	83.08	39.6	38.9	42.4	50	70.10	5.618	39	*	47.51	*
Hungary	16140	68.7	38.3	47.5	52.9	74.04	78.38	48.7	44.6	42.6	54	78.38	6.726	58	4.8	46.62	8.9
Italy	34460	70.4	65.5	43.6	56.2	80.29	88.64	40.5	46.3	40.2	57	83.18	6.768	63	4.8	52.91	20.9
Malta	27290	72.2	50.5	62.7	60.2	78.44	87.95	*	49.0	63.5	*	*	6.232	*	*	62.02	17.3
The Netherlands	53200	84.6	76.3	67.7	68.4	86.41	88.30	74.4	61.4	77.8	74	89.64	8.553	95	5.5	74.99	25.9
Poland	15200	72.1	49.7	45.0	54.1	78.94	81.00	47.2	41.3	49.4	51	*	6.129	56	4.1	49.48	22.4
Romania	12630	62.5	42.3	40.0	48.0	68.51	74.66	33.7	36.8	51.5	51	*	6.238	48	4.4	42.14	*
Slovakia	19320	69.9	46.3	45.2	54.0	73.58	80.97	40.5	42.0	56.5	53	*	6.676	*	*	52.08	*
Sweden	55840	83.7	79.1	69.7	69.1	84.36	89.88	77.1	63.7	78.3	81	90.56	8.369	88	6.4	75.82	23.7
United Kingdom	42370	81.9	78.2	60.4	67.5	84.88	89.05	82.63	61.3	66.2	74	93.92	8.472	78	5.4	72.27	43.7
Correlation coefficient		0.905	0.920	0.831	0.928	0.894	0.864	0.916	0.889	0.820	0.935	0.842	0.881	0.869	0.742	0.939	0.461
Student's criterion		9.05	9.96	6.33	10.56	8.46	7.28	9.41	8.24	6.08	10.54	3.82	7.90	6.33	3.67	11.58	1.79
The critical value		2.101	2.101	2.101	2.101	2.101	2.101	2.110	2.101	2.101	2.120	2.447	2.101	2.160	2.201	2.101	2.179
Significance $\alpha = 0.05$		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	–

* data unavailable.
Source: own elaboration.

and process vast amounts of data. Today, the key to success for many organizations is the speed with which they can integrate such knowledge into their existing business models/processes or share it with a wide range of stakeholders (UNDP, 2019). Thus, the obtained results confirm the decisive role of modern information technologies as the most important catalyst for long-term economic growth.

For a more detailed study of the impact of knowledge management on economic growth, testing hypothesis H1, we developed an appropriate economic and mathematical model using the built-in "Regression" function in the MS Excel software. This feature allows one to identify the mathematical relationship between the parameters of the model and then assess its statistical significance, adequacy, and suitability for practical use.

As a result of a step-by-step assessment of the impact of the parameters listed in Table 2 on GNI per capita based on a multifactor regression model, we identified the below three-factor model (1):

$$y = -137{,}793 + 0{,}85x_1 + 0{,}37x_2 + 1{,}003x_6 \qquad (1),$$

in which y is GNI per capita in USD; x_1 is the value of the 'Skills' sub-index in the Global Competitiveness Index (score); x_2 is the value of the 'Innovation Capacity' sub-index within the Global Competitiveness Index (score); x_6 is the value of the 'Fundamentals of Welfare' sub-index in the Index of Social Progress (score).

The main statistical indicators that confirm the statistical significance and adequacy of this model are shown in Table 3.

Table 3. Results of checking the adequacy of the economic–mathematical model on the main statistical indicators

No.	Indicators	Estimated value
1.	Multiple correlation coefficient	0.959
2.	Coefficient of determination	0.919
3.	F-statistics	60.67
3.1.	The critical value for this model, F	3.24
4.	t-statistics	
4.1.	x_1	2.51
4.2.	x_2	2.15

4.3.	x_3	2.41
4.4.	The critical value for this model, t	2.120

Source: own elaboration.

The obtained results of checking the adequacy of the model allow us to state that the constructed three-factor model is characterized by high theoretical capacity and is suitable for practical use.

To test hypothesis H2, we reduced the sample of countries to 13, according to the available data illustrating the development of skills (Table 2). As a result of assessing the impact of factors – namely international indices in the field of measuring modern skills – the below two-factor model emerged as the most statistically significant one (2):

$$y = -49,07 + 0,709x_{13} + 6,502x_{14} \qquad (2),$$

in which y is GNI per capita in USD; x_{13} is the Global Skills Index (percent); x_{14} is the Hays Global Skills Index (score).

The developed model is statistically significant and adequate, which is confirmed by the main statistical indicators (Table 4).

Table 4. Results of checking the adequacy of the economic-mathematical model on the main statistical indicators

№ з/п	Indicators	Estimated value
1.	Multiple correlation coefficient	0.937
2.	Coefficient of determination	0.879
3.	F-statistics	36.34
3.1.	The critical value for this model, F	4.1
4.	t-statistics	
4.1.	x_1	5.21
4.2.	x_2	2.75
4.3.	The critical value for this model, t	2.228

Source: own elaboration.

Thus, the calculated value of Fisher's criterion (36.34) is more than critical (4.1). The increase in GNI per capita by 87.9% stems from the influence of available skills in the population and only by 12.1% from the influence of other factors not accounted for in the model, as the coefficient of determination $R2 = 0.879$. The dependence of economic growth on current knowledge, skills, and abilities of the population is close and direct, as the coefficient of pair correlation is 0.937, i.e. with increasing value of international indices that assess the necessary skills in today's globalized world – GNI per capita increases. Therefore, skills are of paramount importance for economic growth in modern conditions.

Conclusion

Based on the analysis of data from the European Union, we can confirm the existence of a positive relationship between GNI per capita and knowledge management. At the same time, what is the most effective at the present stage are management actions aimed at developing skills (e.g. the ability to work with new technologies and with people, along with flexibility and cooperation), innovation capacity, access to information, and means of communication. Further development of such components of the knowledge management system will result in achieving the greatest economic efficiency based on the development of the knowledge economy.

The results of modeling these links suggest that to strengthen the competitiveness of countries, governments should support the development of information technology at a high level. It will also position the IT sector as a driver of innovation. However, investing in information technology alone is not enough to strengthen competitiveness and resilience in the digital economy. Without the skills and talents needed to use these technologies and stimulate innovation, countries risk losing their competitiveness, reducing investment attractiveness, and slowing economic growth. This approach is useful for the periodic assessment of changes in relationships and selection of these factors whose impact is the most significant at a certain stage of economic development.

A certain limitation of this and similar studies is the incomparability of some statistical information on the composition of individual indices, as the methodology for determining them is constantly improving. As a consequence, this study was conducted with the limitation of data available for analysis in the context of all dimensions of knowledge management. In particular, some comparable data were unavailable to test hypothesis H2 and develop an appropriate economic and mathematical model due to the fact that not all countries conduct appropriate monitoring, which narrows

the analytical base of the study. Nevertheless, provided that at least the most significant links are taken into account and aligned with national economic development priorities, regulatory action to improve knowledge management will be aimed at developing mechanisms that will best enhance the implementation of knowledge management systems at various levels of economic relations.

References

Adam, I.O. (2020). ICT development, e-government development, and economic development: Does institutional quality matter? *Information Technologies & International Development*, *16*, 1–19.

Akimova, L., Akimov, O., Maksymenko, T., Hbur, Z., Orlova, V. (2020). Adaptive management of entrepreneurship model as a component of enterprise resource planning. *Academy of Entrepreneurship Journal*, *26*(3), 1–8.

André Luhn, A., Aslanyan, S., Leopoldseder, Ch., Priess, P. (2017). An evaluation of knowledge management system's components and its financial and non-financial implications. *Entrepreneurship and Sustainability Issues*, *5*(2), 315–329. https://doi.org/10.9770/jesi.2017.5.2(11).

Askarian, M., Abdollahi, Ch. (2016). Determining the relationship between components of knowledge management and organizational citizenship behavior in experts' Science and Research Branch of Islamic Azad University. *European Online Journal of Natural and Social Sciences: Proceedings*, *5*(3), 135–144.

Atkociuniene, Z.O., Mikalauskiene, A. (2019). Knowledge Management Influence on Implementing Sustainable Development Means in the Organization. *Transformations in Business & Economics*, 18(3C (48C)), 546–564.

Azizi, R., Maleki, M., Moradi-Moghadam, M. and Cruz-Machado, V. (2016). The impact of knowledge management practices on supply chain quality management and competitive advantages. *Management and Production Engineering Review*, *7*, 4–12. https://doi.org/10.1515/mper-2016-0001.

Balcerak, A., and Woźniak, J. (2021). Reactions to some ICT-based personnel selection tools. *Economics and Sociology*, *14*(1), 214–231. https://doi.org/10.14254/2071-789X.2021/14-1/14.

Bannay, D.F., Hadi, M.J., and Amanah, A.A. (2020). The impact of inclusive leadership behaviors on innovative workplace behavior with an emphasis on the mediating role of work engagement. *Problems and Perspectives in Management*, *18*(3), 479. http://dx.doi.org/10.21511/ppm.18(3).2020.39.

Bilan Y., Mishchuk, H., Roshchyk, I., Joshi, O. (2020). Hiring and retaining skilled employees in SMEs: problems in human resource practices and links with organizational success. *Business: Theory and Practice*, *21*(2), 780–791. https://doi.org/10.3846/btp.2020.12750.

Bilan, Y., Mishchuk, H., Samoliuk, N., and Grishnova, O. (2019). ICT and Economic Growth: Links and Possibilities of Engaging. *Intellectual Economics*, *13*(1), 93–104.

Bogdan, T., Lomakovych, V. (2021). Financialization of the global economy: Macroeconomic implications and policy challenges for Ukraine. *Investment Management and Financial Innovations*, 18(1), 151–164. https://doi.org/10.21511/imfi.18(1).2021.13.

Boldeanu, F.T., Constantinescu, L. (2015). The main determinants affecting economic growth, *Bulletin of the Transilvania University of Braşov Series V: Economic Sciences*, *8*(57), 329–338.

Bolisani, E., Bratianu, C. (2018). The Emergence of Knowledge Management. In: *Emergent Knowledge Strategies*. *Knowledge Management and Organizational Learning, 4*, 23–47.

Bryl, Ł. (2018). Knowledge-intensive exports of CEE and developed nations – driven by foreign or domestic capital? *International Entrepreneurship Review*, *4*(3), 69–85. Obtained from: https://ier.uek.krakow.pl/index.php/pm/article/view/1761.

Chión, S. J., Charles, V., Morales, J. (2019). The impact of organisational culture, organisational structure and technological infrastructure on process improvement through knowledge sharing. *Business Process Management Journal (ahead-of-print)*. https://doi.org/10.1108/BPMJ-10-2018-0279.

Chlebisz, A., and Mierzejewski, M. (2020). Determinants of GDP growth in Scandinavian countries with special reference to scientific progress. *International Entrepreneurship Review*, *6*(3), 21–35. https://doi.org/10.15678/IER.2020.0603.02.

Cornell, INSEAD, WIPO (2020). *The Global Innovation Index 2019: Creating Healthy Lives – The Future of Medical Innovation*. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2019.pdf

Coursera (2020). *Global Skills Index 2019*. https://www.coursera.org/gsi.

Dinh, D.V. (2020). Comparison of the impact of lending and inflation rates on economic growth in Vietnam and China. *Banks and Bank Systems*, *15*(4), 193–203. https://doi.org/10.21511/bbs.15(4).2020.16.

EC (2020). *The Digital Economy and Society Index*. Obtained from: https://ec.europa.eu/digital-single-market/en/desi.

Fitri, H., Nugraha, A.T., Hakimah, Y., Manihuruk, C. (2019). Strategic management of organizational knowledge and competency through intellectual capital. *Polish Journal of Management Studies*, *19*(2), 132–141. https://doi.org/10.17512/pjms.2019.19.2.11.

GEDI (2020). The Global Entrepreneurship Index 2019. Obtained from: https://thegedi.org/wp-content/uploads/2021/02/2019_GEI-2019_final_v2.pdf.

GIPC (2020). U.S. Chamber International IP Index 2020. Obtained from: https://www.uschamber.com/report/2020-international-ip-index.

Grishnova, O., Cherkasov, A., Brintseva, O. (2019). Transition to a new economy: Transformation trends in the field of income and salary functions. *Problems and Perspectives in Management*, *17*(2), 18–31. https://doi.org/10.21511/ppm.17(2).2019.02.

Hadad, S. (2017). Knowledge economy: Characteristics and dimensions, *Management Dynamics in the Knowledge Economy*, *5*(2), 203–225. https://doi.org/10.25019/MDKE/5.2.03.

Haseeb, M., Hussain, H.I., Kot, S., Androniceanu, A., Jermsittiparsert, K. (2019). Role of social and technological challenges in achieving a sustainable competitive advantage and sustainable business performance. *Sustainability*, *11*(14), 3811. https://doi.org/10.3390/su11143811.

Hays plc. (2020). The Hays Global Skills Index 2019/2020. Obtained from: https://www.hays-index.com/.

Huawei (2020). Powering Intelligent Connectivity with Global Collaboration. Mapping your transformation into a digital economy with GCI 2019. Obtained from: https://www.huawei.com/minisite/gci/en/index.html.

Inkinen, H. (2016). Review of empirical research on knowledge management practices and firm performance, *Journal of Knowledge Management*, *20*(2), 230–257.

INSEAD (2020). The Global Talent Competitiveness Index 2020: Global Talent in the Age of Artificial Intelligence. Obtained from: https://gtcistudy.com/.

Ivanová, E., Čepel, M. (2018). The impact of innovation performance on the competitiveness of the Visegrad 4 countries. *Journal of Competitiveness*, *10*(1), 54. https://doi.org/10.7441/joc.2018.01.04.

Kalashi, M., Bakhshalipour, V., Azizi, B. and Sareshkeh, S.Kh. (2020). The Effect of the Application of ICT Skills on the Process of Knowledge Management Components and the Effectiveness of Creativity Indicators for the Improvement of Employees' Performance System in the Ministry

of Sports and Youth. *World Journal on Educational Technology: Current Issues*, *12*(1), 48–62. https://doi.org/10.18844/wjet.v12i1.4382.

Karpenko, O., Horbenko, A., Vovk, Y., and Tson, O. (2017). Research of the structure and trends in the development of the logistics market in Ukraine. *Journal Of Sustainable Development Of Transport And Logistics*, *2*(2), 57–66. https://doi.org/10.14254/jsdtl.2017.2-2.5.

Kianto, A., Vanhala, M. and Heilmann, P. (2016). The impact of knowledge management on job satisfaction, *Journal of Knowledge Management*, *20*(4), 621–636. https://doi.org/10.1108/JKM-10-2015-0398.

Kitrar, L., and Lipkind, T. (2021). The relationship of economic sentiment and GDP growth in Russia in light of the Covid-19 crisis. *Entrepreneurial Business and Economics Review*, *9*(1), 7–29. https://doi.org/10.15678/EBER.2021.090101.

Klimuk, V. (2019). Innovative tactics of industrial business in terms of economy digitalization: Case of the Republic of Belarus and the Russian Federation. *Economics, Management and Sustainability*, *4*(1), 58–65. https://doi.org/10.14254/jems.2019.4-1.6.

Klopova, O., Komyshova, L., Simonova, M. (2018). Professional development in the field of human resource management of heads and specialists of the innovative organizations. *Problems and Perspectives in Management*, *16*(1), 214.

Kostiukevych, R., Mishchuk, H., Zhidebekkyzy, A., Nakonieczny, J., and Akimov, O. (2020). The impact of European integration processes on the investment potential and institutional maturity of rural communities. *Economics and Sociology*, *13*(3), 46–63. https://doi.org/10.14254/2071-789X.2020/13-3/3.

Legatum Institute (2020). The Legatum Prosperity Index 2019. Obtained from: https://www.prosperity.com/rankings.

Lestari, A.S., Hamka, S.R. (2018). Analysis of the Components of Knowledge Management on the Postgraduate IAIN Kendari. *Advances in Social Science, Education and Humanities Research, 261*, 19–22. https://doi.org/10.2991/icie-18.2018.4.

Limba, T., Driaunys, K., Kiskis, M., Sidlauskas, A. (2020). Development of Digital Contents: Privacy Policy Model under the General Data Protection Regulation and User-Friendly Interface, *Transformations in Business & Economics*, *19*(1(49), 133–154.

Majid, M.B., Mahmud, M.S.B. (2019). Knowledge Management and its Impact on Organizational Performance: Evidence from Pakistan. *Annals of Contemporary Developments in Management & HR (ACDMHR)*, 1, 7–14.

Masa'deh, R., Almajali, D. A., Alrowwad, A. and Obeidat, B. (2019). The role of knowledge management infrastructure in enhancing job satisfaction: A developing country perspective. *Interdisciplinary Journal of Information, Knowledge and Management*, *14*, 1–25. https://doi.org/10.28945/4169.

Mishchuk, H., Bilan, Y. and Pavlushenko, L. (2016). Knowledge Management Systems: Issues in Enterprise Human Capital Management Implementation in Transition Economy. *Polish Journal of Management Studies*, *14*, 163–173.

Novikova, I., Stepanova, A., Zhylinska, O., Bediukh, O. (2020). Knowledge and technology transfer networking platforms in modern research universities. *Innovative Marketing*, 16(1), 57–65. https://doi.org/10.21511/im.16(1).2020.06.

Obeidat, B.Y., Al-Suradi, M.M., Masa'deh, R. and Tarhini, A. (2016). The impact of knowledge management on innovation: An empirical study on Jordanian consultancy firms, *Management Research Review*, *39*(10), 1214–1238. https://doi.org/10.1108/MRR-09-2015-0214.

OECD (1996). *Organization for Economic Cooperation and Development. The knowledge-based economy*. OCDE/GD (96) 102. https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=OCDE/GD%2896%29102&docLanguage=En.

Oliinyk, O. (2020). Social responsibility assessment in the field of employment (case study of manufacturing). *Scientific Bulletin of National Mining University*, *3*, 131–136. https://doi.org/10.33271/nvngu/2020-3/131.

Oliinyk, O., Bilan, Y., Mishchuk, H., Akimov, O. and Vasa, L. (2021). The Impact of Migration of Highly Skilled Workers on The Country's Competitiveness and Economic Growth. *Montenegrin Journal of Economics*, *17*(3), 7–19. https://doi.org/10.14254/1800-5845/2021.17-3.1.

Písař, P., Tomášková, A. (2020). The importance of social networks for the SME's innovation potential in Industry 4.0. *Innovative Marketing*, *16*(3), 48–61. https://10.21511/im.16(3).2020.05.

Podra, O., Litvin, N., Zhyvko, Z., Kopytko, M., Kukharska, L. (2020). Innovative development and human capital as determinants of knowledge economy. *Business: Theory and Practice*, *21*(1), 252–260. https://doi.org/10.3846/btp.2020.11305.

Polyakov, M., Khanin, I., Bilozubenko, V., Korneyev, M., Nebaba, N. (2020). Information technologies for developing a company's knowledge management system. *Knowledge and Performance Management*, *4*(1), 15–25. https://doi.org/10.21511/kpm.04(1).2020.02.

Poór, J., Juhász, T., Machová, R., Bencsik, A., and Bilan, S. (2018). Knowledge management in human resource management: Foreign-owned subsidiaries' practices in four CEE countries. *Journal of International Studies*, *11*(3), 295–308. https://doi.org/10.14254/2071-8330.2018/11-3/23.

Portna, O.V., Iershova, N.Y., Tereshchenko, D.A., Kryvytska, O.R. (2021). Economic Business Partnerships Within Industry 4.0: New Technologies in Management. *Montenegrin Journal of Economics*, *17*(1), 151–163.

Property Rights Alliance (2020). The International Property Rights Index 2019. Obtained from: https://www.internationalpropertyrightsindex.org/.

Raeeszadeh, S.F., Gilaninia, Sh., Homayounfar, M. (2016). The effects of knowledge management components on marketing performance: a case study of educational centers located across Guilan province. *Kuwait Chapter of Arabian Journal of Business and Management Review*, *5*(9), 23–31. https://doi.org/10.12816/0019415.

Roszko-Wójtowicz, E., Grzelak, M.M. (2020). Macroeconomic stability and the level of competitiveness in EU member states: a comparative dynamic approach. *Oeconomia Copernicana*, *11*(4), 657–688. https://doi.org/10.24136/oc.2020.027.

Rymarczyk, J. (2020). Technologies, opportunities and challenges of the industrial revolution 4.0: theoretical considerations. *Entrepreneurial Business and Economics Review*, *8*(1), 185–198. https://doi.org/10.15678/EBER.2020.080110.

Rymarczyk, J. (2021). The impact of industrial revolution 4.0 on international trade. *Entrepreneurial Business and Economics Review*, *9*(1), 105–117. https://doi.org/10.15678/EBER.2021.090107.

Sadeghi, A., Rad, F.M. (2018). The role of knowledge-oriented leadership in knowledge management and innovation. *Management Science Letters*, *8*, 151–160. https://doi.org/10.5267/J.MSL.2018.1.003.

Simplice A. Asongu, Kuada, J. (2020). Building knowledge economies in Africa: an introduction. *Contemporary Social Science*, *15*(1), 1–6. https://doi.org/10.2139/ssrn.3522820.

Social Progress Imperative (2020). Social Progress Index 2019. Obtained from: https://www.socialprogress.org/?tab=2&code=NOR.

Soniewicki, M., and Paliszkiewicz, J. (2019). The Importance of Knowledge Management Processes for the Creation of Competitive Advantage by Companies of Varying Size. *Entrepreneurial Business and Economics Review*, *7*(3), 43–63. https://doi.org/10.15678/EBER.2019.070303.

Suknunan, S., Maharaj, M. (2019). The role of knowledge management in institutional strategy development and competitiveness at leading African universities. *Knowledge and Performance Management*, *3*(1), 19–30. https://doi.org/10.21511/kpm.03(1).2019.03.

Takhtravanchi, M., Pathirage,C. (2018). Knowledge integration challenges and critical success factors within construction traditional procurement system. *Knowledge and Performance Management*, 2(1), 24–37. https://doi.org/10.21511/kpm.02(1).2018.03.

Torres, A.I., Ferraz, S.S., Santos-Rodrigues, H. (2018).The impact of knowledge management factors in organizational sustainable competitive advantage, *Journal of Intellectual Capital, 19*(2), 453–472. https://doi.org/10.1108/JIC-12-2016-0143.

Tortoise (2020). *The Global AI Index 2019*. Obtained from: https://www.tortoisemedia.com/intelligence/ai/.

Tvaronaviciene, M., and Burinskas, A. (2021). Internal funding determinants of R&D expenditures for U.S. mature firms. *Journal of International Studies*, *14*(1), 276–284. doi:10.14254/2071-8330.2021/14-1/19

Ulewicz, R., Blaskova, M. (2018). Sustainable development and knowledge management from the stakeholders' point of view. *Polish Journal of Management Studies*, *18*(2), 363–374. https://doi.org/10.17512/pjms.2018.18.2.29.

UNDP (2019). The Future of Knowledge: A Foresight Report 2019. Obtained from: https://knowledge4all.com/reports/Future_of_Knowledge_2019_English.pdf.

UNDP (2021). Global Knowledge Index – Methodology. Obtained from: https://knowledge4all.com/Methodology.aspx?language=en.

Ungerman, O., Dedkova, J., Gurinova, K. (2018). The impact of marketing innovation on the competitiveness of enterprises in the context of industry 4.0. *Journal of Competitiveness*, *10*(2), 132–148. https://doi.org/10.7441/joc.2018.02.09.

Van Dung, N., Hoai, N.T., Kien, N.S. (2017). Economic growth: The role of knowledge economy in the context of selected Asian countries. *Journal of Economic Development*, *24*(1), 4–29. http://doi.org/10.24311/jed/2017.24.1.06.

Vovk, I., Vovk, Y., and Lyashuk, O. (2017). Improvement of the organizational-economic mechanism of resource-saving at the machine building enterprise. *Economics, Management and Sustainability, 2*(2), 6–14. https://doi.org/10.14254/jems.2017.2-2.1.

WBG (2020). World Development Indicators database. https://databank.worldbank.org/data/download/GNIPC.pdf.

WEF (2020). *The Global Competitiveness Report 2019*. Obtained from: http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf.

WEF (2020). *The Global Social Mobility Report 2020. Equality, Opportunity and a New Economic Imperative*. Obtained from: http://www3.weforum.org/docs/Global_Social_Mobility_Report.pdf.

Wijaya, P.Y., Suasih, N.N.R. (2020). The effect of knowledge management on competitive advantage and business performance: A study of silver craft SMEs. *Entrepreneurial Business and Economics Review*, *8*(4), 105–121. https://doi.org/10.15678/EBER.2020.080406.

Yousif, N.B.A., Grondys, K., Gad, S., Elsayed, W. (2020). Knowledge management in non-governmental organizations (NGOs). *Administratie si Management Public*, *35*, 90–108. https://doi.org/10.24818/amp/2020.35-06.