THE ROLE OF HUMAN CAPITAL FOR ECONOMIC DEVELOPMENT IN A DIGITALIZED WORLD

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Abstract: The article is aimed at studying the features of the relationship between economic development, human capital and information and communication technologies. The panel sample includes data for 87 countries for 2019. The study uses the World Bank approach to classify countries to groups by income levels. The relationships between the analysed indicators are determined by groups based on the calculation of correlation coefficients. In addition, the paper presents a detailed spatial and graphical analysis of the indicators distribution by groups. The research shows that there are differences between the groups, both in the strength of the relationship and in the distribution of human capital development, digital technologies and GDP per capita. The article also analyses the relationship between GDP and the components of human capital and digital development. The study confirms the heterogeneity of economic development across countries and regions, highlighting differences across groups of countries depending on income levels.

Key words: economic development, human capital, digital development, economic growth

JEL: O1, E24.

DOI: https://doi.org/10.58861/tae.bm.2023.3.01

Introduction

Development issues are particularly relevant in the face of the shocks that have enveloped the global economic system in recent years. In a globalised and informatised world community, crises are also global. The high degree of the economy integration into the global society increases the risk of its dependence on fluctuations in economic activity. Instability is a kind

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of price to pay for integration and openness in the global economic system. The national economy cannot fully withstand the current global crises, but it can adapt to them. Sometimes a crisis brings new opportunities for growth and development. It is important to identify them in time.

Ensuring economic development, both in periods of recovery and recession, is an important challenge for any state. There are no ready-made methods or models for this, as the business environment is constantly changing. However, the patterns identified from past experience can be the basis for decision-making in a changing environment. In this context, it is important to determine the factors for ensuring economic development, their changes in the country and regional aspect, the possibilities of managing and influencing them.

Natural resources, a warm climate, the country's convenient geographical location and rich mineral resources are all important for economic development. But if we look at the example of the most economically developed countries, we can see that they do not have such resources enough. In the digital economy, the resource-material components of success fade into the background, giving way to people and technology. The key to a country's economic prosperity is a highly skilled workforce coupled with the latest information, communication and knowledge-based technology. Therefore, the relevance of providing opportunities for the realization of human abilities in the information age is increasing.

Literature review

Issues of determining the contribution of human resources to economic development in the digital age have not been overlooked by scholars. For example, Acheampong et al. (2022), using data from 79 countries over the period 1990-2018 in a study of human development in developing countries, found that ICT elements such as the spread of mobile broadband and Internet access have the greatest impact on human development. Azam et al. (2021) identified a unidirectional causal relationship from human development to information and communication technologies using developing country case studies. Economic growth has a fairly strong positive impact on human development. Stryzhak (2022), based on a sample of 131 countries, determined that there is a relationship between human capital and digital technologies, but it is uneven from country to country. Mijatović et al. (2020) note that the implementation of digital technologies in industrial firms'

practices improves the efficiency of human resource management, which ultimately contributes to the productivity of firms by increasing their flexibility. Both the spread of ICT and economic growth have a significant positive impact on sustainable human development, by which Verma et al. (2022) mean environmentally adjusted human capital development. Mukhuty et al. (2022) point out that human resource management can be a factor for sustainable development in the context of Industry 4.0.

Most studies confirm the positive impact of human capital on development. Krasnonosova et al. (2022) argue that the reproduction of human capital contributes to the achievement of sustainable development goals. The importance of implementing territorial sustainable development strategies that take into account the specifics of human capital reproduction is highlighted. Mohamed et al. (2022) focus on the importance of transition from a resource-based to a knowledge-based economy, using Qatar as an example. It is concluded that effective promotion of human development is necessary to ensure sustainable development.

Business and societal sustainability depends on intellectual human capital (Amran et al., 2021). Gennaioli et al. (2013) identified the paramount importance of human capital in regional economic development based on data from 110 countries. Anand and Sen (2000) highlight the importance of human development as a means of ensuring equal opportunities. Raising the level of education for the low-income segments of the population would increase productivity and entail higher incomes in the future.

Nevertheless, scholars note that the relationship between human capital and economic development indicators is uneven across countries and regions. Thus, Wielechowski et al. (2021) investigated the relationship between economic development and the determinants of human capital in the Czech and Polish regions for 2004-2019. The analysis showed uneven development of regional clusters in terms of GDP. The study also found a relationship between GDP and the determinants of human capital in Poland and the Czech Republic. He and Yao (2022), based on an analysis of data from 30 Chinese provinces for 2008-2019, identified the impact of the structure of human capital on the quality of economic development, but this effect is uneven.

At the same time, the manifestations of human capital carry not only positive externalities but also negative ones. For example, Ahmed et al (2021) note that human capital has a negative impact on the environment. Moreover, there is a strong correlation between human capital and ICT. Economic growth worsens the state of the environment.

Odugbesan and Rjoub (2019) have found a negative long-term relationship between human capital and sustainable development for Sub-Saharan Africa.

It should also be stressed that human capital can also influence economic development indirectly, for example by stimulating investment. For example, Fagbemi and Osinubi (2020) identify the quality of human capital that matters in investment decisions, using Nigeria as a case study from 1981-2018. Researchers have found a unidirectional causal relationship between human capital and investment over the long term, while the impact of FDI on human capital has turned out to be insignificant.

It is also worth looking at the important manifestation of human capital in terms of reducing inequalities in society. Castells-Quintana et al. (2019) concluded from analysis of panel data from 117 countries over 1970-2010 that the relationship between human development and inequality is negative in the long run. In the short term, there is a positive relationship between inequality and economic development and a negative one between inequality and educational outcomes.

A highly skilled workforce increases the efficiency of economic development. However, the development of capabilities accumulated in human capital can contribute to economic development if conditions for their realisation are created. Investments in R&D and the growth of knowledge-intensive manufacturing contribute to some extent to this. As noted, human capital in interaction with R&D has a significant impact on GDP growth in both the short and long term (Park, 2018).

States are faced with the need to revise the concept of development in a digital context in formation of a new world information order. Humanity is immersed in the digital age. These objective changes determine the importance of assessing the relationship between economic, human and digital aspects of development. In this context, the issues of determining the relationship between economic development, human capital and information, and communication technologies are relevant and timely.

Methodology and research methods

The theoretical framework of the study is based on a bibliographic analysis of the literature. The research methodology includes calculation of Pearson, Spearman's rank and Kendall's Tau correlation coefficients to

examine the relationship between the indicators. The article applies the World Bank's approach to categorise countries into income groups. The author uses graphical analysis methods to visualise the results of the study, including the distribution of indicators in three-dimensional space and the construction of scatter diagrams. The author carries out the calculations in the study using the Statistica application package.

Results

The basic idea behind the concept of sustainable economic development is that development should not come at the expense of future generations. The consumption of resources for economic growth should not lead to their exhaustion. However, development is a rather relative term, as it is almost impossible to determine a particular country's measure or degree of development. To a certain extent, this is a conditional indicator, which implies a balance of development according to the main criteria for its evaluation. And while the economic aspect of development is relatively straightforward to determine using various GDP indicators, the social aspects of development, for example, are rather subjective.

Despite the fact that non-economic aspects of development are important, in this study we will focus on the economic point of development as it reflects the objective side of development and, expressed as GDP in monetary terms, is an indicator that allows for an objective comparison of economic development across countries and regions.

Since the level of GDP ultimately determines the level of other economic indicators, such as price level, inflation rate, unemployment rate, labour productivity, etc., this study uses GDP per capita as the indicator that best reflects the state of economic development in the country. Of course, other economic indicators are also important, but they are secondary to GDP and some of them, for example, quality of life, competitiveness of the economy, cost of living, minimum wage, etc. include a subjective component and differences in the methodology of calculation across countries, so it is difficult to use such indicators for cross-country comparison.

This research uses the Human Capital Index (HCI) to assess the quality of human resource development. HCI is an indicator measured by the World Bank that reflects the level of human capital development in different countries (World Bank, 2020). The index is the geometric mean of the three standardised components - Survival, Schooling (quantitatively and

qualitatively) and Health. The index takes on a value between 0 and 1, where 1 is the reference value. The use of HCI in the article is due to the fact that the index captures the forecasts of future incomes of countries and their citizens based on the expected labour productivity, taking into account the contribution of the health and education system to the productivity of future workers.

This study proposes to use the Digital Intelligence Index (DII) as an indicator of digitalization. DII is an indicator of the digitalization of society that assesses the degree of digital development in 90 countries around the world. 160 standardised indicators first form clusters on 35 aspects of digitalization, and then are combined into four key factors of the index: Supply Conditions (SC), Demand Conditions (DC), Institutional Environment (IE), and Innovation and Change (IC). The best index value is taken as 100, the worst as 0.

The World Bank distributes countries into groups according to income levels; it seems appropriate to determine the features of the relationship between the indicators. Based on this approach, countries are divided into three groups:

1) high-income countries;

2) upper-middle-income countries;

3) lower-middle-income and low-income countries (combined into one group due to the small number of the latter).

The study uses data for 2019, since this year is the last year for which there is information on all analysed indicators.

The initial stage of the analysis consists of calculating Pearson correlation coefficients. Table 1 presents the correlation coefficients by groups.

Table 1 shows that there are differences across groups of countries. In the group of upper-middle-income countries, the relationship between indicators is not strong enough. However, the correlation between GDP and HCI is strong in the lower-middle-income and low-income groups, suggesting the importance of human capital for economic growth in these countries. There is also a fairly strong relationship between DII and HCI in this group. Meanwhile, the group of high-income countries has the strongest correlation between GDP and DII, which shows the importance of digital technologies in providing the basis for economic development. There is also a residually strong correlation between DII and HCI, indicating the important role of digitalization for all spheres of society, including the social. The relationship between the indicators is direct positive in all cases.

Table 1.
Descriptive statistics and Pearson correlation coefficients by groups

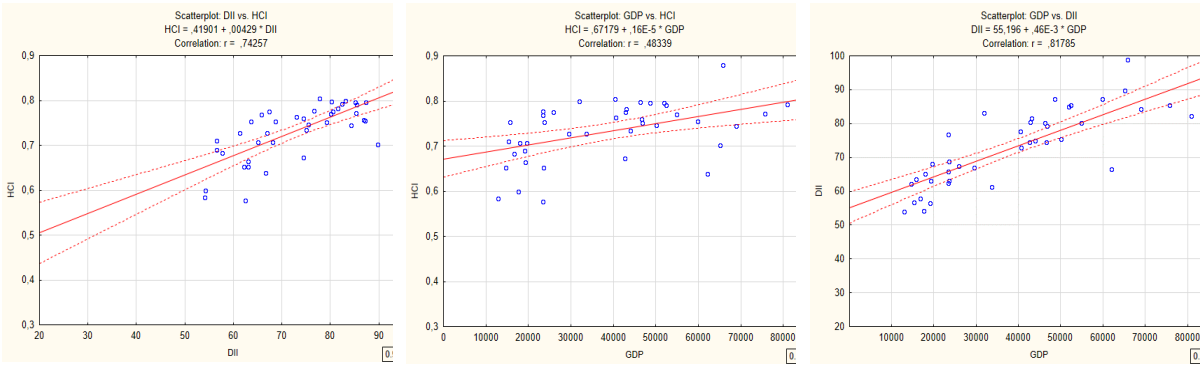
Variable	Mean	Standard Deviation	HCI	DII	GDP
High income group (N=41) Australia, Austria, Bahrain, Belgium, Canada, Chile, Croatia, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Netherlands, New Zealand, Norway, Poland, Portugal, Qatar, Romania, Saudi Arabia, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States, Uruguay					
HCI	0.73	0.06	1.000000	0.742570	0.483393
DII	73.34	11.22	0.742570	1.000000	0.817855
GDP	39573.79	20020.87	0.483393	0.817855	1.000000
Upper middle income group (N=24) Argentina, Azerbaijan, Bosnia & Herzegovina, Brazil, Bulgaria, China, Colombia, Costa Rica, Ecuador, Georgia, Indonesia, Iran, Jordan, Kazakhstan, Lebanon, Malaysia, Mexico, Namibia, Peru, Russia, Serbia, South Africa, Thailand, Turkey					
HCI	0.588	0.062	1.000000	0.354408	0,523569
DII	49.414	7.084	0.354408	1.000000	0.502500
GDP	7722.658	2614.702	0.523569	0.502500	1.000000
Lower middle and low income group (N=22) Algeria, Bangladesh, Cambodia, Cameroon, Côte d'Ivoire, Egypt, Ethiopia, Ghana, India, Kenya, Laos, Morocco, Nigeria, Pakistan, Philippines, Rwanda, Sri Lanka, Tanzania, Tunisia, Uganda, Ukraine, Vietnam					
HCI	0.476	0.089	1.000000	0.702358	0.761129
DII	37.159	7.044	0.702358	1.000000	0.501835
GDP	2361.672	1040.320	0.761129	0.501835	1.000000

Source: Author's calculation
Note: Significant correlations are highlighted in red.
Marked correlations are significant at p < ,05000
GDP - GDP per capita (current US$)

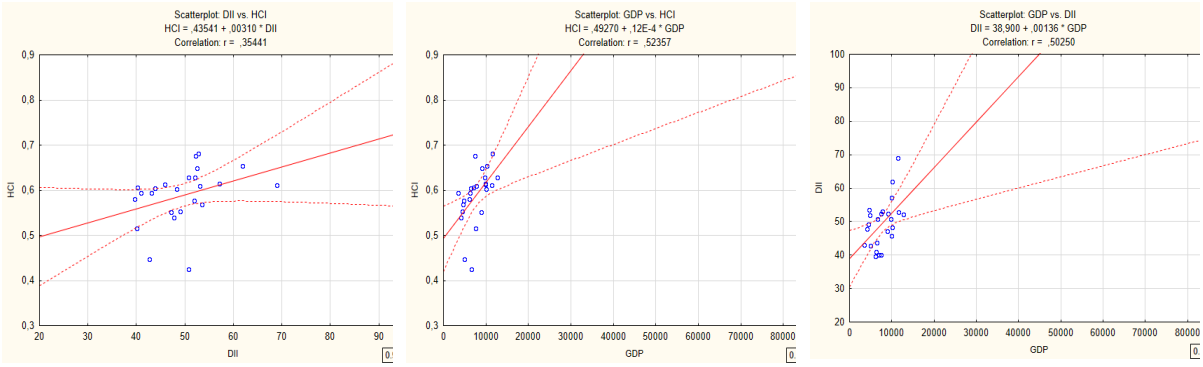
Thus, we can note the fact that there is a moderate and strong relationship between indicators in low-income countries. The correlation is stronger in high-income countries. In middle-income countries, the correlation is much weaker.

The visualisation of the correlation relationship, which is presented in the graphs (Figure 1), makes it possible to compare the distribution of the analysed variables across groups. For ease of comparison, data scales for all indicators are scaled to the same interval.

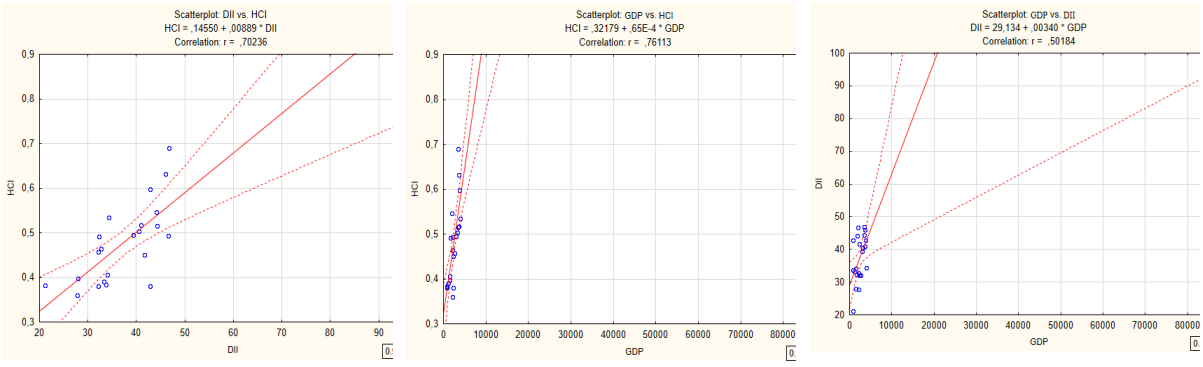
High income country group



Upper middle income country group



Low income and lower middle income country group



Source: Author's calculation

Figure 1. Relationship between GDP, HCI and DII by country groups

However, not only the strength of the relationship between the indicators, but also its nature varies by groups. Fig. 1 illustrates this well. The distribution of indicators is more homogeneous in groups of middle-income countries. The indicators are quite concentrated in space, despite the low correlation between them. This may be due to similar development conditions in these countries.

The graphs show that the greatest variation is in the space between indicators in high-income countries. This may indicate different directions of income distribution across countries. While some countries focus on the human capital development, others prioritise the expansion of information technologies. These factors determine economic development in modern conditions, and the high level of GDP in this country group convincingly confirms this.

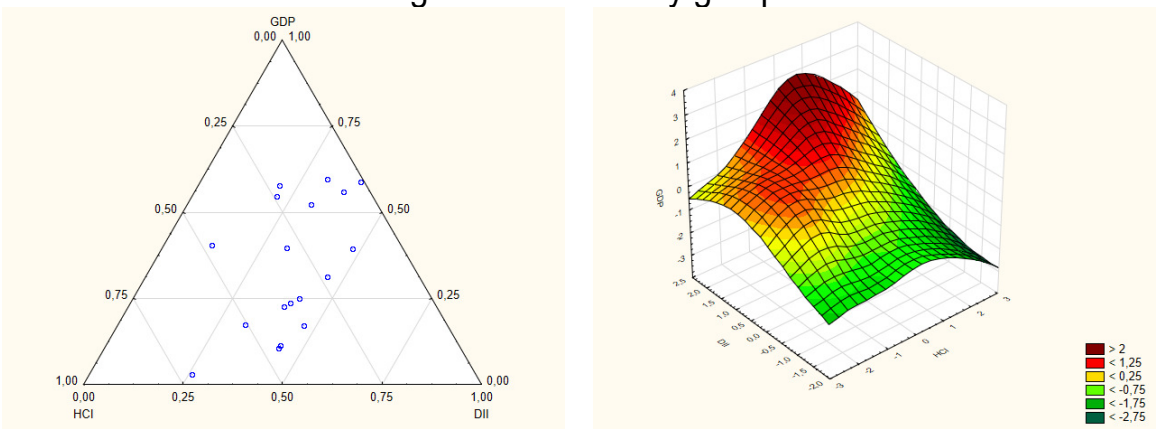
Further analysis involves a detailed consideration of the indicators in each group. Analysis of the distribution of the indicators requires making them comparable, so the standardisation procedure has been applied to the indicators. The distribution of the standardised indicators in the three-dimensional space (see Figure 2) gives reason to conclude that not only the income level determines the differences between groups of countries. Human capital development and digital development indicators also have different distributions. The state socio-economic policy should take this fact into account. This analysis shows that recommendations that have proved effective in developed countries may not work in developing countries. Both low- and middle-income countries therefore need to design their own development strategies in line with their specific socio-economic situation.

The next stage of the study is to analyse the relationship between components of DII and HCI and GDP. The results of the correlation analysis are presented in Table 2 (see Table 2).

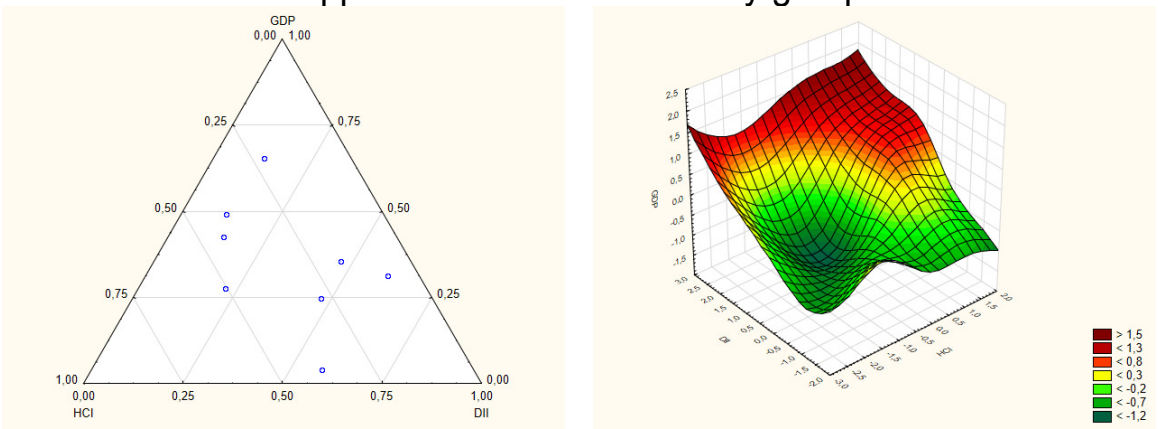
Since Spearman and Kendall correlation coefficients are usually used for small sample sizes (as in this case), the table presents Pearson's coefficient for comparing the results of the analysis.

Ternary plot for both HCI and DII and GDP (HI)	3M Surface plots for GDP; HCI and DII GDP = Distance Weighted Least Squares

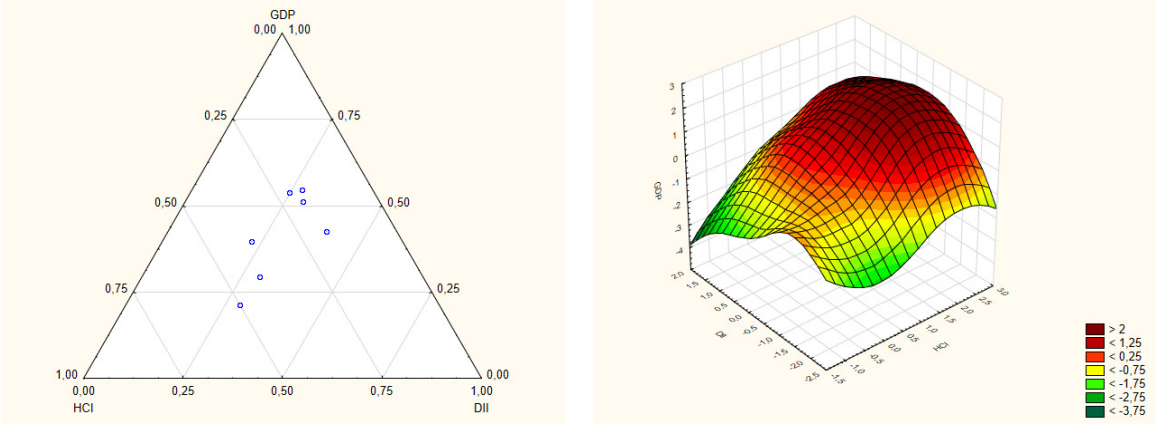
High income country group



Upper middle income country group



Low income and lower middle income country group



Source: Author's calculation

Figure 2. Distribution of GDP, HCI and DII by country groups

Table 2.
Relationship between GDP and DII and HCI components by groups

Variable	Mean	Standard Deviation	Pearson Correlations	Spearman Rank Order Correlations	Kendall Tau Correlations
High income group (N=41)					
SC	77.08	10.37	0.768378	0.804355	0.617073
DC	83.17	11.28	0.695559	0.741234	0.572300
IE	72.46	13.26	0.761231	0.789199	0.585366
IC	53.42	14.49	0.792714	0.819112	0.623551
PSA5	1.00	0.00	0.290165	0.387805	0.268293
EYS	13.38	0.49	0.373446	0.368118	0.263415
LAYS	10.74	1.05	0.386255	0.387456	0.268293
ASR	0.93	0.03	0.592724	0.678920	0.492683
Upper middle income group (N=24)					
SC	53.241	7.885	0.564319	0.582609	0.413043
DC	54.958	10.843	0.526916	0.550435	0.384058
IE	42.418	11.223	0.077133	0.007826	-0.007246
IC	34.339	9.340	0.391927	0.385217	0.297101
PSA5	0.986	0.009	0.507189	0.567826	0.391304
EYS	12.299	1.109	0.432899	0.473913	0.340580
LAYS	8.362	1.143	0.516657	0.673913	0.478261
ASR	0.868	0.060	0.105780	0.026957	0.014493
Lower middle and low income group (N=22)					
SC	35.285	10.186	0.742817	0.661208	0.463203
DC	34.100	10.657	0.352875	0.370977	0.229437
IE	33.856	12.516	-0.025380	-0.142857	-0.073593
IC	28.885	7.294	0.445723	0.378882	0.290043
PSA5	0.958	0.027	0.522379	0.653303	0.463203
EYS	10.289	2.040	0,842056	0.823828	0.670996
LAYS	6.403	1.791	0,721574	0.713156	0.558442
ASR	0.814	0.076	0,529750	0.544890	0.350649

Source: Author's calculation
Note: Significant correlations are highlighted in red.
Marked correlations are significant at p < ,05000
GDP - GDP per capita (current US$);
PSA5 - Probability of Survival to Age 5;
EYS - Expected Years of School;
LAYS - Learning-Adjusted Years of School;
ASR - Adult Survival Rate.

The interpretation of the values obtained as a result of the analysis suggests, in the case of the Spearman correlation coefficient, to compare the result with the generally accepted value of the indicator. The level of strength of the nexus between the variables is considered strong if $\rho > 0.75$ and moderate if $\rho > 0.5$.

In the case of the Kendall tau correlation, the interpretation of the results of the analysis involves calculating a critical point using the formula:

$$T_{cr} = z_{cr}\sqrt{\frac{2(2n+5)}{9n(n-1)}}$$

where: n - sample size;

zcr - the critical point of the bilateral critical region, which is determined from the Laplace function table.

According to the Laplace function table zcr = 1.96.

The critical point value was calculated for each group of countries:

$$T_{crHIgroup} = 1.96\sqrt{\frac{2(2\times 41+5)}{9\times 41(41-1)}} = 0.21;$$

$$T_{crUMIgroup} = 1.96\sqrt{\frac{2(2\times 24+5)}{9\times 24(24-1)}} = 0.29;$$

$$T_{crLM\&LIgroup} = 1.96\sqrt{\frac{2(2\times 22+5)}{9\times 22(22-1)}} = 0.30.$$

Next, the results of the calculations have to be compared with Tcr by groups.

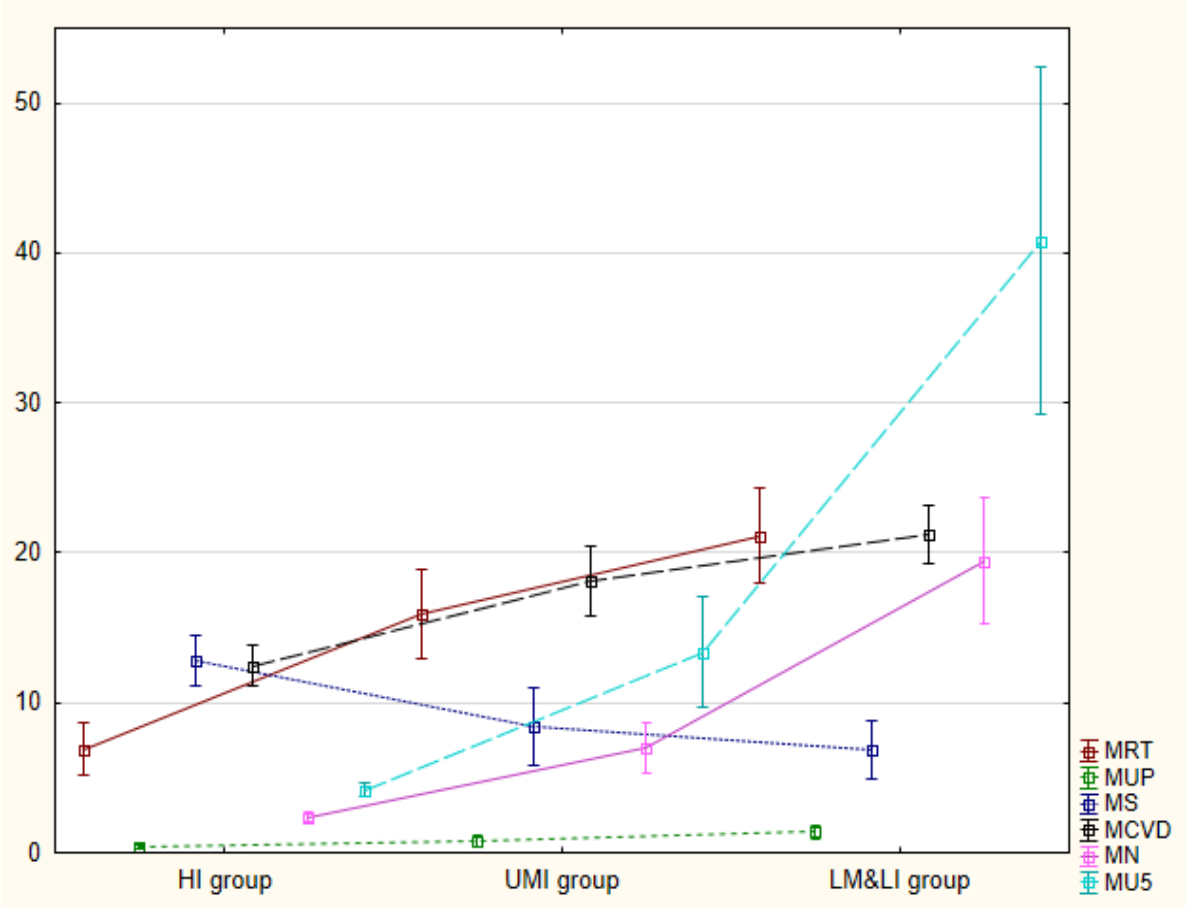
When τ > Tcr the tau Kendall correlation is considered significant, respectively when τ < Tcr the relationship is considered insignificant. The next step is to compare the calculated values of τ with Tcr. Significant correlations are highlighted in red in Table 2.

Table 2 shows that there is a strong relationship between GDP and the DII and HCI components in the high-income group. The exception is the PSA5 indicator, which has a perfectly logical explanation, namely that high income levels in countries tend to result in lower child mortality rates. This is confirmed by the increasing value of the correlation coefficient for these indicators in the groups as income levels decrease. The relationship between the other sub-indices and GDP is observed in most cases.

The relationship between GDP level and the institutional environment, innovation and change, and survival is not present in the group of middle-income countries. This indicates that other factors in these countries are

driving economic development. The situation is similar in the group of low-income countries. While such a link is found in high-income countries. The results of the analyses presented in Table 2 show that there are also some differences between the values of the Spearman and Kendall correlation coefficients. This is due to the methodology of their calculation.

The next stage of the study is an analysis of mortality rates by groups, which is necessary to assess the potential of human capital as the basis for ensuring future economic development. For this purpose, the article uses scatter diagrams, which display not only the mean values but also the interval values of the indicators by groups (Fig. 3).



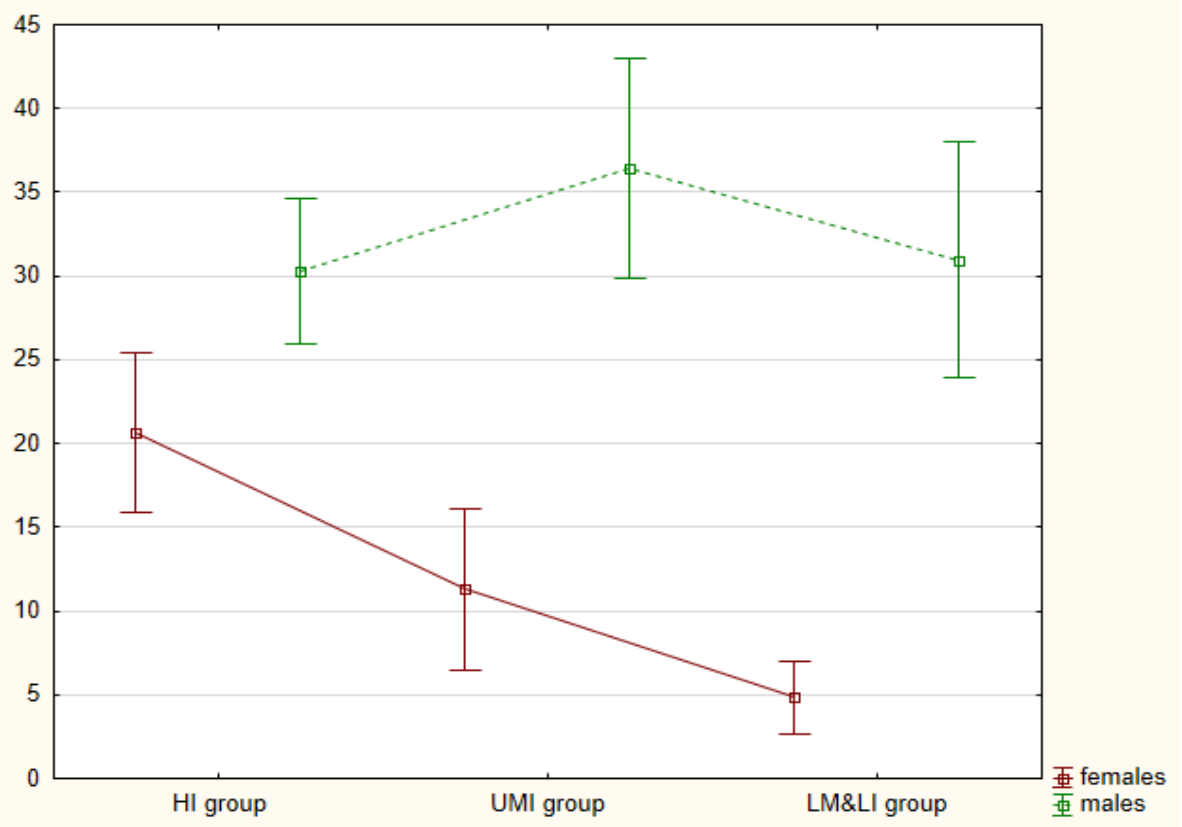
Source: Author's calculation

Note:

MRT - Mortality caused by road traffic injury (per 100,000 population);
MUP - Mortality rate attributed to unintentional poisoning (per 100,000 population);
MS - Suicide mortality rate (per 100,000 population);
MCVD - Mortality from CVD, cancer, diabetes or CRD between exact ages 30 and 70 (%);
MN - Mortality rate, neonatal (per 1,000 live births);
MU5 - Mortality rate, under-5 (per 1,000 live births).

Figure 3. Mortality by groups

As can be seen from the figure, mortality rates are declining as countries' incomes rise. But there is one exception - this is the increase in the number of suicides as well-being grows. The significant increase in child mortality after age 5 in low-income countries, linked to poor quality of life, lack of health care, etc., is a cause for concern. Assessing future human capital also involves comparing the share of smoking men and women by country groups (Fig. 4).



Source: Author's calculation
Note:
females - % of female adults;
males - % of male adults.

Figure 4. Prevalence of current tobacco use by groups, %

Fig. 4 shows that the proportion of smoking women increases with growing income in society. At the same time, there is no such pattern in the case of men. For men, the highest share of smokers is observed in middle-income countries. This distribution of values indicates that income is not a determinant of smoking. However, this fact may indicate gender differences in the demand for other goods and services, which may be accepted as a prerequisite for further researches.

Conclusions

This study confirms the heterogeneity of economic development across countries and regions, highlighting the differences by income groups. Quite predictably, it turned out that high-income countries show a strong positive relationship between GDP and human capital development and digital development indices. Moreover, there is no such linkage in middle-income countries and it is re-emerging in low-income countries.

The study concludes that economic development is possible only if human resources and information technology are developed. But the research also reveals certain dependencies that are not determined solely by the level of income in the country. For example, as income rises, suicide rates increase. The situation with smoking is also ambiguous, as tobacco consumption does not depend on welfare level. Consequently, income growth in a society can cause both positive and negative externalities. And while the issue with positive externalities lies in financing certain areas of development, the problem with negative externalities is much more complex because economic factors are not determinative in this case.

Discussion

The development of any state has its own peculiarities. However, there are certain patterns that allow a country to use ready-made recommendations rather than applying a trial-and-error method. The identification of patterns allows to unify measures of influence on certain areas in order to improve the specified indicators.

Development tends to involve investment. And while developed economies can finance a large number of development directions, for developing countries with limited financial capacity, choosing one area of development finance often means refusal to fund others. Therefore, it is very important for low-income countries to choose key development paths to form the basis for long-term economic development. Based on the results of this study, low- and middle-income countries should focus on indicators of digital development, such as the institutional environment, innovation and changes.

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ISSN 0861 - 6604
ISSN 2534 - 8396

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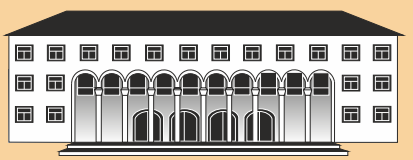

PUBLISHED BY
D. A. TSENOV ACADEMY
OF ECONOMICS - SVISHTOV

3/2023

BUSINESS management 3/2023

The printing of the issue 3-2023 is funded with a grand from the Scientific Research Fund, Contract KP-06-NP4/75 /16.12.2022 by the competition "Bulgarian Scientific Periodicals - 2023".

Submitted for publishinq on 21.09.2023, published on 28.09.2023,
format 70x100/16, total print 80

BUSINESS management

D. A. Tsenov Academy of Economics, Svishtov

Year XXXIII * Book 3, 2023

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